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Fasten seat belts: Do car safety systems cause positive externalities?

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Abstract

Although traffic safety belongs to the quite intensively regulated sectors, there has been little discussion about the adequacy of the arguments underlying these regulations. We argue that passive and active car safety systems might cause positive externalities for other traffic participants and present empirical evidence in favour of this hypothesis.

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1. Introduction

In most developed countries the market for road traffic safety systems is highly regulated. The high level of car and driving safety regulation imposes considerable costs on traffic participants. Surprisingly enough, neither the public nor the scientific debate about road traffic safety is very much concerned with the theoretical foundations of traffic safety regulations. Most politicians' view on safety regulations is characterized by the opinion that the mere existence of risk is per se undesirable and should be eliminated at almost any cost (see Viscusi and Gayer, 2002, p. 55). This view is substantiated when reading through official documents explaining why certain measures of traffic safety were taken (see e.g. European Commission, 1995). These documents are almost always lamenting the high number of the injured and dead. Most safety professionals believe that road traffic deaths and injuries are to a great extent preventable by driving carefully (e.g. at lower speeds) and making use of active and passive driving and vehicle safety systems. In consequence, governments around the globe focus their efforts on pressing engineers to develop various sorts of car safety systems. Moreover, the existing regulations force traffic participants to make use of these safety systems and to stick to certain driving security standards. Behind this reasoning is the implicit assumption that the associated increases in cost and the utility reductions from sticking to the rules are negligibly small (see Lave, 1987, p. 30). Interestingly enough, the fact that a society without any risk would be tremendously costly and is thus infeasible is rarely a policy concern of consequence.

Up to now, neither the public nor the scientific debate about traffic safety is very much concerned with the theoretical foundations of traffic safety regulations. This note aims at contributing to filling this gap in the literature. We argue that most arguments employed to justify vehicle and driving safety regulations are unconvincing. We introduce a new argument into the discussion, which has yet not been discussed: positive externalities resulting from safety actions. Based on an accident-database we then present empirical evidence in favour of the hypothesis that these externalities in fact exist.

2. Externalities

According to the economic approach to (safety) regulation individuals make rational choices between available alternatives of behaviour. Only if market failures occur there might be room for governmental intervention. While natural monopolies and public goods play no role in the context of vehicle and driving safety, some authors argue that informational asymmetries might serve as a justification of regulation (see e.g. Arcuri, 1999). According to this view, the consumers of vehicle or driving safety are badly informed about either the risks of unsafe driving or the advantages of undertaking safety efforts. Both leads to a suboptimal low demand for safety actions and thus constitutes a market failure which calls for safety regulation. However, one might argue that providing the lacking information is superior to any technology-forcing regulation since traffic participants are not constrained in their individual choices (see Schwartz and Wilde, 1979 and Viscusi and Gayer, 2002). According to a different line of argument, traffic accidents in general might cause spillover effects on the rest of society whenever welfare states take over the responsibility for those unable to avail themselves of the minimal provisions for a good life (see Seebode, 1986). This might lead to serious moral hazard behaviour of citizens and result in excessive costs. For example, traffic participants might decrease their safety efforts since they expect to be supported by the state whenever they suffer a serious injury from a traffic accident causing excessive health care or recovery costs or leading to permanent total disability. Several states such as e.g. Germany follow this line of argument when justifying traffic safety regulations (see Seebode 1986). However, one might question whether this sort of moral hazard behaviour in fact occurs in a magnitude sufficient to justify the enormously high level of traffic safety regulation in most developed countries.

Interestingly enough, for a long time externalities have not played a significant role in the discussion on the justification of traffic safety regulation. We argue that safety efforts might generate both a positive risk and a damage externality. A risk externality occurs whenever the safety efforts of a traffic participant lower the risk of other traffic participants to cause an accident. A damage externality results whenever a car driver's safety efforts lower the damages occurring in an accident which was caused by someone else. Since both sorts of externalities are neglected by car drivers (and passengers) the chosen safety levels are inefficiently low and thus might demand regulation.

3. Data

For our empirical analysis we employ data from the GIDAS-database (German In-Depth Accident Study), the largest accident study in Germany.[1] Since mid 1999, the GIDAS project collects data on accidents with personal injuries. Our sample covers the period of July 1999 until June 2008. Since externalities primarily occur when more than one vehicle is involved we focus on accