



Providing a Corrective Subsidy to Insurers for Success in Reducing Traffic Accidents

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**PROVIDING A CORRECTIVE SUBSIDY TO INSURERS FOR SUCCESS
IN REDUCING TRAFFIC ACCIDENTS**

Noam Noked*

This paper presents the concept of a corrective subsidy that would be paid to insurers for a reduction of traffic accidents of their insured drivers. Insurers can take socially desirable measures to reduce traffic accidents. However, under current conditions, a large portion of the social benefit from the potential reduction would not be internalized by the insurers. Sharing the social gain from the actual reduction with the insurers may align insurers' incentives with social goals of reducing social waste from accidents.

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1. Introduction

The damages from traffic accidents per year in the US alone range from 231 to 433 billion dollars,¹ of which approximately 100 billion dollars are covered by insurance.² A large share of these damages can be avoided with a cost of prevention lower than the potentially prevented damage. In other words, under the current conditions, there is inefficient social waste from traffic accidents. This social waste is probably the result of the sub-optimal behaviors of the principal actors involved: drivers, insurers and the government.

Drivers cause inefficient traffic accidents for different reasons, such as optimism and above-average biases that lead to excessive risk-taking, lack of information, social norms of bad driving,³ moral hazard for the damages covered by insurance⁴ and externalization of some of the damages that are not borne by the risk creating drivers.⁵ Although the deterrence achieved by enforcement of traffic laws may mitigate these behavioral inefficiencies to some extent, this solution is probably not complete if the level of deterrence is not optimal and if there are inefficient behaviors which cannot be prevented by enforcing traffic laws.⁶

Arguably, governments also do not employ the optimal measures to reduce inefficient traffic accidents. The problem of traffic accidents is not sector specific and it is typically not in the front line of political and public attention. Although usually there are no political forces that oppose reducing traffic accidents, it might be difficult to create a political coalition for prioritizing this issue in resources allocation. This, as well as other reasons, such as political difficulties in taking unpopular measures, leads in many cases to underfunded enforcement, sub-optimal regulation and insufficient public goods that promote safety.

¹ The different estimations are elaborated in chapter 2.

² See Aaron S. Edlin and Pinar Karaca-Mandic, *The Accident Externality from Driving*, 114 J. POL. ECON. 931, 933 (2006); Daniel P. Kessler and Daniel L. Rubinfeld, *Empirical Study of Civil Justice Law*, in 1 HANDBOOK OF LAW AND ECONOMICS, 358 (A. Mitchell Polinsky and Steven Shavell eds., 2007).

³ See Tom Vanderbilt, *TRAFFIC* 51-73, 211-230 (2008).

⁴ See J. David Cummins, Richard D. Phillips and Mary A. Weiss, *The Incentive Effects of No-Fault Automobile Insurance*, 44 J. L. and Econ. 427 (2001); Alma Cohen and Rajeev Dehejia, *The Effect of Automobile Insurance and Accident Liability Laws on Traffic Fatalities*, 47 J. L. & ECON. 357 (2004)

⁵ See William Vickrey, *Automobile Accidents, Tort Law, Externalities, and Insurance: An Economist's Critique*, 33 LAW AND CONTEMPORARY PROBLEMS 464 (1968); Erik Verhoff, *External Effects and Social Costs of Road Transport*, 28A-4 TRANSP. RES. 273, 284-286 (1994); Gunnar Lindberg, *Traffic Insurance and Accident Externality Charges*, 35-3 J. TRANSP. ECON. & POL'Y 399-416; Aaron S. Edlin, *Per-Mile Premiums for Auto Insurance*, in ECONOMICS FOR AN IMPERFECT WORLD: ESSAYS IN HONOR OF JOSEPH E. STIGLITZ 53 (Richard Arnott, Bruce Greenwald, Ravi Kanbur and Barry Nalebuff eds., 2003); Edlin and Pinar Karaca-Mandic, *supra* note 2.

⁶ Examples of behaviors that cannot be easily prevented by enforcing traffic laws include inattentive driving, driving while the driver is tired, excessive driving (i.e., higher than optimal activity level), etc.

In addition, insurers do not have an incentive to reduce the accidents of their insured drivers to the socially optimal level since their self interest is not aligned with the social interest. *First*, a risk reduction does not necessarily result in higher long-term profits for insurers. *Second*, even if we assume that insurers do benefit from the accident reduction, the externalities of driving lead to the situation where an insurer bears the full cost of the measures taken to reduce accidents, while it enjoys only a part of the positive effect of preventing the inefficient accident.⁷ Similarly, since they fund only approximately 100 billion dollars of the social damages ranging from 231 to 433 billion dollars insurers do not have an incentive to prevent an accident when the cost of prevention exceeds the expected insurance liability. These factors result in unnecessary social waste.

In this paper, I suggest incentivizing insurers to take measures to reduce accidents by letting them share the social gain from the actual reduction. Setting this mechanism of sharing the social gain, by providing corrective subsidies for insurers on the basis of success in reducing accidents, may align insurers' incentives with social goals of reducing accidents. An insurer's "success" in reducing accidents would be defined as a reduction in accidents caused by drivers insured by a particular insurer over a period of time. The reduction should be measured in a way that accounts for the differences between insured populations in different companies. This may be achieved if the reduction is measured in comparison to the baseline of the current risk expected of drivers in different risk categories. If an insurer shows a significant reduction in the number of accidents, compared to the expected number of accidents, the government will award him a grant that represents a share of the social-cost-saved.⁸

Insurers can affect drivers' behavior, the demand for safety technologies and government decision-making. Insurers can affect drivers' decisions and behaviors by using the contractual relations they have with the insured and insured-to-be drivers. These relations can be used to internalize current negative externalities created by drivers, to enhance education and knowledge of drivers that may reduce excessive and irrational risk-taking, to promote the use of cost-effective safety equipment and safer cars, and to willingly impose private enforcement systems on drivers.

⁷ See Edlin, *supra* note 5, at 54-57; Edlin and Pinar Karaca-Mandic, *supra* note 2, at 954.

⁸ It is also possible to impose a penalty/tax on insurers when there is an increase in the number of accidents compared to the expected number of accidents.

Insurers are able to increase the demand for new technological developments that can effectively reduce traffic accidents. More informed drivers and contractual requirements for safety devices may increase the demand for the most effective safety equipment and safer cars. Moreover, it is possible to require from insurers that want to participate in the subsidies mechanism to contribute a minimal amount of capital to funds that would be invested in companies that develop safety technologies.

Insurers can also affect the political decision-making regarding governmental measures to reduce traffic accidents. If insurers become significant beneficiaries of a reduction in accidents, they will probably increase their lobbying to induce the government to take measures in order to reduce accidents, such as stricter enforcement, higher regulatory safety requirements, and so on. This may lead to excessive and inefficient government intervention, if insurers try to gain the highest subsidies while shifting the costs of prevention of accidents to the government. This risk could be mitigated if the subsidy to insurers would be reduced by the incremental government expense towards accident prevention.

The structure of this paper is as follows: section 2 presents the social cost and social waste of traffic accidents; section 3 tries to analyze why inefficient traffic accidents are not prevented by drivers, insurers and the government; section 4 presents some of the actions that insurers may take to reduce traffic accidents; section 5 develops the suggested design of corrective subsidies for insurers on the basis of success in reducing traffic accidents; section 6 discusses alternatives to this proposal; section 7 concludes.

2. Social Cost and Social Waste from Traffic Accidents

2.1 Methods of Evaluating Social Cost

The economic literature focuses on the overall cost of traffic accidents to society, which differs from the social waste that derives from sub-optimal accident prevention.⁹ I will first review the overall costs of traffic accidents in the world and in the United States. Then I will discuss the question of social waste and the optimal level of traffic accidents.

Generally, the methods used for evaluating the cost of accidents involve multiplying the number of casualties, injuries and material damage from accidents by the estimated per unit cost of death, injury and material accident. The estimates of deaths and injuries used by different countries typically include direct costs (such as medical expenses), indirect costs (such as production losses, sometime with a subtraction of consumption eliminated as a result of death), and an evaluation of the value of life to the society.¹⁰

There are two main approaches to this evaluation. The first is the Comprehensive Cost method that includes the effects of injury on people's entire lives and places a dollar value on that. The main components of the comprehensive cost calculation are: property damages, lost earnings, lost household production, medical costs, emergency services, travel delay, vocational rehabilitation, workplace costs, administrative, legal, and pain and reduced quality of life. Nonmonetary damages are usually calculated under the Willingness-to-Pay method, that refers to the cost people are willing to pay for safety improvements to avoid a fatality or injury.¹¹ The second approach to valuation is the Human Capital Cost (also termed 'gross output'), which includes all comprehensive cost components except pain and reduced quality of life.¹² This approach equates the loss of life through traffic accidents with lost earnings.¹³

⁹ All the sources that I henceforth review in this matter estimate the social cost of traffic accidents; I am not aware of similar studies that try to assess the net social waste from not taking optimal measures in preventing traffic accidents.

¹⁰ See Emile Quinet, *The Social Costs of Transport: Evaluation and Links with Internalisation Policies*, Chapter 2 in INTERNALIZING THE SOCIAL COSTS OF TRANSPORT (OECD, 1994).

¹¹ See U.S. Department of Transportation, Federal Highway Administration website: Dennis C. Judycki, *Motor Vehicle Accident Costs* (1994). available at <http://www.fhwa.dot.gov/legsregs/directives/techadv/t75702.htm> (last visited April 17, 2010); it is also mentioned there that a review of the economics literature reveals that these cost estimates are drawn from safety markets showing how much people actually pay to reduce safety risks, not necessarily what they are willing to pay.

¹² See *Id.*

¹³ See World Health Organization, WORLD REPORT ON ROAD TRAFFIC INJURY PREVENTION 48 (Margie Peden, Richard Scurfield, David Sleet, Dinesh Mohan, Adnan A. Hyder, Eva Jarawanand Colin Mathers eds., 2004) [hereinafter WHO report]. Arguably, using the Comprehensive Cost method is more accurate since it does not omit components of the cost. However, the assessment of the economic value of pain, suffering and reduced quality of

Evaluations based on ‘willingness to pay’ are higher than evaluations based on ‘gross output’, although arguably that the latter should be augmented by an allowance for ‘pain and suffering’ in order to capture some of the nonmonetary values of human life and well-being reflected in the ‘willingness to pay’ approach.¹⁴ Valuations also differ in their accommodation of unreported crashes.

2.2 Social Cost in the United States

According to US National Highway Traffic Safety Administration (NHTSA), in the year 2000, the costs of accidents under the ‘human capital’ method, which does not take into account the intangible consequences such as pain and suffering, was 230.6 billion dollars. This cost consists of damages and expenses of medical and emergency services (\$34 billion), market productivity (\$61 billion), household productivity (\$20 billion), insurance administration (\$15 billion), workplace cost (\$4 billion), legal costs (\$11 billion), travel delay (\$26 billion) and property damage (\$59 billion).¹⁵

The comprehensive cost of accidents that includes the cost of pain, suffering and loss of life amounts to 433 billion dollars in the year 2000.¹⁶ The evaluation under this includes the same estimates in addition to the economic value, estimated under the ‘willingness to pay’ method, of the intangible pain and suffering for individuals and families. The nonmonetary loss from a fatal injury is estimated as 2.4 million dollars, and non-fatal injuries range between \$0 for mild injuries to 1.3 million dollars for severe injuries.¹⁷ This estimation, of approximately 420 to 433 billion dollars as the social cost of traffic accidents, is the figure often referenced by commentators.¹⁸

life might be contested, and the Human Capital Cost method may provide a benchmark to the cost even if we assume that the nonmonetary costs equal zero.

¹⁴ See G Jacobs, A Aeron-Thomas and A Astrop, *Estimating Global Road Fatalities*, 445 TRL Report, 10 (2000).

¹⁵ See NHTSA, *THE ECONOMIC IMPACT OF MOTOR VEHICLE CRASHES 2000*, 61-62, appendix 1 (2002).

¹⁶ NHTSA, *Id.*, at 8; Ian W.H. Parry, Margaret Walls and Winston Harrington, *Automobile Externalities and Policies*, 45 J. Econ. Literature 373, 382 (2007).

¹⁷ See NHTSA, *Supra* note 15, at 61-62.

¹⁸ See, e.g., Kessler and Rubinfeld, *supra* note 2, at 358; Parry et al., *supra* note 16, at 381.

2.3 Global Social Costs

Numerous studies have been carried out in order to evaluate the economic costs of traffic accidents in different countries and regions.¹⁹ According to one evaluation, the cost of road crash injuries is estimated at roughly 1 percent of gross national product (GNP) in low-income countries, 1.5 percent in middle-income countries and 2 percent in high-income countries.²⁰ Under this evaluation, the global yearly cost is approximately 518 billion dollars.²¹ As mentioned above, under the ‘human capital’ method, the social cost in the US is evaluated at 230 billion dollars. According to the World Health Organization (WHO), if comparable estimates were made of the direct and indirect economic costs of traffic accidents in low-income and middle-income countries, the total global economic cost of traffic accidents would probably exceed the estimate of 518 billion dollars.²² Table 1 presents the estimated casualties in the year 2002, by region and country income level.²³

Table 1

Region	All Casualties	High Income Countries	Low/Middle Income Countries
All	1,183,492	117,504	1,065,988
Africa	190,191		190,191
Americas	133,783	47,865	85,918
South-East Asia ²⁴	296,141		296,141
Europe	127,129	43,902	83,227
Eastern Mediterranean	132,207	1,425	130,782
Western Pacific ²⁵	304,042	24,313	279,729

¹⁹ See Jacobs et al., *Supra* note 14, at 11, table 10, to a review of different evaluations.

²⁰ See WHO report, *supra* note 13, at 5.

²¹ See Jacobs et al., *Supra* note 14, at 11.

²² See WHO report, *supra* note 13, at 5.

²³ See *id.* at 172.

²⁴ The South-East region, as defined by WHO, includes Bangladesh, Bhutan, Korea, India, Indonesia, Maldives, Myanmar, Nepal, Sri Lanka, Thailand and Timor-Leste.

²⁵ The Western Pacific region, as defined by WHO, includes China, Korea, the Philippines, Cambodia, Japan, Singapore, Korea, Mongolia, Australia, New Zealand, and different pacific islands.

Two current models for predicting future trends in road traffic fatalities are the WHO Global Burden of Disease (GBD) and the World Bank's Traffic Fatalities and Economic Growth (TFEC). Both models predict a significant increase in road traffic deaths if present policies and actions in road safety continue and no additional road safety measures are taken.²⁶ The GBD model predicts the following scenario for 2020 compared to 1990: road traffic injuries will become the sixth most significant cause of death worldwide; road traffic injuries will rise to become the third leading cause of disability-adjusted life years (DALYs) lost and DALYs lost will increase worldwide from 34.3 million to 71.2 million. The GBD model further suggests that road traffic deaths will increase on average by over 80 percent in low-income and middle-income countries and decline by almost 30 percent in high-income countries.²⁷ It should be noted that although a decrease in accidents in high-income countries is projected, the social-economic costs incurred in these countries is still very high.²⁸ The TFEC model also predicts similar trends.²⁹

In addition, the welfare consequences of traffic accidents that hurt low-income people might be devastating. The most productive age group, between 15 and 44 years, is at a higher risk of traffic injuries. According to WHO, injuries to low-income individuals in this age group tend to affect productivity harshly, especially when their earning capacity relies on physical abilities. A case study conducted in Bangladesh found that poor families were more likely to lose their head of household and suffer immediate and harsh economic effects as a result of traffic accidents in comparison to higher earnings families. The loss of earnings and other expenses (such as medical and legal expenses) can have a devastating effect on a household's financial situation, and this effect is worse when the household is poor to begin with. Results range from higher rates to a decrease in income food consumption and production and an increase in indebtedness.³⁰

²⁶ See *id.* at 37-38.

²⁷ See *id.*

²⁸ For example, if a decrease of 30% is achieved today in the US, it may reduce the costs of accidents from 433 billion dollars to 303 billion dollars, which is still a huge social cost. Moreover, as long as the economy is evolving, the tariff should be updated upwards, since human capital is worth more in monetary values and since people are willing to pay more in order to prevent accidents.

²⁹ See WHO report, *supra* note 13, at 38-39.

³⁰ See *id.* at 52.

2.4 Social Waste from Traffic Accidents

It is important to note that the cost of traffic accidents is not the social waste from traffic accidents. Social waste from traffic accidents is the cost for society that derives from suboptimal prevention of accidents, which creates damage that exceeds the cost of optimal prevention. The social waste is the excess of the accident's damage over the hypothetical cost of the optimal means of prevention. Thus, in order to calculate the social waste we should estimate the social cost of the preventable accident and the cost of the efficient prevention means.

Preventive measures may vary. Prevention may be achieved by drivers' behavior and by government policy in a myriad of fields, such as investment in enforcement, safe infrastructure, alternatives to driving and so on. Optimal prevention depends in the short term on the available safety and enforcement technologies. In the long term, optimal prevention depends on the optimal investment in research and development of safety and enforcement technologies. It is likely that during the course of this century, driving will be transferred from humans to computers, a step that is expected to result in a dramatic decrease in traffic accidents.³¹ Even before that, the use of new safety technologies, such as Anti-Lock Braking System (ABS) and Electronic Stability Control (ESC), can significantly decrease the damage from accidents.³² Similarly, the declining costs of electronic enforcement measures enable more effective enforcement of traffic laws.

The next chapter will deal with the question of why there is social waste from traffic accidents and why the optimal prevention of these is not achieved. I will discuss the factors involving drivers, insurers and the government.

³¹ On projects of intelligent transportation, see <http://www.tfhr.gov/its/its.htm> (last visited April 17, 2010).

³² See David Burton, Amanda Delaney, Stuart Newstead, David Logan and Brian Fildes, *Effectiveness of ABS and Vehicle Stability Control Systems*, Research Report 00/04 (2004) estimate that the use of ABS reduces the risk of multiple vehicle crashes by 18 percent and the risk of run-off-road crashes by 35 percent; NHTSA estimates ESC would save 5,300 to 9,600 lives and prevent 156,000 to 238,000 injuries in all types of crashes annually once all light vehicles on the road are equipped with ESC; see <http://www.nhtsa.gov/portal/site/nhtsa/menuitem.012c081c5966f0ca3253ab10cba046a0/> (last visited April 17, 2010).

3. Why are Inefficient Traffic Accidents not Prevented?

3.1 Drivers

Drivers have a very good reason to try to avoid traffic accidents: to avoid property damage, physical injury or even death, of themselves, of family and friends that ride with them and of other users of the roads. Nevertheless, many of the decisions drivers make are decided in a socially suboptimal way. Among the decisions, we can include: 1) whether to use a private vehicle or to commute as alternative options; 2) the desirable level of activity: the amount of driving; 3) the behavior on the road: how to drive; 4) the desirable equipment: which car and safety equipment to invest in.

Several factors affect these decisions in a way that might lead to inefficient accidents. These factors include the externalities of driving, moral hazard, optimism and above-average biases, lack of information, irrational evaluation of costs and social norms. I will henceforth discuss these factors and their influence on drivers' decision-making.

Other factors may reduce traffic accidents. For example, if some people overestimate the risk of traffic accidents it could lead to less driving and a reduction of accident risk, although not in an efficient way (since more driving on their part may be socially desirable). This discussion is focused on the factors that result in increasing the risk for inefficient accidents.

A. Externalities of Driving

According to several commentators, starting with Vickrey, there is a substantial marginal accident externality in driving.³³ Assume that two vehicles crash when one driver runs a red light while the other has a green light. The accident would not occur if either driver took a train instead of driving. Therefore, it can be viewed that both drivers fully caused the accident, even though only one is negligent. The average accident cost of the two people's driving is the damages to two vehicles (which is the entire damage divided by the number of vehicles). However, the marginal cost of driving for either vehicle, negligent or non-negligent, is the damage to the two vehicles combined together, which is twice the average cost. Drivers pay, roughly, the average cost of accidents and not the marginal cost. Thus, there is a substantial accident externality to driving: a damage allocation system, such as torts law, can provide proper

³³ See *supra* note 5.

incentives for careful driving, but it will not set proper incentives at the margin of deciding how much to drive or whether to become a driver.³⁴

A study conducted by Edlin and Karaca-Mandic provided estimates of the size of the accident externality from driving. They found that traffic density increases accident costs substantially when measured by insurer costs or insurance rates. This estimate suggests that an extra driver raises others' insurance rates and costs, especially in high-traffic density states. In California, for example, Edlin and Karaca-Mandic estimate that an additional driver increases the total insurance costs for other drivers in this state as 2,150 dollars each year.³⁵ In comparison, the average American spends \$817 per year and vehicle on car insurance. A driver who wants comprehensive coverage and collision coverage as well as liability coverage would pay an average of 936 dollars.³⁶ The national costs of this externality are estimated as 113 billion dollars in 1996.³⁷ These estimates of externalities refer only to accident costs that are covered by insurance and do not include costs that are not covered, such as pain and suffering.³⁸ If these uninsured costs behave like the insured costs, then accident externalities could be 3.5 times larger than they have estimated.³⁹

In addition to the marginal accident externality, there are other externalities where third parties bear some of the damages of the accident, while the driver does not internalize the full cost. Among these we may count non-compensated damages caused to other road users, traffic delays caused by accidents and medical costs that are borne by third parties.⁴⁰ In the United States, access to emergency medical services is not denied on the basis of lack of insurance, so at least part of the medical costs are not borne by the drivers.⁴¹ Since drivers do not internalize these externalities, they do not have incentives to drive the optimal mileage and exert the optimal care in driving.

³⁴ See Edlin and Karaca-Mandic, *supra* note 2, at 932.

³⁵ See *id.* at 936; Aaron S. Edlin and Rinar Karaca-Mandic, *Erratum: 'The Accident Externality from Driving'*, 115:4 J. POL. ECON. 704-705 (2007).

³⁶ Thorsten Moenig, *A Bottom-Up Approach to Pay-As-You-Drive Car Insurance*, 2 (Working Paper, 2009); Insurance Institute of Michigan, *2008 IIM Fact Book* (2008).

³⁷ See Edlin and Karaca-Mandic, *supra* note 35.

³⁸ See Edlin and Karaca-Mandic, *supra* note 2, at 946

³⁹ See *id.* at 951

⁴⁰ See Parry et al., *supra* note 16, at 381-382.

⁴¹ Jeff Strnad, *Conceptualizing the Fat Tax: The Role of Food Taxes in Developed Economies*, 78 S. CAL. L. REV. 1221, 1235 (2005).

B. Moral Hazard

All states, except New Hampshire, require drivers to have auto liability insurance that covers the other driver's medical and car repair costs and other costs when the policyholder is at fault in an auto accident. All states have laws that set the minimum amounts of insurance or other financial security that drivers must pay for the harm caused by their negligence.⁴² The estimated percentage of uninsured drivers in the United States is close to 14 percent.⁴³

According to the economic theory, insurance has a moral hazard cost of reducing the policyholder's incentives to take precautions against the insured loss.⁴⁴ One incentive that may reduce the moral hazard cost is drivers' concern for their own safety and health, even if they would receive coverage for damages. However, the prediction of moral hazard cost is supported by empirical evidence.

Cohen and Dehejia found that a reduction in the incidence of uninsured drivers produces an increase in traffic fatalities.⁴⁵ They analyzed a natural experiment: the adoption of compulsory insurance regulations in some states governed by tort law, which led to a reduction in the number of uninsured drivers, and its consequences on traffic fatalities. They found a 2 percent increase in number of fatalities for each percentage point decrease in the number of uninsured drivers. Earlier studies found a strong positive correlation of no-fault regime with compulsory insurance on the fatal accident rate.⁴⁶

C. Optimism and Above-Average Biases

Optimism and above-average biases, well-known phenomena in the social psychology literature,⁴⁷ have fatal consequences when it comes to driving. Optimism bias is people's tendency to be over-optimistic about the outcome of planned actions: over-estimating the likelihood of positive events and under-estimating the likelihood of negative ones. Above-average bias is a variation on optimism bias: it is the tendency of humans to evaluate themselves as better than the "average" others. Several studies found that drivers generally perceive their

⁴² I elaborate on the minimum insurance requirements, which are relatively low, in the subchapter 3.2.

⁴³ See <http://www.iii.org/media/hottopics/insurance/compulsory/> (last visited April 17, 2010).

⁴⁴ See Steven Shavell, *On Liability and Insurance*, 13 Bell J. Econ. 120 (1982); Steven Shavell, *ECONOMIC ANALYSIS OF ACCIDENT LAW* (1987).

⁴⁵ See Cohen and Dehejia, *supra* note 4, at 357-361, 388-389.

⁴⁶ See Kessler and Rubinfeld, *Supra* note 2, at 359-360.

⁴⁷ See David A. Armor and Shelley E. Taylor, *When Predictions Fail: The Dilemma of Unrealistic Optimism*, in *HEURISTICS AND BIASES: THE PSYCHOLOGY OF INTUITIVE JUDGMENT* 334 (Thomas Gilovich, Dale Griffin, Daniel Kahneman eds., 2002).

own chance of being involved in a traffic accident to be significantly lower, and their own skill to be greater, than that of their peers.⁴⁸ When groups of drivers were asked to compare themselves to the “average driver”, a significant majority responded that they were “better” than the average.

Optimism bias and above-average bias are hypothesized to promote risk-taking and this hypothesis is supported by empirical evidence.⁴⁹ One study found that optimism bias and other variables increase the likelihood of drunk driving among young adults. Namely, drivers who believed they could avoid having a crash due to drunk driving (and hence have optimism bias) were more likely to drink and drive.⁵⁰ It was also found that taxi and bus drivers who lack concern over traffic risks and injuries tend to be more involved in crashes.⁵¹ A recent study found that some scales of risk perception have indirect effects on risky driving behavior through the influence on the attitude towards rule violations and speeding.⁵² It also found that past experience matters: past experience of driving safely while tired or while performing illegal driving behavior is correlated significantly and positively with the frequency of continuing to drive in the same risky manner.⁵³

Therefore, optimism and above-average biases might endanger drivers and other road users by encouraging excessive risk-taking (such as traffic violations and driving while tired) and by inducing under-investment in preventive and other risk-reducing measures (such as safer cars and optional safety equipment).⁵⁴ The behaviors that might be aggravated because of optimism and above-average biases take a large toll on human lives and on social costs. Driving under the

⁴⁸ See Carol A. Holland., *Self-Bias in Older Drivers' Judgments of Accident Likelihood*, 25:4 ACCIDENT ANAL. & PREV. 431 (1993); DM DeJoy, *The Optimism Bias and Traffic Accident Risk Perception*, 21:4 ACCIDENT ANAL. & PREV. 333 (1989).

⁴⁹ N. D. Weinstein, & J. E. Lyon, *Mindset, Optimism Bias about Personal Risk and Health-Protective Behaviour*, 4 BRITISH J. HEALTH PSYCHOL., 4, 289–300 (1999); N. D. Weinstein, *The Precaution Adoption Process*, 7 HEALTH PSYCHOL. 355–386 (1988).

⁵⁰ Fernandes Ralston, R.F. Soames Job & Julie Hatfield, *A challenge to the assumed generalizability of prediction and countermeasure for risky driving: Different factors predict different risky driving behaviors*, 38 J. SAFETY RES. 59-70 (2007).

⁵¹ McKenna, F.P., and M.S. Horswill. *Risk taking from the participants' perspective: the case of driving and accident risk*. 25:2 HEALTH PSYCHOL. 163-170 (2006).

⁵² Ming Ma, *Occupational Driver Safety of Public Transportation: Risk Perception, Attitudes, and Driving Behavior* (working paper, November 2009).

⁵³ See J.R. Dalziel and R.F.S. Job, *Motor Vehicle Accidents, Fatigue and Optimism Bias in Taxi Drivers*, 29(4) ACCIDENT ANAL. & PREV., 489 (1997).

⁵⁴ See David Dunning, Heath Chip and Jerry M. Suls, *Flawed Self-Assessment: Implications for Health, Education, and the Workplace*, 5:3 PSYCHOL. SCIENCE IN THE PUB. INTEREST 69 (2004).

influence of alcohol is one of the main causes of accidents.⁵⁵ In 2008, there were 11,773 alcohol-impaired-driving fatalities, 32 percent of the total traffic fatalities of that year. Over 1.43 million drivers were arrested in 2007 for driving under the influence of alcohol or narcotics. In addition, speeding was a contributing factor in 31 percent of all fatal accidents in 2008, and 11,674 lives were lost during that year in speeding-related accidents.⁵⁶

The limited feedback a driver receives on some risky driving habits magnifies the risks of optimism and above-average biases in driving. Above-average biased students, who predict that they would be in the top two deciles of their class, receive feedback in the form of a grade, whereas drivers, including bad and dangerous drivers, receive only a limited feedback on their driving. Feedback for risky driving can be provided via complaints made by passengers, horn honking of other drivers, police tickets and involvement in perceived near-accident situations. However, there might be situations and risky driving habits in which these feedback mechanisms are not effective. For example, a driver, who usually drives alone or with passengers who do not provide feedback, could have a bad driving habit that increases the risk of an accident, but is not considered an enforceable traffic violation. A lack of effective feedback results in less ability to learn from one's mistakes.⁵⁷

D. Lack of Information

Excessive risk-taking and underinvestment in safety measures are explained not only by the abovementioned biases, but also by lack of information. The evolution of safety ratings of cars in Europe is a fascinating example for the role of information about safety.⁵⁸

By the early 1990s, research conducted by the European Experimental Vehicles Committee (EEVC) resulted in the development of full scale crash test procedures, for protection of car occupants in frontal and side impact, and a component test procedure for assessing the protection of pedestrians, hit by the fronts of cars. The assessment protocol aimed to extend the validity of the assessment to cover a wider range of seating positions and impact situations. The standard of the assessment was set as higher than the minimal standard allowed in legislation.

⁵⁵ See NHTSA, Traffic Safety Facts, 2008 Data, Overview, 4-5, available at <http://www-nrd.nhtsa.dot.gov/Pubs/811162.PDF> (last visited April 17, 2010).

⁵⁶ See *id.* at 6-7.

⁵⁷ See Vanderbilt, *supra* note 3, at 57-73.

⁵⁸ For a more detailed review of Euro NCAP history see <http://www.euroncap.com/history.aspx> (last visited April 17, 2010).

During the mid 1990s, proposals for the adoption of the EEVC test proposals in European legislation were strongly resisted by the car industry. Fortunately, some European organizations joined the initiative and European New Car Assessment Program (Euro NCAP) was formed in December 1996. In February 1997, the first results of crash tests were presented. The publication caused media interest and a strong negative response from the car industry. One of the claims of car manufacturers was that the assessment criteria were so severe that no car could even achieve four stars for occupant protection.

These safety ratings changed the course of traffic safety: they resulted in customer demand, mainly in Europe, for safer cars. This demand enhanced the competition of manufacturers in achieving better safety scores. While only one car received a 4 stars rating in July 1997, in the following years this rating was granted to many new models. In 2001, a new model became the first car to be awarded 5 stars for occupant protection. Today, the exception became the rule and it is very rare to find a new model of a leading brand that receives less than 5 stars for occupant protection.

During the last decade, the Euro NCAP increased the standards of assessment (e.g., requirements for side air-bags), while giving positive scores for additional safety equipment (e.g., a buzzer that signals that a safety belt is not in place). The assessment is made on the model which is marketed as the standard model. Recently, Euro NCAP launched a new rating system that will reward the overall safety of the vehicle, including the safety for pedestrians and “active safety” potential of advanced driver assistance technologies such as electronic stability control.⁵⁹

This ongoing ratings mechanism resulted in a huge leap in traffic safety in an amazingly short period of time. The customer is given a measurement instrument with which she can decide whether to invest more in safety. Moreover, in Euro NCAP’s website, one can see a photo of a specific model from a specific year after the crash, and a picture of the impact of a crash on the different body parts of the driver and passenger (painted with red for the lowest safety scores and green for the highest). A detailed report of the impact of front and side crash, on the driver, passenger, child occupant and pedestrian is also available on the website.⁶⁰

This information became widespread. Even if the potential buyer was not aware of the availability of such data regarding safety, friends and family members who ask how many stars

⁵⁹ *See id.*

⁶⁰ For example, *see* http://www.euroncap.com/tests/mitsubishi_lancer_1998/38.aspx (last visited April 17, 2010).

the car that you consider buying received, and salesmen and advertisements that stress the safety scores, keep this consideration in the awareness of many buyers. Without these safety ratings, even drivers who are concerned with safety issues and willing to pay for safer cars lack the reliable information for comparing safety between models.⁶¹ Insurers usually take into account the overall safety of the car in setting the premium.⁶² They also try to provide information regarding cars' safety. The Insurance Institute for Highway Safety (IIHS), a nonprofit research and communications organization funded by auto insurers, also runs crash tests and provides safety information to the general public on its website with the goal of "reducing the losses... from crashes on the nation's highways."⁶³

This example presents the significance of information in this field. Today, even though information regarding passive safety is widespread, other important information is not as known. Many people do not know the actual risks associated with their driving habits. For example, many drivers associate traffic accidents with traffic violations and not with lack of concentration in driving, while the large risks associated with inattention—including the distraction risk of using mobile phones—are documented and known in the scientific community.⁶⁴ In addition, many drivers are not informed of what they should do in cases of emergency, such as dangerous skidding. In addition, information about active safety instruments is not as well known as passive safety.

E. Irrational Evaluation of Costs

Even when information and bias problems are mitigated, decision-making can still be sub-optimal because of other irrational patterns of human thinking and behavior. One significant factor is salience: people put more weight on salient costs and under-evaluate costs that are not

⁶¹ It is interesting to note that although NHTSA started to conduct crash tests in 1979, a similar effect did not occur. A possible reason is significantly lower standards and more generous ratings. For example, some models that had received 4 or 5 stars rating in early 1990s, would not have been rated more than 1 star under the Euro NCAP standard of assessment.

⁶² See, e.g., http://www.pueblo.gsa.gov/cic_text/cars/autoinsu/autoinsu.htm (last visited April 17, 2010).

⁶³ See <http://www.iihs.org/> (last visited April 17, 2010). In subchapter 3.2 I discuss why the acts of insurers today might not suffice in providing information to the public.

⁶⁴ Jane Stutt, John Feaganesa, Donald Reinfurta, Eric Rodgmana, Charles Hamletta, Kenneth Gishb & Loren Staplin, *Driver's Exposure to Distraction in their Natural Driving Environment*, 37 ACCID. ANAL. PREV 1093-1101 (2005); Vicki L. Neale, Thomas A. Dingus, Sheila G. Klauer, Jeremy Sudweeks & Michael Goodman, *An Overview of the 100-Car Naturalistic Driving Study and Findings* (19th International Technical Conference on Enhanced Safety of Vehicles, Washington DC, June 2005), available at http://www.nhtsa.gov/staticfiles/DOT/NHTSA/NRD/Multimedia/PDFs/Crash%20Avoidance/2005/100Car_ESV05summary.pdf (last visited April 17, 2010).

salient.⁶⁵ One example is the choice whether to buy a car or to use a taxi instead. The salient costs of owning a car will be the gasoline costs, occasional repair bills and the yearly insurance bill. Once the car is purchased, people stop thinking of the less salient costs, such as depreciation, whereas the cost of a taxi is salient every time one needs a ride.⁶⁶ This might encourage people to prefer the use of private vehicles, even when this outcome would not have been preferred if there hadn't been any salience effects on human behavior.

The risk of traffic accidents is also not as salient as other certain and salient costs, such as the costs of safety equipment. For example, the Electronic Stability Control (ESC) device can significantly reduce the risk of traffic accidents. The cost of an ESC device is approximately 250 dollars. The expected reduction of risk varies between countries, depending on the risk of skidding (which is influenced by weather conditions). According to the Insurance Institute for Highway Safety, Electronic stability control could prevent nearly one-third of all fatal crashes.⁶⁷ One study estimates the ESC's benefit-cost ratio as ranging from 4.1 in France up to 8.0 in Germany.⁶⁸ However, in 2009, ESC is fitted as standard only in 63 percent of the new vehicles sold in the UK.⁶⁹ It is not clear if drivers who do not purchase ESC reach this decision after a calculated cost-benefit analysis or whether the choice is a product of other factors such as a lack of salience to traffic accident costs, lack of information or optimism bias.

F. Social Norms

Social norms dominate many driving behaviors. Social norms are customary rules of behavior that coordinate interactions between people. Once a particular behavior becomes established as a rule, it continues to exist because people prefer to conform to the rule given the expectation that others are going to conform.⁷⁰ One significant social norm that varies across countries is the level of compliance with traffic laws. In Delhi, for example, there is almost no compliance with traffic laws.⁷¹ In other countries, such as most of the western European

⁶⁵ See, e.g., Raj Chetty, Adam Looney and Kory Kroft, *Salience and Taxation: Theory and Evidence*, 99:4 AM. ECON. REV. 1145 (2009).

⁶⁶ See Richard H. Thaler and Cass R. Sunstein, NUDGE: IMPROVING DECISIONS ABOUT HEALTH, WEALTH AND HAPPINESS 100-101 (2008).

⁶⁷ See <http://www.iihs.org/news/rss/pr061306.html> (last visited April 17, 2010).

⁶⁸ See Herbert Baum Sören Grawenhoff and Torsten Geißler, *Cost-Benefit-Analysis of the Electronic Stability Program (ESP)*, Summary Report (Institute for Transport Economics at the University of Cologne, 2007).

⁶⁹ See <http://www.thatcham.org/esc/> (last visited April 17, 2010).

⁷⁰ See "Social Norms" in THE NEW PALGRAVE DICTIONARY OF ECONOMICS (Steven N. Durlauf and Lawrence E. Blume eds., 2nd ed. 2008).

⁷¹ See Vanderbilt, *supra* note 3, at 211-213.

countries, the level of compliance is high. Even where drivers usually comply with traffic laws, specific social norms of disobedience can evolve, and an important key to changing the risky behavior is changing the relevant social norm.⁷² One study analyzing the relation between social willingness to comply with the law and traffic accidents among 15 European countries during 1996-2000 found that those nations that had citizens who were more likely to obey traffic laws had fewer traffic fatalities.⁷³

Social norms in many places endanger drivers and other road users' lives, and yet people adhere to them. One enforcement mechanism of social norms is social approval or disapproval of behaviors.⁷⁴ Friends who drive with a driver who drives "too slow", other drivers behind him who get upset with the delay caused by "slow driving"—these can put social pressure on the driver to comply with a social norm of speeding. A second reason for compliance with social norms is coordination. A driver who drives slower than the social norm exposes herself to the risks that other drivers might crash into her car or try to cut her off dangerously. In this situation, a rational driver should prefer to comply with the dangerous social norm, rather to expose herself to a higher risk from the lack of coordination with her peers.

G. Do Law Enforcement and Tort Liability Mitigate the Abovementioned Inefficiencies?

The inefficiencies discussed above can be mitigated to some extent by enforcement of traffic laws. As long as a driver complies with traffic laws, her personal biases, lack of information and other inefficiencies do not result in violating traffic laws (although this might be the result in a world without enforcement). Thus, deterrence is expected to reduce the excessive risk that derives from the discussed inefficiencies.

However, this effect is limited. *First*, as I discuss in subchapter 3.3, it is not clear whether the government sets the level of penalties and probability of being caught (i.e., enforcement) at the optimal level. I am not aware of a system in which the budget of traffic law enforcement is determined according to the resulting social cost reduction. Without a system that tries to set enforcement to the optimal level, it is not likely to achieve an outcome of optimal enforcement.

⁷² For the example of social norms and driving under the influence of alcohol, see Jeff Linkenbach & H. Wesley Perkins, *Montana's MOST of Us Don't Drink and Drive Campaign A Social Norms: Strategy to Reduce Impaired Driving Among 21-34-Year-Olds* (NHTSA report, September 2005, available at http://www.nhtsa.dot.gov/people/injury/alcohol/SocialNorms_Strategy/images/SocialNorms.pdf, last visited April 17, 2010).

⁷³ Lode Vereeck & Klara Vrolix, *The Social Willingness to Comply with the Law: The Effect of Social Attitudes on Traffic Fatalities*, 27 INT'L REV. L. & ECON. 385-408 (2007).

⁷⁴ See "Social Norms", *supra* note 70.

Factors that I henceforth discuss could lead to a result of under-enforcement and insufficient penalties.

Second, there are inefficient behaviors that could not be deterred by traffic laws, even if we assume that there is optimal deterrence. Enforcement of traffic laws is limited to behaviors that can be observed, while there are risky behaviors that cannot be observed (or behaviors in which the enforcement cost exceeds the benefit). One example is driving when the driver is tired. Although a tired driver might be as risky as an intoxicated driver, it is not practically possible to observe it and to impose penalties in this situation if no accidents or other violations occurred.⁷⁵ Another example is inattentive and distracted driving. While some of the distractions come from outside, a large portion of it is a result of behaviors that the driver controls (such as talking on a mobile phone, smoking, changing music, turning back to talk with another passenger and not focusing on the road for no apparent reason).⁷⁶ It is not practical to enforce a ban on inattentive driving, if it does not involve other violations. Excessive level of activity (such as inefficiently high miles driven) and suboptimal but legal safety standards are also important inefficiency factors that enforcement cannot solve. Thus, even though deterrence could mitigate some of the abovementioned inefficiencies, this effect is limited.

Tort liability also does not provide a full solution to these inefficiencies. It can deter behaviors that people perceive as such that might lead to liability, but if a driver has optimism or above-average biases or lacks information she might underestimate the liability risk. As mentioned, moral hazard from insurance coverage also aggravates risky behaviors and limits the deterrent effect of tort liability.⁷⁷ The externality of driving derives from the additional driving itself and not by the level of care, and thus, a careful driver that increases the risk for others by her additional driving will not be liable under negligence tort regime for the damage associated with the increased risk. Therefore, it is likely that the deterrence effect of traffic law enforcement and from tort liability does not achieve the optimal level of traffic accidents.

⁷⁵ If driving while tired increases the probability of violating traffic laws, then enforcement of these traffic laws may deter from doing so. However, it is possible that the increase in probability for causing traffic accident is not similar to the increase in probability for committing traffic violations.

⁷⁶ See Stutt et al., *supra* note 64; Tim Horberry, Janet Anderson, Michael A. Regan, Thomas J. Triggs & John Brown, *Driver distraction: The Effects of Concurrent In-Vehicle Tasks, Road Environment Complexity and Age on Driving Performance*, 38 ACCI. ANAL. PREV. 185–191 (2006).

⁷⁷ See Cohen and Dehejia, *supra* note 4.

3.2 Insurers

Private insurance can encourage measures that reduce the risk associated with the insured activity in exchange for a discount in the premium. There is empirical evidence that a switch from governmental insurance to private insurance results in a reduction in the actual damages of environmental risks.⁷⁸ It is not clear whether under current market conditions insurers would be better off with a significant accident risk reduction that could be embedded in lower premiums (since the risk is lower) and less demand for insurance above the mandatory requirement (since roads are safer). However, it may still be profitable for insurers to reduce accident risk—at least in the short-run. Insurers could have short-term profits from a risk reduction, before the premiums are adjusted to the lower level of risk. Moreover, if there is imperfect competition, the profits from risk reduction may be significant even in the long run. If the management is short-term biased when it comes to profits, then they may prioritize a risk reduction that would result in a short-term profit but long-term loss. Another possible factor that may incentivize insurers to reduce risk is the fear from state intervention in setting maximum insurance premiums.⁷⁹

Nevertheless, even if we assume that insurers gain from accident reduction, they do not have incentives to take measures to reduce traffic accidents to the socially optimal point. *First*, only part of the damages is covered by insurance, and thus the insurers' interests are not aligned with the social interests. *Second*, even if the entire cost were borne by insurers, a particular insurer who tries to reduce the marginal accident externality of driving would bear the total cost of the reduction measures, but would not internalized the full social benefit.

A. *Partial Insurance Coverage of Traffic Accident Costs*

While the total social costs of accidents range between 230 to 433 billion dollars (depending on inclusion or exclusion of nonmonetary damages), only approximately 100 billion dollars of the damages are covered by insurance.⁸⁰ The gap, of 130 to 333 billion dollars, represents costs borne by the drivers, their families, their employers, the government and other

⁷⁸ Haitao Yin, Howard Kunreuther and Matthew White, *Risk-Based Pricing and Risk-Reducing Effort: Does the Private Insurance Market Reduce Environmental Accidents?* (NBER working paper, 2009).

⁷⁹ These explanations were presented to me by Professor Louis Kaplow.

⁸⁰ See *supra* note 2.

drivers and road users. Table 2 shows the distribution of the costs estimated under the Human Capital method (i.e., not including pain, suffering and loss of life).⁸¹

Table 2

	Government	Insurer	Other	Self
Medical	24.16%	54.85%	6.36%	14.62%
Emergency Services	79.62%	14.74%	1.71%	3.93%
Market Productivity	19.26%	41.09%	1.55%	38.10%
HH productivity		41.09%	1.55%	57.36%
Insurance Admin	1.40%	98.60%		
Workplace costs			100.00%	
Legal		100.00%		
Travel Delay			100.00%	
Property Damage		65.00%		35.00%

The partial coverage is explained by different reasons. *First*, drivers do not insure cost they do not bear (neither directly nor through liability). As mentioned above, in subchapter 3.1, these externalities sum up to a significant share of the cost of accidents.

Second, the minimal insurance coverage required by state law is considerably lower than the actual damage that is borne by the insured drivers. In most states' laws there are three minimal coverage requirements: a minimal coverage for per person bodily damage liability, a minimal coverage for all bodily liability of persons involved and property damage liability. The average minimal requirements, in thousands of dollars, are 24, 47 and 15, respectively. The mode is 25, 50 and 10.⁸² This minimal mandatory coverage is obviously below the actual damage of more than mild traffic accidents.

Third, although there is optional insurance coverage that is more comprehensive than the minimal mandatory requirement, different human factors induce drivers to choose a coverage which is less than the costs they bear. Optimism and above-average biases, discussed above in subchapter 3.1, make drivers underestimate the risk they impose on themselves (including risks

⁸¹ Lawrence J. Blincoe, *The Economic Costs of Motor Vehicle Crashes 1994*, U.S. Dept. of Transportation, National Highway Traffic Safety Administration (1996).

⁸² For details of the minimal coverage requirements see <http://www.iii.org/media/hottopics/insurance/compulsory/> (last visited April 17, 2010).

to their family and to the vehicle) and on third parties. Salience effects can also lead to lower coverage. In addition, it is arguably rational for drivers to bear the risk of pain and suffering to themselves and their family without insuring it because pain and suffering usually does not increase one's need for money.⁸³

B. Marginal Accident Externality of Driving

Most auto insurance premiums have mainly lump-sum characteristics that are only weakly linked to mileage. As noted above, an ideal tort and insurance system would charge each driver the full social cost of her particular risk exposure on the marginal mile of driving. Otherwise, people would drive too much and cause too many accidents. In principle, insurers could adopt a Pay As You Drive (hereinafter PAYS) premium approach: charging for driving an extra mile.⁸⁴ According to Edlin, implementing per-mile premiums would be roughly equivalent to a 70 percent hike in gasoline price and could be expected to reduce driving nationally by 9.5 percent.⁸⁵ Parry compared the welfare gains of PAYD with a comparable gasoline tax and found that gasoline tax would achieve only 32 percent of the welfare gains of PAYD, since mileage-related externalities are significantly larger than fuel-related externalities.⁸⁶ He projected that a full implementation of PAYD would lead to a reduction of gasoline demand by 9.1 percent. Bordoff and Noel estimate the national reduction in driving by implementing PAYD as 8 percent.⁸⁷ Natural experiments, though in small sample sizes, confirmed these estimates reporting 8 to 10 percent reduction in driving.⁸⁸

Moenig argues that under PAYD drivers will reduce their efforts to prevent accidents (i.e., the level of caretaking), so the reduction in accident costs might be lower than estimated. In addition, the general reduction of driving under PAYD would lower per-mile premiums and people would have incentives to drive more and thus it offsets some of the initial mileage

⁸³ A. Mitchell Polinsky & Steven Shavell, *The Uneasy Case for Product Liability* 30-31 (working paper, November 2009). The incentive is different when it comes to risk of pain and suffering of third parties: since the tort system imposes liability on these damages, a risk-averse driver has an incentive to insure this risk.

⁸⁴ See *supra* note 5.

⁸⁵ See Edlin, *supra* note 5, at 55.

⁸⁶ See Ian Parry, *Is Pay-As-You-Drive Insurance a Better Way to Reduce Gasoline than Gasoline Taxes?*, 95:2 Am. Econ. Rev. 288-293 (2005).

⁸⁷ See Jason Bordoff and Pascal Noel, *Pay-As-You-Drive Auto Insurance: A Simple Way to Reduce Driving-Related Harms and Increase Equity* (Hamilton Project Discussion Paper, 2008).

⁸⁸ See Moenig, *supra* note 36, at 4.

reduction from increasing marginal costs of driving. Furthermore, infrequent drivers would increase their driving and the number of drivers and cars is expected to increase.⁸⁹

Edlin and Karaca-Mandic note, as a possible explanation as to why insurers do not adopt per mile premium policies, that most of the gains are external and the monitoring costs are fully internal. An insurer that implements such a premium system bears all the costs of monitoring mileage but gains only a part of the overall benefits: as its insured drivers reduce their driving volume, others avoid accidents with them, and these other people and their insurers benefit. Thus, the gains that a particular insurer could realize by switching to per-mile premiums are considerably less than the social gains from this step.⁹⁰ This explanation does not account for why there are insurers today that offer only very low discounts for low mileage. While it is measured in the car's annual state inspection (and hence the monitoring costs, apart from fraud costs, are not borne by the insurer). It is possible that even when the monitoring costs are very low, the internalized gain is still low and a significant part of the gain is external. Another possible explanation for the low discounts given today for low mileage is imperfect competition between insurers that do not have incentives to compete by lowering the premiums for low-mileage drivers. This question is a subject for a further research.

3.3 Government

The government has the ability to dramatically reduce traffic accidents to the social optimum. There is a myriad of policy tools to achieve this purpose: optimal enforcement of traffic laws, regulation of driving education and licensing, safety regulation, corrective charges on marginal driving, investment in research and development of safety and enforcement measures, development and maintenance of safe infrastructure and investments in substitute means of transportation for private vehicles where it is socially optimal. In many countries, governments do not take the optimal measures to reduce traffic accidents. When governments adopt steps that reduce traffic accidents, it is usually long after these steps could have been taken. I will henceforth elaborate on the role of the government in reducing traffic accidents.

⁸⁹ See *id.* at 9.

⁹⁰ See Edlin, *supra* note 5, at 56, 66-69, 73; Edlin and Karaca-Mandic, *supra* note 2, at 954.

A. Enforcement of Traffic Laws

It is not likely that the current level of penalties for traffic violations and the funding for enforcement to assure a certain probability of catching traffic offenders are set in an optimal way. For example, while it is found that increasing the probability of catching traffic offenders results in fewer traffic accidents and casualties,⁹¹ I am not aware of a budgeting system that takes into account the resulting reduction in social costs when the budget of the enforcement bodies is decided. Not surprisingly, some regulators and enforcement bodies tend to be underfunded so they cannot achieve optimal deterrence.⁹² The level of penalties also has a significant impact on deterrence.⁹³ I am not aware of a policy design that tries to set the sanction optimally in accordance with the probability of catching the traffic offenders (even if we take the funding for enforcement as given by a budget constraint). It is likely that setting penalties' levels and funding enforcement without doing it in a way that ensures optimal deterrence might lead to under-deterrence in some cases and maybe over-deterrence in others.

In addition, it appears that even the funds that are allocated to enforcement are not always used in the optimal way. While the costs of electronic enforcement are decreasing dramatically, and the initial investment in enforcement equipment can be recouped by revenues from fines in a short period while achieving a desirable deterrence effect, many countries have not implemented it yet. Technology can theoretically reform work methods and improve the efficiency of traffic police officers. For example, one undistinguishable police vehicle can visually document a large amount of traffic violations and a ticket (with the video of the offence) can be sent to the driver via mail. Although an investment in efficient enforcement may have very high social return,

⁹¹ See, e.g., Richard Tay, *General and Specific Deterrent Effects of Traffic Enforcement: Do We Have to Catch Offenders to Reduce Crashes?* 39:2 J. TRANSP.ECON. & POL'Y 209-223 (2005) found that increasing either the number of random breath tests performed or the proportion of drivers tested positive for drunk driving significantly reduced the number of serious crashes on the roads in Australia; Andrew Scott, Philip Darby & Robert Raeside, *Police Enforcement and Road Accident Reduction* (Transportation Research Board 86th Annual Meeting, January 2007) found that an increase in levels of enforcement results in a reduction in the rates of killed and seriously injured in the U.K.

⁹² In Israel, for example, a professional committee, appointed by the minister of transportation, recommended in 2005 to increase the budget of the traffic police up to the level that the increase in economically efficient. Even a more modest proposal of lower increase, that was included in the committee's final report, was never adopted, although nearly all of the political parties stress the importance they attribute to traffic safety.

⁹³ See, e.g., Maria De Paola Vincenzo Scoppa, *The Deterrent Effects of Penalty Point System in Driving Licenses: A Regression Discontinuity Approach* (working paper, 2010).

governments might fail to act.⁹⁴ For example, cutting police officers' jobs in order to shift budget to electronic enforcement devices might be opposed by political and organizational pressures.

One possible explanation is that enforcing traffic laws is not popular and thus not a politically smart thing to do. A factor that may contribute to a negative approach towards more enforcement of traffic laws is that people are frequently over-optimistic, underestimate risks and lack information. Assume, for example, that drivers mistakenly think that it is safe to drive 20 mile per hour faster than the legal speed limit. In this situation, it would be difficult for politicians to persuade drivers that increasing the probability of them being caught speeding or the level of the penalty is desirable (as long as the drivers correctly perceive the increase in the probability of being caught).⁹⁵ However, the above-average bias may have a different effect: drivers may endorse tighter enforcement—but on other drivers. They may support higher levels of penalties and enforcement if they think that it is not relevant to them, but for other drivers (that are thought to drive worse than them).

In addition to the possible contribution of the psychological biases, other arguments are made against higher levels of enforcement and penalties. In different countries, oppositionists to electronic enforcement, for example, argue that the government tries to use traffic laws as a source of revenue.⁹⁶ Some claim that this kind of enforcement hurts their privacy (although they are documented violating traffic laws in the public domain). On similar grounds people oppose allocation of additional resources for more traffic police officers and more efficient procedural and evidence law regarding traffic violations. Organized lobbying groups, such as groups of professional drivers and transportation companies, might try to block initiatives that might impose costs on them. Although they may benefit from the reduction of externalities that other drivers impose on them, it is likely that professional drivers who drive for many hours a day (and

⁹⁴ It should be noted that several developed countries, such as the United Kingdom and France, began implementing widespread electronic enforcement, resulting in a significant decrease in accidents. *See*, e.g., <http://www.parliament.uk/documents/upload/POSTpn218.pdf> (last visited April 17, 2010).

⁹⁵ This is also an explanation for the political difficulties in levying a “fat tax” to change unhealthy dietary habits, *see* Strnad, *supra* note 41, at 1259, 1294-1298.

⁹⁶ Opposition groups have formed in some locations where automated traffic enforcement has been used. For example, in the US city of Scottsdale Arizona, an activist group CameraFraud was formed and staged sign-wave protests and petition drives to oppose the use of photo radar. *See* <http://www.abc15.com/content/news/phoenixmetro/story/Valley-activists-working-to-protest-photo-radar/CfKdulyJ0EGDqa7OXX2BuA.csp> (last visited April 17, 2010). Other organizations operate in different countries; for an example in the U.K., *see* <http://www.speedcameras.org/> (last visited April 17, 2010).

in heavier vehicles in the case of trucks) impose more externalities than the ones they bear and thus could be worse off from internalizing them.

Another possible explanation for the sub-optimal governmental policy is that the support in the goal of reducing traffic accidents is politically diffused. Formally, it is hard to find a political party and candidate who do not support this goal. However, since the benefit from reduction in accidents is enjoyed by most members of society, usually there is not a particular interest group that supports this issue enough to prioritize it when it comes to allocation of resources.

Moreover, there are fiscal constraints on governmental expenses and the separation between government revenues and expenses. In some countries, there are laws that restrict the growth of the government budget's expenses. Under this constraint, even if an additional expense of 0.1 percent of the GDP can increase the GDP by 1 percent, and even if the government revenues it generates are higher than the expense, it is prohibited if it exceeds the ceiling on the expansion of the budget.

B. Safety Regulation

Regulation is also not optimal. Some steps that could reduce traffic accidents are likely to be blocked where there is a strong opposition from the relevant industry. One example is to require a built-in maximal speed limit in new cars: not more than the maximal speed allowed in the country. This is a technologically feasible and cheap measure that could simply make extreme speeding practically impossible. Another example is the way mobile phones are used during driving. There is a social benefit from using driving-time to have phone calls, as well as large profits to the cellular companies, but clearly, it causes a significant increase of risk, especially while dialing and dealing with text messages.⁹⁷ It seems that in many places, there was no serious analysis of the benefits and costs, and even where laws require the use of speaker-phone and ban text-messaging while driving, the enforcement is frequently loose.

As described above, the dramatic improvement in motor safety in the last few decades is more likely to be explained by market responses to information regarding safety ratings and not by higher standards set by regulation.

⁹⁷ See, e.g., Dean Sugano, *Cell Phone Use and Motor Vehicle Collisions: A Review of the Studies* (Hawaii, Legislative Reference Bureau, 2005), available at: <http://hawaii.gov/lrb/rpts05/cellcar.pdf> (last visited April 17, 2010).

C. Corrective Charges on Marginal Driving

As noted by Edlin and Karaca-Mandic, the straightforward way to address the external marginal costs from driving is to levy a substantial corrective charge, either per mile, per driver, per gallon or on the insurance premium. If each state charged Edlin and Karaca-Mandic's estimation of external marginal cost as a corrective tax for each mile driven or each new driver, the total national revenue would be \$113 billion per year at the end of their sample (1996). Other commentators also support levying corrective taxation on driving.⁹⁸ However, a widespread adoption of the ideal set of externality taxes is considered by commentators as politically unrealistic.⁹⁹ Even in European countries, where the gasoline tax is higher, it is not high enough to internalize the marginal externalities according to Edlin and Karaca-Mandic's estimations.¹⁰⁰

D. Investment in Research and Development

The role of research and development in preventing traffic accidents is extremely important. Technological developments, such as ABS, ESC and the significant improvement of passive safety of new vehicles in the last 15 years, have saved many lives and will continue to do so in the future. Moreover, the future of technology and safety looks promising. The vision of a "driverless car" and of computer-coordinated traffic may be achieved in the next decades, and if so, will reduce traffic accidents significantly.¹⁰¹ Although private-sector companies may be interested in conducting research in this field, the clients of large-scale transportation coordination systems are governments. A substantial funding to research and development, by the U.S. or the E.U., may prove as a domestic and global efficient step.

However, according to the WTO report, the actual research and development investments in prevention of traffic accidents are low when compared to other health threats (ranked according to the harm they cause).¹⁰² A complete comparison and analysis of the efficiency of the allocation of resources to the different health threats should take into account many other factors that affect the return over the investment in research and development in a particular field, such as the susceptibility to research solutions and alternative ways to reduce the relevant health

⁹⁸ See Parry et al., *supra* note 16, at 394-395.

⁹⁹ See Edlin and Karaca-Mandic, *supra* note 34.

¹⁰⁰ As discussed above, a gasoline tax alone might not be the ideal corrective tax, and in order to mitigate the vehicle externalities, a different set of corrective taxes should be set. Edlin and Karaca-Mandic, *supra* note 2, suggest an externality charge as an alternative for gasoline tax.

¹⁰¹ See, e.g., http://www.technologyreview.com/read_article.aspx?id=18908 (last visited April 17, 2010).

¹⁰² See WHO report, *supra* note 13, at 5-7.

threat. This comparison is beyond the scope of this paper, but it is possible that efficient investments of the government in research and development in this field are not made.

E. Investment in Substitutes for Private Vehicles

Different countries and cities vary in the public transportation they provide to their residents as a substitute for private vehicles. It seems that the cost of traffic accidents is not always weighted by decision-makers as a cost which is relevant as the cost-benefit analysis of an investment in substitutes for private vehicles.¹⁰³ The diffused political support and the fiscal constraints on government expenses can explain sub-optimal under-investment in providing a substitute for private vehicles.

To sum, many efficiency-promoting actions are not taken by the government. Inefficiencies can be found in safety regulation and enforcement of traffic laws and the (lack of) government response to the marginal accident externality, and government investment in research, development and substitutes for private vehicle. The reasons for these inefficiencies may include, among others, diffused political support, political difficulties in taking unpopular measures and influence of the relevant industries on the regulators and policy-makers.

¹⁰³ Public transportation, including buses, is far safer than private vehicle. [While in 2007, for example, a total of 16,614 car occupants and 12,458 occupants of light trucks died in traffic accidents, only 36 bus occupants died in traffic accidents; See Bureau of Transportation Statistics website at \[http://www.bts.gov/publications/national_transportation_statistics/html/table_02_01.html\]\(http://www.bts.gov/publications/national_transportation_statistics/html/table_02_01.html\) \(last visited April 17, 2010\).](#)

4. What Can Insurers Do to Reduce Traffic Accidents?

Before I discuss the proposed subsidy that aims to incentivize insurers to take measures to reduce traffic accidents, I will present some of these potential measures. Insurers have several features that put them in a suitable position to take measures to reduce the risk of traffic accidents. *First*, they have contractual relationships with the insured drivers in which they charge for the risk associated with the drivers. This kind of relationship provides the insurers direct contact with drivers, enables “nudging” opportunities and opens possibilities for drivers’ consent to safety measures that cannot be mandated by the government for political and privacy reasons.¹⁰⁴ *Second*, they have or may have access to a large amount of information about factors that influence the risk of accidents for different types of drivers and what measures—currently not taken due to lack of insurer’s profitability—may reduce that risk in a socially desirable way. *Third*, insurers can be relatively flexible in their decision-making regarding discounts and incentives for safety measures. They are less exposed to political pressures and lobbies, and when they have a financial incentive to reduce traffic accidents they will probably try to maximize their profits by doing so.

Insurers can influence both the mileage level and the caretaking level in driving. I will henceforth elaborate several examples of measures that insurers may take in order to reduce traffic accidents. *First*, even today insurers grant insured drivers discounts if they use safety equipment and lower rates if they have safer cars. Insurers may subsidize purchasing safety equipment that reduces risk. This is an indirect subsidy for commodities that are complementary to risk-reducing activities—a result which is supported by Arnott and Stiglitz in the presence of moral hazard.¹⁰⁵ Today, many insurers do grant lower premiums for safer cars and discounts for safety equipment. For example, in March 2009, Capital Insurance Group (CIG) launched a driver safety program promoting the hands-free use of cell phones. Drivers with CIG Auto insurance can get a CIG Bluetooth headset for free by recommending the insurance to a friend, or purchase one at 50 percent below retail price.¹⁰⁶ However, it is plausible that the current level of discounts offered today by insurers is lower than is socially optimal. Since insurers cover only 23 to 43 percent of the overall social damage, their incentive to offer discounts for safety measures exists

¹⁰⁴ However, there could be political pressure on the government to restrict such measures taken by insurers.

¹⁰⁵ See Richard Arnott and Joseph E. Stiglitz, *Moral Hazard and Optimal Commodity Taxation*, 29 J. PUB. ECON. 1-24 (1986).

¹⁰⁶ See <http://www.internetautoguide.com/auto-news/25-int/41878/index.html> (last visited April 17, 2010).

only where the benefit for the insurer (from a decrease in the insured risk) exceeds the discount cost. If insurers' incentives would be aligned with the social interests, more discounts and encouragement from insurers to drivers would probably take place.

Second, insurers may affect the research and development in the field of prevention of traffic accidents. As mentioned above, the current investment in research and development in the field of preventing traffic accidents might be less than is socially desirable. Granting lower premiums and discounts for safer cars and safety devices would probably increase consumer demand to these products, and thus the level of research and development of new safety products would rise. In addition, insurers may increase the investment in research and development directly. The Insurance Institute for Highway Safety (IIHS), established in 1959, is a nonprofit research and communications organization funded by auto insurers (this method of joint funding mitigates the free rider problem).¹⁰⁷ The IIHS goal is to research what works and what does not work in the prevention of motor vehicle crashes and reduction of injuries in the crashes that still occur.¹⁰⁸ By aligning the insurers' incentives to social interests, insurers may increase their investment in research and development.

Third, insurers can try to mitigate the problem of lack of information of some drivers. Useful information on accident prevention may be transmitted from insurers to drivers: for example, by giving a brochure or sending it via mail, or, for example, by requiring the insured driver to watch a 30 minute informative movie on the insurer's website in exchange for a 100 dollars refund. Currently, insurers—who still have a significant incentive to reduce the insured risks—do try to mitigate problems of lack of information. The IIHS website, for example, is designed to provide information about safety issues.¹⁰⁹ Other insurance-related websites provide a wide range of safety information.¹¹⁰ However, it is possible that by aligning the insurers' incentives to social interests, insurers may choose to deliver information more extensively.

Fourth, insurers may encourage drivers to improve their driving skills and driving patterns. One means to improve driving skills is to give a discount or subsidize an advanced

¹⁰⁷ 96 insurance companies participate in funding of the IIHS, include many major insurers; See <http://www.iihs.org/members.html> (last visited October 15, 2010).

¹⁰⁸ See <http://www.iihs.org/about.html> (last visited April 17, 2010). Even if consumers are not aware of this particular website, the availability of data about safety issues can help insurers, government agencies and other agents in providing this data to the consumers.

¹⁰⁹ See <http://www.iihs.org/default.html> (last visited April 17, 2010).

¹¹⁰ See, e.g., http://automotive-insurance.suite101.com/article.cfm/how_to_lower_auto_insurance_costs_for_teens (last visited April 17, 2010).

driving course (if the social benefit from it exceeds its cost). Some insurers today provide discounts and price subsidies to insured drivers who participate in safety training programs.¹¹¹ By providing more incentives to drivers to use methods which are expected to improve their driving, insurers may reduce traffic accidents. Those incentives may not be exclusively monetary: at least some drivers are probably not aware of the benefit from such measures (i.e., they have an information problem), and the insurer can invest in increasing the awareness rather than providing an ineffective discount.

Another means is to promote feedback measures to the driver. As noted above, the limited feedback in driving makes the optimism and above-average biases dangerous. When an effective feedback is given to drivers, by documenting driving patterns and events, the drivers' driving improves and crash rates drop dramatically.¹¹² "How's My Driving?" stickers may utilize other people to provide feedback to the driver and were found effective in reducing traffic accidents significantly.¹¹³ One type of product, commonly known as Event Data Recorder (EDR), can provide such feedback. The NHTSA report from 2001 notes that the use of EDR reduces the number of crashes by 20 to 30 percent.¹¹⁴ For example, one device, produced by a company called DriveCam, consists of a small camera located around the rearview mirror. The camera constantly buffers images of the driver and the exterior view, and when a driver makes a sudden turn or pushes the brakes abruptly, the camera records ten seconds before and after the event. The recorded clip is sent to the DriveCam's workers who analyze it and file a report. Other monitoring devices, such as Driver's Alert,¹¹⁵ that analyze driving patterns (such as sharp turns, frequent and abrupt use of brakes, frequent change of speed and so on) are also available in the market.

EDRs are much more commonly used as "black boxes": different kinds of data (e.g., speed) that is collected and retrieved only in case of an accident. About 60 million vehicles now

¹¹¹ See, e.g., <https://www.discount-car-insurance-rates.com/car-insurance-discounts-for-good-drivers> (last visited April 17, 2010).

¹¹² See Vanderbilt, *supra* note 3, at 62-63.

¹¹³ See Lior Strahilevitz, *How's My Driving?' for Everyone (and Everything?)*, 81 NYU L. Rev. 1699 (2006). Strahilevitz argues that the use of How's My Driving stickers transforms loose-knit environments, where reputation often fails to constrain antisocial behavior, into close-knit environments, where reputation constrains misbehavior more effectively and more efficiently by replacing state policing with citizen policing and social norms. The effectiveness of "How's My Driving" may derive not only from the effect of providing feedback but also, and maybe mainly, from the deterrent effect of reporting to the employer, who might penalize the employee or at least cause her an inconvenience and embarrassment.

¹¹⁴ See NHTSA, *R&D Event Data Recorder (EDR) Working Group, Final Report* (2001).

¹¹⁵ See http://www.driversalert.com/en/Risk_Reduction.aspx (last visited April 17, 2010).

have them and approximately 85 percent of new cars in 2010 will come standard with a "black box" in the United States, according to NHTSA estimates.¹¹⁶ This device is useful in finding the causes of an accident after it happens, and may increase deterrence by reducing the probability that a driver who is at fault would not be found liable, but it does not provide feedback before accidents occur. Thus, the use of EDRs, which can be expanded to being more than just a "black box", could serve as an important means in providing feedback to drivers.

Moreover, insurers can try to affect drivers' behaviors by adopting a premium system that adjusts the premium to the actual risk associated with the driver's driving patterns as monitored by the EDR. This premium system is called by one insurer that offers it as Pay How You Drive.¹¹⁷ Monitoring the quality of driving would increase efficiency and welfare as bad drivers would be charged higher per-mile premiums and would thus either better internalize the risk they create—or change their driving habits and reduce their risk.¹¹⁸ According to Moenig, implementing a per-mile pricing without monitoring the quality of the driving would internalize the costs a driver imposes on others by driving frequently but not the costs from driving carelessly.¹¹⁹ One insurer, Progressive, gives drivers a customized rate based on how, how much, and when the car is driven (i.e., based on both mileage and quality of driving). The information is collected by a chip which is installed in the car and transfers the data to the insurer. The impact on the rate could be anywhere from a 60 percent discount to a 9 percent surcharge. However, it seems that this premium system is offered only by an extremely small number of insurers worldwide and that the demand for it is very limited.

It is likely that without contractual consent, the use of information collected by this device—that documents how, how much and when the car is driven—by people other than the driver would be considered an invasion of privacy.¹²⁰ Privacy concerns may also arise in the relations between the driver and the insurer. In addition, drivers (especially the risk-taking ones) might refrain from using EDRs, including "black boxes", since there is a risk that the data collected will be used against the driver. These concerns can be eased, at least partially, if the

¹¹⁶ See Mary-Rose Abraham, *Is That a 'Black Box' in Your Car?*, ABC NEWS, Feb. 22, 2010, at <http://abcnews.go.com/Technology/MelodyHobson/car-black-box-records-key-data/story?id=9814181&page=1> (last visited April 17, 2010).

¹¹⁷ See <https://www.payhowyoudrive.co.uk/> (last visited April 17, 2010).

¹¹⁸ See Moenig, *supra* note 36, at 8.

¹¹⁹ See *Id.* at 5.

¹²⁰ In this sense, a "black box" EDR is less intrusive since the data is retrieved only with regard to an accident.

EDR were used only to gather general information on the patterns of driving.¹²¹ By using the contractual relations, the insurer can encourage drivers to use this device willingly. Insurers can also increase the salience of the insurance price, by billing the driver on a monthly basis, based on their recent driving patterns, so the linkage between driving habits and premium will be more salient.

Fifth, insurers can adjust the premiums to the marginal risk of driving by charging the drivers that drive more a higher premium. This is called the Pay As You Drive (PAYD) premium system. As mentioned above, this is expected to induce a significant and efficient reduction in driving and traffic accidents. Such a usage-based plan became available in 1999, and is now optionally available in 30 states from a number of insurers. The uptake of these plans by drivers has been low and the demand is limited. Similar market responses occur also outside of the United States. For example, one U.K. insurer has dropped its PAYD program, citing extremely limited demand.¹²² A possible reason for the low uptake is that the discounts are not high enough to induce a significant shift of insured drivers to these programs. The discounts may be low since insurers do not have a large benefit from the reduction of externality imposed by their insured drivers (since most of the gain goes to other drivers). By aligning insurers' incentives to the social interests and by using the potentially saved social cost of accidents as a source, insurers may incentivize drivers to switch to a PAYD program by increasing discounts or by other means.

In addition to the measures insurers can take to encourage drivers to reduce their risks, insurers may also try to influence the government to take actions to reduce traffic accidents. As noted above, this can also prove as an efficient means if the increased costs borne by the government and the drivers are subtracted from the reduction of accident cost for the calculation of the subsidy.

¹²¹ See Carmela Troncoso, George Danezis, Eleni Kosta, Bart Preneel, *PriPAYD: Privacy Friendly Pay-As-You-Drive Insurance*, In WPES, 99-107 (Peng Ning and Ting Yu eds., 2007).

¹²² See <http://arstechnica.com/tech-policy/news/2009/07/eff-to-ca-metered-auto-insurance-is-still-a-slippery-slope.ars> and <http://newsroom.progressive.com/2008/June/myrate-launch.aspx> (last visited April 17, 2010).

5. Corrective Subsidy for Insurers

5.1 The Proposed Subsidy

A. *The Basic Subsidy*

As described in chapter 3, various factors and constraints lead to the result where the social waste from traffic accidents is tremendous. Currently, the costs from traffic accidents—between 230 and 433 billion dollars per year in the United States alone—are borne by society. I suggest that it may be more desirable for society to share the social-cost-saved with the insurers whose actions reduced it, rather than society bearing the social waste itself. Thus, by equating the private gains of the insurers with the social gains from the social cost reduction, incentives for agents would be aligned with the social interests.

Edlin, who supports charging drivers for the marginal accident externality of driving, suggests as an alternative to a corrective tax on premiums, a subsidy to insurance companies that reduce their customers' driving equal to the resulting external accident cost reductions.¹²³ Edlin notes that this alternative may be easier to legislate than corrective tax, but it might be more difficult to administer. My proposal is to adopt a broader criterion: the actual reduction in damage from traffic accidents, calculated by subtracting the actual traffic accident damage from the expected risk (as predicted by actuarial analysis) from the insured drivers. It is also possible to impose a tax on insurer whose insured drivers are involved in more traffic accidents than is expected. In this paper, I focus on granting a subsidy on a cost reduction, but the option of taxing an increase of traffic accidents is also worth examining.

The basic concept is that the subsidy for any particular insurer should be determined as the gap between the expected risk and the actual social costs from the insured drivers.¹²⁴ Assume that S_i is the subsidy granted to insurer I and that $D_{\text{expected-}i}$ is the expected damage from the insured drivers of insurer i , calculated according to the general baseline. The baseline is based on the risk associated with drivers in the same categories across insurers¹²⁵ before the subsidy is

¹²³ See Edlin, *supra* note 5, at 74.

¹²⁴ I henceforth analyze and present the necessary adjustments to this basic model.

¹²⁵ For example, the accident risk of 18 year old male drivers in the state or country. The baseline level assumes that no special measures are taken by the insurer and it is not specific to a particular insurer. It is determined by the general actuarial data in the state or country, and not by the particularized baseline of the specific insurer, in order not to benefit insurers who take fewer measures to reduce accidents today and also not to penalize insurers that do take measures, more than others, to reduce accidents today.

enacted.¹²⁶ The calculation of the expected damage is specific to the insured population of every insurer, so that the different composition of insured drivers in the different insurance companies will be taken into consideration.¹²⁷

$D_{\text{actual-}i}$ is the actual damage and social costs induced by the insured driver of insurer i , measured after subsidy is enacted (and the insurer's actions are taken). The social costs should be determined by adopting one of the measures of the social costs of traffic accidents.¹²⁸ As discussed in subchapter 2.2, the abovementioned measures provide an average value of social costs for different levels of injuries. The actual damage could be calculated by multiplying these values and the actual injuries incurred by the insured drivers.¹²⁹ By taking into account the actual traffic accidents during the examined period, we use a very important feature of traffic accidents: the result of implemented measures is observable and within a relatively short period of time—at least with respect to serious body injuries that are usually treated in medical facilities and reported to the police.

The expected damage ($D_{\text{expected-}i}$) and the actual damage ($D_{\text{actual-}i}$) should consist of uninsured costs only, since the insurer already has the proper incentives to take efficient measures for the cost it internalizes, and granting a subsidy for a reduction in the insured risk means a double benefit stemming from the same cost reduction (which might result in an excessive prevention of accidents). In the following discussion, I will treat the expected damage ($D_{\text{expected-}i}$) and the actual damage ($D_{\text{actual-}i}$) as if they refer only to the uninsured social costs.¹³⁰ The resulting incentive to the insurers will be to take measures to reduce accidents of the insured drivers as long as the marginal revenue (from subsidies and insurance payment saved) exceeds the marginal cost of such measures.

¹²⁶ If the subsidy can be granted during a limited period of time, as discussed below, it is reasonable to use the pre-subsidy risk as a baseline for the calculation of the expected risks. If the subsidy is set for an unlimited time period, it is possible to set a system of updating the expected risk in a way that would still maintain the insurers' incentives.

¹²⁷ For example, if insurer A has only 10,000 insured drivers who are all in one risk category in which the expected social damage per driver is 10, then the expected damage ($D_{\text{expected-}i}$) is 100,000.

¹²⁸ Determining the preferable measure of social costs of traffic accidents is outside the scope of this paper.

¹²⁹ For administrative purposes, it may be preferable to limit the calculation to the medium and serious injuries. Another consideration that should be taken into account is how to prevent insurers' ability to influence the classification of injuries in order to create an artificial reduction of costs.

¹³⁰ The calculation of the uninsured actual costs can be done by subtracting the insurance payments and liabilities to the insured drivers that incurred accidents from the overall actual social damage (calculated as mentioned above). After extracting the ratio of the insured costs out of the social costs in the actual damages, this ratio can be used in determining the uninsured expected costs. Other calculation methods are possible.

Thus, the basic subsidy can be expressed as:

$$S_i = D_{\text{expected}-i} - D_{\text{actual}-i}$$

The insurer's profit (P_i) is the subsidy (S_i), plus the saving of insured costs (I_i), minus the costs it incurred in reducing the accidents (C_i):

$$P_i = S_i + I_i - C_i$$

Example 1

Assume that the overall damage expectancy from a group of 1,000 insured drivers at the age of 18 is 1 million dollars a year. Assume also that the insurer can reduce the expectancy to 500 thousand dollars with the cost of 400 thousand dollars. The insurer covers only 50 percent of the social cost.¹³¹ Thus, it is not profitable to the insurer to invest 400 in order to save 250. If the insurer would receive the uninsured social-cost-saved (250) as a subsidy, it would take measures to reduce the number of accidents: the insurer would have a gain of 100 while the society would save a social waste of 100.¹³² (If the insurer would get a subsidy also for the insured damages, it would get 500 as subsidy and 250 in the form of saving insurance payments—more than the social damages saved).

Now assume that the insurer gets only 80 percent of the uninsured social-cost-saved. In this case, it will not affect the decision to take the reduction measure, and the insurer would invest the 400 to receive 450, of which 200 as 80 percent of the uninsured social-cost-saved ($250 \times 80\% = 200$) and 250 as reduced insurance claims. In this case the insurer would have a gain of 50 while the society would same a social waste of 100.¹³³

When the internalized benefit is lower than the social benefit, it might create a disparity between the insurer's incentives and the social interests, and the insurer might not take socially desirable measures. For instance, in this example, if the insurer would get less than 60 percent of the uninsured social-cost-saved, it would not take the abovementioned measure. Although it might lead to inefficiencies, a subsidy lower than the social benefit may be found desirable by

¹³¹ As mentioned in chapter 3.2, in the United States the insurers cover damages of approximately 100 billion dollars: 23% to 43% of the overall social damage.

¹³² In this case all of the saved social-wasted-saved goes to the insurer.

¹³³ The overall social savings include the 50 that was earned by the insurer and the other 50 which are spread among the drivers and other parties that suffer from externalities.

policy-makers on distributive or political grounds, since the gains from the reduction of the social waste fall not only on the insurer but on sides that incur today the social costs.

B. *The Marginal Accident Externality*

In order to take the externalities of driving into account, the actual and expected accident damage amounts should include every accident that caused damage in which the insured driver was involved, even if the insurer did not incur the entire cost of that accident. When there is a clash between two insured drivers, splitting the damage between the two drivers does not take the full marginal accident externality of driving into account.¹³⁴ As noted, an insurer might be disinclined to reduce this externality when the internalized gain from the reduction is low. Assigning the cost for the insurers of the drivers—without splitting it—would take into account the marginal accident externality. However, the same cost reduction should not be counted twice in the subsidies of two different insurers.¹³⁵

The design of the subsidy can address this issue: the saved social cost of this externality would be allocated to the rest of the insurers according to the approximated contribution of them to the reduction of the externality.¹³⁶ I will present one option of attributing the reduction of the externality proportionately to the reduction of accidents involving two vehicles or more. The assumptions for this attribution are 1) that a reduction of externality is accompanied by a reduction of internalized cost (since the prevention of a collision saves both internalized and externalized costs), 2) that we can observe the reduction of the internalized costs, and 3) that we can estimate the ratio between internalized costs and externalized costs (that we want to gauge).

First, we calculate for each insurer the internalized expected damage for accidents of two vehicles or more. The calculation is according to the baseline level of the internalized risk associated with different categories of drivers across insurers ($D_{\text{expected, cars} \geq 2}$). *Second*, we find the internalized cost reduction by subtracting the actual internalized damage of accidents in which two or more cars were involved ($D_{\text{actual, cars} \geq 2}$) from the expected risk ($D_{\text{expected, cars} \geq 2}$).

¹³⁴ As presented by Edlin and Karaca-Mandic, *supra* note 2, at 933, both the two drivers is the “but for” cause for the entire damage from the accident, regardless of their fault.

¹³⁵ Assume, for example, the expected damage of accidents between two cars of two insurers is 100, and the actual damage is zero. If the cost reduction is fully attributed to both of them (i.e., each one is granted a subsidy of a 100), then the overall sum of subsidies is 200 while the social cost reduction is only 100.

¹³⁶ If the externality that the driver imposes is taken into account in calculating the subsidy, it may reduce the fear of aggravating the Peltzman effect, that insurers would take measures to reduce the risk for the insured driver and occupants but increase the risk for other road users.

We then compare the values received among the various insurers in the market. If the values are the same, under the abovementioned assumptions, we infer that the contribution of every insurer to the reduction of the externality is the same. If it varies, then there is a difference between the contributions of the insurers. *Third*, by using an estimate for the ratio of the internalized and externalized costs in case of lower than expected damages, we can extract the cost that insurer i saved to other insurers by reducing the externalities imposed by its insured drivers. *Finally*, after determining the proper attribution of the reduction of the subsidy, we should adjust the subsidy by increasing it for the insurer that reduced the externality and reducing it for insurers that enjoy an externality reduction induced by another insurer.

Example 2

Assume that in the market there are 5 insurers, and each covers 20 percent of the drivers. The driver groups are identical across insurers. Also assume that the current overall externality is 500, contributed to equally by the drivers of each insurer. By reducing driving by 40 percent, an insurer would enjoy an internalized benefit of 20 (by reducing the costs of insured accidents) and also reduce the externality by 20 (i.e., each of the other insurers would have a gain of 5). Thus, the ratio between internalized and externalized benefits of reducing the risk for accidents in which two or more cars are involved is 1:1. Given that we observe only the reduction of internalized costs, we should estimate this ratio. By using this ratio we can infer which insurer reduced (or did not reduce) externalities and to what extent and then we should adjust the subsidy accordingly. In this example, the subsidy for the insurer that reduced the externality should be increased by 20, while the subsidies for each of the other insurers should be decreased by 5.

As an alternative to this approach, we can adopt Edlin's approach of determining the externality by measuring the mileage of every insured driver. The practical difference between the approaches may not be very large, since a significant portion of the externality of driving is caused by excessive driving and thus it is likely that the approach I presented would also incentivize insurers to charge premiums on the basis of mileage. The advantage of this approach is that it encourages insurers not only to reduce the insured drivers' mileage but to take any efficient measure to reduce the risk of involvement in an accident with another car.

C. Screening Practices

There is a possibility that insurers will try to improve the screening of the potential clients in order to enlist the better drivers in every risk-group. Then, if one insurer succeeds in getting the best 10 percent of 18 year-old drivers, it will look as if there is a reduction since the expected risk exceeds the actual damage from accidents, while other insurers will have an increase. There are several optional responses to this concern, although they might not fully mitigate it.

First, it is not clear if this problem will occur in a competitive environment, where several companies compete for the same good drivers. The competition may reduce the benefit from this manipulation. However, this might induce large waste since if many insurers incur costs in screening and competing for the good drivers, their benefit would be low and most or even all of them might be worse off. It is not clear whether the threat of competitive race-to-the-bottom could deter insurers from launching a screening competition, and it depends in the competitive characteristics of the market.

Second, some screening and pricing methods may be banned for insurers that want to participate in the subsidy schedule. Even today, some screening and pricing practices are banned by state laws.¹³⁷ The government can condition participation in the subsidy program on the application of certain limitations to the insurer's screening and eligibility of new customers and policy termination of current ones. The ban could be set on the criteria used in the screening process or on the use of different manners of collecting information about the future consumers.¹³⁸ However, the use of bans might induce other efficiency costs, such as increased adverse selection. Moreover, pricing methods may be used to incentivize drivers to reduce their risk and set limits on pricing methods might undermine the efforts to reduce accident risk.

Third, the changes in the aggregated accident damage of every risk group should be taken into consideration in determining the sum of the subsidy granted. If the aggregated accident damage of a particular risk group stays the same as the expected risk but some insurers show a reduction in their insured drivers from this group while others show an increase, no subsidy should be granted. In other words, i represents an insurer and j represents a risk category. If after the subsidy is enacted, no overall reduction is achieved in a certain risk category (i.e., Σ_i

¹³⁷ For example, discrimination on the basis of race.

¹³⁸ For example of the latter, the use of interviews in the screening process could be banned.

$D_{\text{actual-}i,j} = \sum_i D_{\text{expected-}i,j}$), but some insurers show a reduction in the actual damages compared to the expected, one explanation could be that the reduction that some of the insurers present derives from more sophisticated screening techniques, and no subsidy should be granted since no real reduction of risk occurred.¹³⁹ However, this will not remedy a situation in which a net reduction of the aggregated risk is achieved (i.e., when $\sum_i D_{\text{actual-}i,j} < \sum_i D_{\text{expected-}i,j}$), and at the same time, some insurers present higher reductions as a result of more sophisticated screening techniques and not a real risk reduction.

Fourth, as an additional design option, it is possible to grant the agency operating the subsidy discretion to reduce the subsidy to a particular insurer if the insurer did not induce an actual reduction in risk that resulted in fewer accidents, but used other methods to create a favorable gap between the expected and actual number of accidents, assuming that the use of these methods could be observed. The insurers that want to have the opportunity to get the subsidy may be required to provide a detailed report both on their screening and pricing techniques and on the measures they took to reduce traffic accidents.

In sum, there are possible ways to mitigate, probably only partially, the risk that insurers would use screening methods to present artificial risk reduction. These partial solutions might induce other efficiency and administrative costs.

D. Shifted Costs

Insurers can try to shift the cost of prevention to other parties. The insurance industry can try to use its political power to influence the government to take measures to reduce traffic accidents. Some of these measures might have a significant governmental cost, such as an increase in enforcement resources. Other measures, such as regulations, might result in significant compliance costs borne mainly by drivers. As long as these measures are socially efficient, it is desirable that the insurers will have incentives to use their influence in the political arena to adopt these measures. By creating these incentives to the insurers, the problem of diffused political support in measures to reduce traffic accidents can be mitigated to some extent.

However, if the insurers shift reduction costs to other parties and yet get a subsidy based on the cost saved, it might incentivize insurers to influence other parties to take inefficient

¹³⁹ Another explanation could be that the insurers that show a reduction truly took measures to reduce their insured drivers risk and did it effectively, while the other insurers lessened their efforts and induced a real increase in the risk associated with their insured drivers.

measures. Assume, for example, that the government can invest 1,000 in reducing accident costs by 800. If the subsidy to the insurers is granted on the basis of this reduction (i.e., they get a subsidy of 800 while they do not incur the 1,000 cost), they will have incentive to lobby for the adoption of this measure, although it is not socially desirable.

The subsidy should be designed to prevent inefficient accident prevention, when the cost of prevention exceeds the social cost of accidents. In order to do so, the additional cost borne by the other party during the period after the subsidy enacted, presented as C_{external} , should be subtracted from the overall amount of subsidy for all insurers (S). In order to calculate C_{external} there is a need to check what are the changes in costs that the government and drivers incur after the subsidy was enacted (compared to the costs baseline before the enactment of the subsidy). The cost could be apportioned to the particular insurer in a simple and rough way by subtracting the value of $C_{\text{external}} * S_i / S$ from the subsidy S_i paid to insurer i , or in a more complex apportionment that takes into account the drivers' risk category which is affected by the additional costs borne by other parties.

This way the insurers can still benefit from the reduction of the social waste when efficient measures are taken by other parties during the examined period, if they still get a subsidy for the reduction of social cost saved minus the cost borne by other parties.¹⁴⁰ In other words, the overall insurers' profit is: $P = S + I - C - C_{\text{external}}$.¹⁴¹ Thus, the insurers have incentive to incur an additional cost (by themselves or by other parties) only if it results in higher increase in their profit (which is determined by the social-cost-saved)—the incentive for insurers to induce other parties to take inefficient measures is eliminated.

Moreover, when the other party can reduce accident costs in a more efficient way than insurers can, hence C_{external} and C are substitutes and $C_{\text{external}} < C$ for the same accident cost reduction, then the insurers would prefer the less costly measure to maximize their profits.

¹⁴⁰ This is actually a subsidy at the sum of the social waste that was saved. This point is further developed in subchapter 4.4 and it involves several issues of lobbying costs, coordination between insurers, free-riding aspects and other points which are beyond the scope of this paper.

¹⁴¹ This is the subsidy plus reduction of insured risk minus the costs of the internalized reduction measures minus the shifted reduction costs. As mentioned above, C is the cost incurred by insurers in reducing traffic accidents and I is the gain from the reduction of the insured risk. The overall subsidy is $S = \sum S_i = \sum_i D_{\text{expected}-i} - D_{\text{actual}-i}$.

Example 3

Assume that after the subsidy was enacted, the government increases the expenditure on enforcement by 50 million dollars and issues a regulation which imposes a compliance cost of 30 million dollars on the drivers. These steps, which were strongly supported by the insurance industry, result in a reduction of 100 million dollars in social uninsured damages. The social waste saved is 20. According to the abovementioned approach, the insurers should get as a subsidy up to the sum of 20—the uninsured accident cost reduction (100) minus the additional costs borne by other parties (80).

Now assume that the insurers can achieve the same reduction of 100 by investing 70 (rather than 80 by the government and drivers) and that the insurers' and the other parties' measures are substitutes. Then, if the insurers would take their measure it would result in a subsidy of 100 while their net profit would be 30 (which is 100 as a subsidy minus 70 that they incur as the cost of reducing the accident risks). They would prefer this measure over lobbying for the measures taken by the other parties, which would yield in a lower net profit of 20. Thus, the socially efficient measure would be taken.

E. Length and Information

This subsidy can be set for a limited period of time. For example, it can be granted annually during a time period of 10 years, and subject to a renewal by the government afterwards. The selected period should be long enough to incentivize insurers to adopt large scale programs, with possible feedback during the early years. Setting a sufficiently long period of time may also encourage other companies, in the motor industry and outside of it, to invest in safety improvement that would be endorsed by insurers. After a certain period of time, 10 years for example, in which the proposed subsidy is operated, better safety standards may be adopted, social norms may change and the policy-makers will probably know better which particular strategies succeed in reducing traffic accidents. Then, it may be socially desirable to refrain from extending the operation of the subsidy or to update it with a new expected risk baseline. Distributional considerations may also support enacting the subsidy only for a limited period of time.

It is important to note that this proposal is based on the assumption that the government can reliably predict the expected risk from drivers and to collect the data on the actual accidents. While in most western countries, the data regarding medium and serious injuries is collected in a

reliable way, different nuances, such as the level of the degree of the injury, should be determined in a uniform and credible way. If the subsidy mechanism would refer only to the data of accidents with medium or severe body injuries, which are reported to the police by law and documented by medical institutions, then it could mitigate the risk that insurers would try to suppress reporting.¹⁴²

The risk evaluation also creates many challenges, which are beyond the scope of this paper, such as the level of dependence on the insurer's data or general measurable actuarial data. It is critical that the risk estimations and other calculations, such as the costs borne by other parties to be subtracted from the subsidy, be done by a professional and unbiased agency. It should be independent from influences of the insurance industry or any other interest group. Its work should be transparent and based on professional actuaries and economists. The interests that may come from the Treasury to reduce subsidy payments should also be restricted. After the rules of the subsidy are set, in order to achieve the social goal, fair play must be ensured.

One requirement that can be set is that every insurer that participates in the subsidy program must publish a detailed report on its policies in reducing accidents and the actual reduction that it attributes to each measure, on a periodic basis. This requirement may increase the available data for other insurers, for researchers and for policy makers. These natural experiments may lead to a better understanding that can be utilized for accident-prevention.

F. Other Design Issues

As a general matter, there is a risk that insurers will try to manipulate the subsidy mechanism to get more money without actually reducing risk. The agency in charge of the subsidy mechanism can be granted the authority to set rules to ban manipulations of the subsidy and to reduce subsidy in such occasions.

In addition, it is possible that insurers would encourage people who belong to a "high-risk" group, that do not drive today but commute in public transportation, to start driving. This might increase the overall driving and overall traffic accidents. To mitigate this risk, it can be set

¹⁴² An approximation of the damages of the minor injuries could still be taken into account in determining the subsidy, if there is a correlation between light accidents (that are more likely to be underreported) and medium and severe accidents, and if we can reliably estimate the ratio between them. If these assumptions hold, we can use this approximation instead of the actual reporting of light accidents.

in the subsidy design that the entitlement for the subsidy would be given only for a driver that had been insured for a certain period of time beforehand, or for a young driver.¹⁴³

Another design issue is how to mitigate the problem that private companies tend to invest more in short-term profits rather than more socially efficient long-term profits. This tendency might lead to underinvestment in more efficient safety measures that show their results during a period of several years or more (e.g., upfront discounts or subsidies for training courses or safety equipment). In our context, this tendency can be explained by managerial short-term bias and by the threat of migration of customers to a competitor—after the long-term investment had already been made.¹⁴⁴

A possible solution for the customers' migration threat is to set a system of subsidy-adjustments and transfers between a current insurer and a previous insurer (that made the long term investment from which the current insurer enjoys). This solution may be administratively complex but manageable. It requires that the agency in charge of the subsidy mechanism will publish the subsidy-adjustments needed for different long-term investments. For administrative reasons, in the trade-off between accuracy and simplicity, it may be better to publish a set of bright-line rules based on rough estimations rather than evaluating on a case-to-case basis. The traditional short-term bias of management may be addressed by the methods recommended by the research in the field of executive compensation.¹⁴⁵

5.2 Efficiency and Distribution Considerations

In this subchapter I discuss a range of efficiency features and considerations of the proposed subsidy: its impact on externalized and internalized inefficiencies, its corrective nature, its effect on adverse selection and the efficiency considerations in determining the optimal funding source of the subsidy.

¹⁴³ A downside of this rule is that it does not encourage drivers that drive without insurance today to get insurance.

¹⁴⁴ If the insurer does not give an upfront discount for a long-term investment, but a periodical discount in premiums, this threat is eliminated. However, it is possible that in some cases an upfront discount would be the most effective means to encourage drivers to take an efficient long-term investment. If this possible advantage is not significant, this discussion can be disregarded. In addition, the insurer may give an upfront discount conditioned on a certain length of contract and if the customer switches insurer she will have to pay back some of the cost incurred by the insurer.

¹⁴⁵ See, e.g., Lucian Arye Bebchuk and Jesse M. Fried, *PAY WITHOUT PERFORMANCE, THE UNFULFILLED PROMISE OF EXECUTIVE COMPENSATION* (2004).

A. Externalities and Internalized Inefficiencies

The suggested subsidy schedule addresses not only the externalities from driving but also the internalized inefficiencies that lead to social waste. The inefficiencies that do not necessarily create externalities include biases, such as optimism and above-average biases, lack of information, irrational evaluation of costs and suboptimal social norms. For example, if a driver has an above-average bias, she might underestimate both the risk for herself (internalized cost) and for others (negative externality if she is not liable for all costs). In these situations the driver does not make optimal decisions even though she internalizes the associated costs.

It is socially desirable that the insurer will take more measures than it is currently taking to reduce the risk associated with the abovementioned biases and inefficiencies, whenever the cost of such measures is lower than the social benefit from the reduction of risk. Some of the ways that insurers can undertake to do so are discussed in chapter 4. By creating incentives for insurers to reduce all the inefficiencies—external and internal alike—the efficient social outcome is more likely to be achieved. This is a significant difference between this proposal and other proposals that focus on internalizing driving externalities and do not address other inefficiencies that result in social waste.

Arguably, it is possible that the measures insurers are already taking today (since they bear the insured risk) and the deterrence effect of penalties on traffic violations and tort liability have already led to a reduction of a major portion of the hypothetical risk in a world without these factors. Thus, it is possible that the most efficient measures—in which low cost measures yield the highest return of accident reduction—are already taken.¹⁴⁶ Nevertheless, since the costs of traffic accidents are still very large, and it is possible that many of the expected future accidents may be prevented in a cost lower than the predicted damage, taking additional measures to reduce inefficient traffic accidents is socially desirable.

B. The Corrective Nature of the Subsidy

The proposed subsidy is actually a corrective subsidy that equates the marginal social benefit of the behavior with the marginal social cost by providing a subsidy equal to the marginal

¹⁴⁶ As mentioned in chapter 4, many of the possible measures that insurer could take to reduce traffic accidents are already taken, but at a level that might be lower than socially optimal.

external benefit to society.¹⁴⁷ By granting a subsidy on the basis of “success” in reducing traffic accidents, insurers will internalize the positive externality from their actions to reduce traffic accidents. In the economics literature, corrective taxes and subsidies are usually levied on consumption or production of certain units (e.g., consumption of gasoline) ex ante. Here, the proposed subsidy is granted ex post, after the external benefit and the “production” of safety occurred, and without specification about the means needed to achieve the desired result. However, these differences do not change the nature of this subsidy as a corrective subsidy that equates the marginal social benefit of the behavior with the marginal social cost.

The advantage in an ex post measurement is the lack of need to determine what the “production units” are on which the insurer would get a subsidy. By letting the insurers decide which measures they take, and granting the subsidy on the basis of actual reduction, there is less risk of setting the corrective unit-based on the wrong value or the wrong unit. This approach may result in different measures taken by different insurers—a large scale natural experiment to find out what actually works most efficiently in the prevention of traffic accidents.

This success-based system can only exist when the outcome of the desired behavior is relatively prompt and observable. Many of the measures that can be taken by insurers may result in a reduction in a relatively short period of time (such as months or several years). As mentioned earlier, when there are more efficient long-term measures, the proposed subsidy might lead to a preference for the measures which are more profitable in the near future. I addressed this problem in subpart 4.1 F. This feature of relatively prompt and observable outcomes does not exist, for example, in the medical and environmental effects of pollution—a field in which corrective taxes and subsidies are frequently considered.

C. Adverse Selection and Related Inefficiencies

As a result of the abovementioned steps, drivers who will not agree to take part in the insurers’ initiatives to reduce risks, will probably face a higher premium because their behavior may signal that they are bad drivers who persist in their driving manners. The most likely assumption is that the good drivers and the bad drivers who are willing to reduce their risk would join the safety initiatives. This would create a welfare gain by reducing the current adverse selection and it would improve efficiency by internalizing the risk by the bad drivers. A

¹⁴⁷ For a review on corrective taxes see Louis Kaplow, *Taxation*, in 1 HANDBOOK OF LAW AND ECONOMICS, 49-53 (A. Mitchell Polinsky and Steven Shavell eds., 2007).

reduction of the adverse selection is also possible from large scale use of EDR devices as a means to determine the actual risk from drivers. This result also increases fairness by removing the current subsidies from the group of low-risk drivers (or initially high-risk drivers who take measures to reduce their expected risks) to the group of high risk drivers.¹⁴⁸

However, if the insurer lacks the ability to observe risk associated with particular drivers, the targeting of the subsidy might be suboptimal. One situation is when the subsidy might lead to a behavior which is inefficiently excessively safe. For example, assume that a particularly safe driver who belongs to a generally risky category of drivers is entitled by her insurer to buy subsidized safety equipment. Also assume that the overall reduction of risk associated with this driver is lower than the cost of the device, and she agrees to buy the equipment only because it is subsidized. Another situation is when the subsidy is not effective in the sense that the particular driver already makes the efficient choices. For example, assume that a driver who always uses a safety belt agrees to install a device that ensures the use of safety belts in exchange of a discount in the insurance premiums. Since the insurers have incentives to choose the subsidy maximizing policy, they would probably try to target the costly measures they take in the optimal way. However, these targeting problems would probably reduce the efficiency of the subsidy.

D. Distributive Effects, Behavioral Responses and the Funding of the Subsidy

The funding method of the subsidy may have significant efficiency outcomes. One possibility of funding is by an increase of taxes, with no special treatment for drivers and other beneficiaries from the subsidy.¹⁴⁹ This possibility results in welfare gains for the group of drivers and other beneficiaries and an increase of taxes for a group of taxpayers that does not necessarily overlap in identity and benefit. This might distort the optimal taxation and might result in increasing the deadweight loss driven by taxation. This might also result in an increase in the demand for driving, since drivers only enjoy the gains from the reduction of traffic accidents (and lower insurance costs) without bearing the cost of achieving it. An increase in the demand for driving, driven by a subsidy, would result in more driving than is socially desirable.

¹⁴⁸ See Moenig, *supra* note 36, at 7.

¹⁴⁹ To some extent, implementation of the proposed subsidy would result in an increase of the tax revenues of the government: fewer damages are deducted and more income (by people who otherwise would have been hurt) is produced. In addition, it may also decrease some governmental expenditures, such as on public health and on disability benefits.

Nevertheless, this increase in the demand for driving could be reduced if after the initial period of time in which the subsidy is enacted (e.g., 10 years) the risk baseline is updated upwards to the average post-subsidy level. This may reduce the demand for driving mostly after the baseline has been updated. Another short-run means to reduce the increased demand for driving may include a corrective tax on mileage (directly on odometer readings or on gasoline) and a higher annual lump-sum fee for driving.

Another funding option is to finance the subsidy by a distribution-neutral system.¹⁵⁰ Under this approach, adjustments to the income tax and transfer system would be made to offset the distributive incidence of the subsidy. For example, assume that the benefit to individuals from the subsidy equals exactly one percent of their income. Then, the distribution-neutral income tax adjustment would be to increase the income tax by one percent to offset the distributive incidence. The advantages of this approach are that there would be no distribution effect to the subsidy (assuming such an effect is not desirable through this mechanism) and that no labor supply distortion would occur. If the adjustments are made only through the income tax, this will not mitigate the problem of increased demand for driving discussed above, since the income tax is not directly linked to the decision of whether or not to drive and how much, and since the driving costs are expected to be lower.

The implementation of the distribution-neutral approach may be complicated since it should track the distributive effects of the subsidy. The beneficiaries (apart from the insurers) include drivers, passengers, family members, employers and the state (that carries some of the current externalities). The treatment of the state does not raise any problem since the budget used today to cover accident costs could be transferred to fund the subsidy. It is reasonable to assume that the benefit from accident reduction increases with income, since a substantial portion of the accident costs consist of income-related components, such as loss of productivity and earning capacity, cost of traffic delays (where rich people value the lost time more than poor people), etc. The ability of rich people to invest more in safer cars may reduce to some extent the assumed increase of benefit with income. This is a question for further research.

However, there may be distribution effects across groups—such as drivers and people who use public transportation or walk—and among groups (e.g., between drivers who are more

¹⁵⁰ See LOUIS KAPLOW, *THE THEORY OF TAXATION AND PUBLIC ECONOMICS* 179-197, 202-209 (2008); Louis Kaplow, *On The (Ir)Relevance Of Distribution and Labor Supply Distortion To Government Policy*, 18:4 J. ECON.PERS. 159-175 (2004).

and less risky). It seems that using the income tax as a sole instrument to make the distribution adjustment would be a rough and imprecise tool. Instead, a more subtle set of adjustments could be considered. For example, these adjustments may include a fee on driving (which can be levied on car owners with or without income-adjustments), higher subsidies for public transportation (to offset the net cost that public transportation might incur), and other similar adjustments. Even if such adjustments are made, it is possible that some of the distributive effects would not be fixed.

5.3 Political Considerations

The proposed subsidy has three advantages as a means to achieve political decisions towards efficient reduction of traffic accidents. The first advantage is that it is more likely that the political arena would adopt a subsidy from which a strong and influential lobbying group would enjoy, while imposing the optimal corrective tax (on gasoline or premiums) might not be a feasible political decision. According to Edlin and Karaca-Mandic, if each state charges its estimated external marginal cost as a corrective tax, the total national revenue would be approximately 113 billion dollars per year on the insured damages alone, excluding the resulting reductions in driving. If the uninsured damages are taken into account, the corrective tax might rise, before accounting for driving reductions, 395.5 billion dollars.¹⁵¹

Even significantly smaller increases in taxes on drivers face strong political opposition, so the likelihood of adoption of the optimal corrective tax is very low. As noted above, even if the cost of the subsidy is levied on the drivers, it may be more politically easy to levy a tax based on an actual success in reducing traffic accidents, than a corrective tax which might not be understood by the public as a desirable means of accident prevention.

Besides the expected support of the insurance industry in the proposed subsidy, the opposition from other interest groups is not likely to be very strong. Gas companies might oppose it if they assume that aligning insurers' incentives with society's interests will result in less driving, but since the actual effect of this subsidy on other industries is not explicit and salient (like, for example, in corrective taxes on gasoline), their opposition would probably be less harsh. The motor industry may have gains and losses from an adoption of the proposed subsidy. Less traffic accidents means less vehicles damaged that need to be replaced. On the other hand, the proposed subsidy will probably induce more demand for safer cars, which are

¹⁵¹ See Edlin and Karaca-Mandic, *supra* note 2, at 951-952 and *supra* note 35, at 704-705.

usually newer, and for new safety technologies. It will give manufacturers that put more effort on safety an advantage.

The second advantage of the proposed subsidy is that after the subsidy is set, the insurance industry is likely to become an influential promoter and lobbyist for the goal of efficient governmental actions to reduce traffic accidents. As noted above in subchapter 5.1, the design of the subsidy should take this possible behavior into account by subtracting the increase of accident prevention costs borne by the government and other parties from the subsidy.

The combined nature of these two advantages is as follows: when there are political constraints that prevent achieving the optimal social policy and the current policy leads to a continuous social waste, the government may turn to a doable political step of incentivizing an interest group to reduce the social waste by sharing the profits from the reduction with the interest group. After this is done, the incentivized interest group may change the political balance to eliminate the political constraints than prevent the optimal policy from happening.

The third advantage of the proposed subsidy is that it may increase the political salience of the social costs of traffic accidents: if huge sums were paid to insurers for a partial reduction of traffic accidents, then maybe more people would be more aware of the costs that are still borne by the society because of traffic accidents. Increasing the salience may enhance more effective governmental policies to address the problem of inefficient traffic accidents—even regardless of insurers' lobbying. The increased salience of the costs may also influence people to drive more safely, since they would become more aware of the accident costs and risks.

If insurers are entitled to a subsidy only on the reduction of risk of their insured drivers, it might lead to an opposition of insurers to governmental initiatives to reduce the number of drivers, for example by developing alternatives for driving. On the other hand, the increased salience of the social costs of traffic accidents may lead to stronger public and political support for solutions such as enhancing public transportation. Thus, these trends may offset each other to some extent.

6. Policy Alternatives

In this chapter, I will compare the advantages and disadvantages of the proposed subsidy with those of other policy alternatives. One alternative is direct governmental regulation: the government will mandate or set incentives in order to reduce the abovementioned human inefficiencies and externalities. Another alternative is to give the subsidy to another agent that may be more effective in reducing traffic accidents. The alternative of corrective taxation was discussed throughout the paper and therefore it will not be discussed in this chapter.

6.1 Governmental Regulation

A. The Proposed Subsidy vs. Governmental Regulation and Direct Actions

As mentioned in subchapter 3.3, the government can do much more in order to reduce inefficient traffic accidents. I have already discussed some of the reasons why the government does not take the optimal measures to reduce inefficient traffic accidents, such as diffused political support, political difficulties in taking unpopular steps and the influence of the relevant industries on the regulators and policy-makers. In this part I want to address other considerations which are relevant for comparing governmental regulation and the proposed subsidy.

First, the government has a larger set of tools than the insurers: it can mandate and it can use enforcement forces which the insurers do not have. However, this is only an advantage where the mandate and its enforcement are more cost-effective than reaching to a similar result without compulsory means.¹⁵² This can be the case when, for example, a certain safety device, such as a safety belt or ABS, is especially efficient in reducing traffic accidents: mandating and enforcing its use may be cheaper than encouraging its use without a mandatory requirement.

Second, governmental intervention might not be possible where it contradicts other values, such as the right to privacy. It is unlikely, due to privacy concerns, that the government will mandate the use of monitoring devices, with the output sent to the government. Even if the mandatory requirement is more moderate, drivers might be suspicious and hostile towards it. Insurers, on the other hand, in their contractual relations with drivers, may persuade them to agree to things that the government cannot do directly—such as installation of such monitoring devices. This may lead to another problem: too much invasion of privacy by insurers. This can be dealt with by regulation of the information that can be sent to the insurer.¹⁵³

¹⁵² For example, the dramatic increase in safety standards of vehicles that I discuss in subchapter 3.1.

¹⁵³ See Moenig, *supra* note 36, at 31-32.

Third, the government can deal with problems that the insurers will not have incentives to deal with under the proposed subsidy. One example is shifting drivers to substitutes for driving when it is socially desirable. If the insurers get a subsidy based only on the reduction of risk in the drivers they insure, they do not have an incentive to promote switching to non-driving alternatives. They would have incentives to increase safe driving and reduce mileage, but not to encourage switching from driving to alternative means of transportation. They might even lobby against governmental efforts to shift drivers to public transportation. On the other hand, if the cost of traffic accidents would be more politically salient because of the subsidy, this may increase political pressure to do whatever is more efficient to reduce accidents—including measures that insurers cannot take or do not have incentives to take.

Fourth, there is the question of who can achieve the optimal allocation of resources and optimal choice of measures, in the areas where both the government and insurers can and have incentives to act. Both government and insurers have or may have access to information on causes of traffic accidents, ways of reducing them and expected risk from different drivers. However, insurers may have an advantage over the government when it comes to risk assessment of drivers, since they conduct the actuarial assessments and have a strong financial incentive to do so accurately. Even if the government can do so as well, it will result in wasteful duplicity.¹⁵⁴ In addition, the political process might damage the final governmental allocation of resources and measures chosen. As noted in subchapter 5.1, the government can improve the operation of the insurers under the proposed subsidy if it requires that insurers that want to receive the subsidy publish a detailed public report on the methods they use and their effectiveness.

Fifth, it is not clear which option is better: a variety of insurers that use different measures to reduce traffic accidents, or one centralized governmental policy. If the most effective and efficient way to reduce traffic accidents is clear and the government can apply this approach, a centralized policy is superior. If the most effective and efficient way is uncertain or may change a lot over time while the government reacts slowly to changes, using diverse non-governmental agents, driven by proper incentives to reduce traffic accidents, may actually help reveal the optimal way of reducing inefficient traffic accidents.

¹⁵⁴ In order to set the subsidy, the government needs data about the baseline risk of the different categories of drivers. This information may be obtained from the data collected by the insurers themselves. Other data needed for the proper function of the subsidy mechanism can be collected in the same way. Providing the data to the government could be mandated or required from insurers that want to have the opportunity to gain a subsidy.

Sixth, insurers may be more flexible than the government in changing the adopted policies. The institutionalized decision-making process of the government results in constraints on its flexibility. Insurers, on the other hand, can change their policies regarding the measures they take in a very flexible way, through a management decision, as long as they do not breach their current obligations.

Seventh, as noted, insurers might have a short-term bias and they may reject more efficient policies that are not expected to yield profits in the near future. This might derive from a management short-term preference or a fear of customer migration. As discussed above, proposals to reform methods of executive compensation in the literature may address the former and design features of the subsidy may address the latter. It can be claimed that the government may not be as short-term biased, although this claim is sometimes questionable.

To conclude, my argument with regard to governmental regulation is not that the insurers will always be superior to the government in reducing traffic accidents. However, in some fields where both insurers and government may operate there are some significant advantages of insurers over the government. The ideal way to address the problem of inefficient traffic accident is that both the government and insurers will operate where they have the relative advantage. The proposed subsidy may, at least partially, get closer to this result.¹⁵⁵

B. The Proposed Subsidy vs. Performance-Based Regulation

In a recent paper, Sugarman suggests implementing a performance-based regulation system.¹⁵⁶ He proposes that the government would define performance goals, such as the reduction of a certain percentage of current health harm during a certain time period, and would impose the responsibility of achieving this goal on parties who gain from the current harm. If the responsible party fails to deliver this outcome, it would be fined by the social cost of its underperformance. Sugarman suggests imposing such responsibility on manufacturers of cigarettes, alcohol, guns, junk food and motor vehicles.

This proposal resembles the proposed subsidy in the sense that it incentivizes private parties to promote social goals on the basis of actual outcomes. However, Sugarman's suggested

¹⁵⁵ As discussed in subchapter 4.1, the additional resources that the government would invest in reducing traffic accidents would be subtracted from the subsidy, while insurers would still benefit from it, if they could achieve the same reduction with a higher cost (and then their net profit would be lower).

¹⁵⁶ Stephen D. Sugarman, *Performance-Based Regulation: Enterprise Responsibility for Reducing Death, Injury, and Disease Caused by Consumer Products*, 34(6) J. HEALTH POL., POL'Y & LAW 1035-77 (2009).

regulation might be inferior to the proposed subsidy in the contexts of traffic accidents and maybe in other contexts as well. *First*, the most efficient and effective agents to achieve the reduction might not be the manufacturers of motor vehicles but insurers. While the manufacturers mainly influence the safety of the car, insurer discounts or surcharges for vehicle safety features (or lack thereof) will influence demand for production of safer vehicles. Moreover, insurers may have much more influence on drivers' decisions and behaviors—regarding safety as well as mileage, quality of driving and other factors discussed above. The manufacturers may contract with more efficient parties, such as the insurers, to achieve the performance goal imposed on them, but incentivizing the most efficient agent directly may save additional unnecessary costs.

Second, the lack of political feasibility for ideal corrective taxation might apply also to Sugarman's proposal since it is very similar to corrective taxation on manufacturers who are expected to resist it strongly. Sugarman's proposal is based on the notion of manufacturer fault. He suggests imposing the burden of reducing the health risk on the manufacturers that gain from selling products that kill and injure people. While manufacturers may be perceived to be at fault by the public in some contexts, (e.g., cigarettes), they may not be in others. In the context of obesity, for example, a Gallup poll from 2003, nearly 9 in 10 Americans oppose holding the fast-food industry legally responsible for the diet-related health problems of people who eat that kind of food on a regular basis.¹⁵⁷ Since the public does not perceive junk food companies as the ones to blame for the obesity and overweight problems, it might not be politically possible to hold them accountable as Sugarman suggests. It is likely that the same holds with regard to vehicles manufacturers.

Third, implementing Sugarman's proposal requires a determination of the performance goal, which is problematic on two accounts: if it is too high, it might have a chilling effect on the industry and social waste from excessive and inefficient risk reduction; if it is too low, which is more likely because of the political constraints, the social optimum would not be achieved. Under Sugarman's proposal, there is no incentive to the manufacturer to achieve a cost reduction larger than the one set in the regulatory performance goal, even if it is socially desirable. If the manufacturer is granted a subsidy for a reduction greater than the one set in the performance goal, it would then resemble the proposed subsidy. The proposed subsidy circumvents these possible

¹⁵⁷ Lydia Saad, *Public Balk at Obesity Lawsuits*, GALLUP POLL, July 21, 2003.

errors in determining performance goals by setting incentives for insurers to achieve the socially efficient accident reduction without determining a particular performance goal.

6.2 Alternative Subsidies

The government can grant a subsidy to other agents or activities for the purpose of reducing traffic accidents. One possibility is governmental support in research and development in this field. It is not implausible that in a few decades the vision of driverless car will become a reality and traffic will be managed by computers, with many fewer errors in driving and far fewer accidents.¹⁵⁸ The social return on investment in research and development that would lead to this goal may be vast—much higher than any other investment in preventing traffic accidents. The social damages that can be saved as a result of an acceleration of the realization of this vision may be huge, even in present value numbers.

For example, if we assume a discount rate of 4 percent, and that a current investment will accelerate the development of this vision in one year: 30 years from now instead of 31 years, if no investment is made. Also assume that this acceleration is expected to generate a 100 billion dollars reduction during the year 30 years from now. This acceleration, of one year only, 30 years from now, is worth approximately 31 billion dollars in present value numbers.¹⁵⁹

The overall 2009 budget of the Research, Development and Technology Department of Transportation was approximately 624 million dollars, of which the budget of the Intelligent Transportation Systems was 103 million dollars. This includes funds for research in areas which are not related to safety.¹⁶⁰ NHTSA's estimated 2010 budget includes \$107 million dollars for Highway Safety Research and Development activities.¹⁶¹ None of these, as is seen in the budget description, was determined in correlation with the estimated present value of the projected effect of the research on the reduction of traffic accidents.

Although the government should prioritize investments according to their expected return, I think that the proposed subsidy in this paper is not in a real competition with more governmental investment in research and development, even if the latter may have higher return

¹⁵⁸ For general elaboration on the vision of driverless car see http://en.wikipedia.org/wiki/Driverless_car (last visited April 17, 2010); for details on governmental projects on intelligent transportation systems see <http://www.tfrc.gov/its/its.htm> (last visited April 17, 2010).

¹⁵⁹ $100/1.04^{30}$

¹⁶⁰ See FHWA FY 2010 Budget, Exhibit V-2; a link to FHWA budget estimates is available at <http://www.dot.gov/budget/2010/> (last visited April 17, 2010).

¹⁶¹ Budget, U.S. Department of Transportation, Estimates Fiscal Year 2010, NHTSA, 27; a link to NHTSA budget is available at <http://www.dot.gov/budget/2010/> (last visited April 17, 2010).

on investment. *First*, the proposed subsidy would induce a social gain by reducing the social waste, so the social resources that could be used to fund a subsidy for research and development should be higher—not lower. *Second*, the political problems that I discussed in subchapter 3.3 might lead to a situation in which a significant increase in the governmental research budget is unlikely to happen. In this situation, adopting the proposed subsidy may be the feasible second best solution. *Third*, the proposed subsidy may operate as an indirect subsidy for research and development, since it would increase the demand for safety products. The downside is that if the subsidy is limited to several years, it will not incentivize research that might last more than this time period. In addition, a safety product which has a long-term effect might not be appealing to insurers because of the abovementioned threat of short-term bias.

Another alternative subsidy is a government subsidy for vehicle manufacturers for safer vehicles and safety equipment. This subsidy might not have many advantages over the proposed subsidy to insurers. *First*, as mentioned, the proposed subsidy may serve as an indirect subsidy for manufacturers of safer cars. *Second*, the insurer would probably choose the most efficient measures to achieve the maximum risk reduction. For example, if it is cheaper to persuade a driver to buy a safer car by filling her information gaps, this would be preferred to a more expensive subsidy. Thus, the proposed subsidy is more likely to be more efficient.

7. Conclusion

This paper presents the concept of a corrective subsidy that would be paid to insurers for a reduction of traffic accidents of their insured drivers. This subsidy mechanism, despite its complexities and imperfections, may still pose significant advantages towards an efficient reduction of traffic accidents. The proposed subsidy would take the current social cost of traffic accidents to utilize it as an incentive for insurers to take measures to reduce traffic accidents.

There are several reasons why drivers, insurers and the government do not reach the optimal prevention of inefficient traffic accidents. While drivers create negative externalities, they also behave in a sub-optimal manner with regard to the risks that they bear—mainly due to behavioral biases, lack of information and social norms. The proposed subsidy addresses the externalities as well as the internalized inefficiency problems. In this respect, it is different than corrective taxes, supported by several commentators, which only internalize externalities. It is likely that the deterrence effect of penalties on traffic violations and tort liability corrects some of the current inefficiencies, but there are plausibly still large inefficiency costs which are not corrected due to either sub-optimal deterrence or inefficiencies that cannot be efficiently eliminated by deterrence.

Even if we assume that insurers gain from accident risk reduction—which is questionable, they do not have incentives to take measures to reduce traffic accidents to the socially optimal level since they bear only part of the accident costs—only approximately 100 billion dollars out of 231 to 433 billion dollars damages per year—and because they would enjoy only a part of the reduction of the externality of driving of their drivers. The amount of the proposed subsidy is up to the saved social cost that is not insured by the insurer. By granting a subsidy on the basis of “success” in reducing traffic accidents, insurers would internalize the positive externality from their actions to reduce traffic accidents, and their incentives would become aligned with the interests of the society.

The government today does not take the optimal measures to reduce inefficient traffic accidents for various reasons, such as diffused political support, political difficulties in taking unpopular measures and the influence of the relevant industries on the regulators and policy-makers. The proposed subsidy may gain political support since insurers would probably support it and it would be easier to gain public support for a success-based plan, which is not perceived as an unpopular tax (such a corrective gasoline tax). Subsequently, insurers may become

influential in supporting efficient governmental measures to reduce accidents (as long as they benefit from this reduction). The subsidy may also increase the salience and public awareness for the social costs of traffic accidents, and this may lead to a political pressure to take efficient governmental measures.

Insurers can affect drivers' decisions and behaviors in many ways: granting discounts for the use of safety equipment and lower rates for safer cars; mitigating the problem of lack of information of certain drivers by supplying information in effective ways; improving driving skills by granting discounts for advanced driving courses; adopting a Pay As You Drive premium system, that charges extra premium for any additional mile of driving, and by doing so leads to internalizing of the marginal accident externality of driving; adopting a Pay How You Drive premium system, that charges more for risky driving patterns, monitored by monitoring driving devices. Many of these measures are already implemented to some extent by insurers. However, since the insurers' incentives are not aligned with the social interests (because they do not benefit the uninsured reduction of accidents), they do not have the socially proper incentives to take those measures.

The design of the proposed subsidy should take into account many factors, such as the method of allocating the benefit from reducing externalities, treatment of shifting of reduction cost to other parties (such as the government or the drivers), limitations on screening techniques, treatment of short-term bias and other design issues. Another important question is how to fund the subsidy: by general taxes or by doing distribution-neutral tax adjustments to offset the distributive incidence.

Finally, I compared the proposed subsidy to alternative policies for reducing traffic accidents, such as governmental regulation, performance-based regulation system and subsidies to research and development and vehicle manufacturers. My analysis shows that the proposed subsidy may have significant advantages over its alternatives in many respects, and I also point out its relative disadvantages. To conclude, the proposed subsidy may play a significant role in the reduction of traffic accidents even if implemented on a partial scale. Many aspects in its design and in the analysis should be further developed before turning this proposal into an applicable subsidy system. The large social costs at stake make this proposal worth examining.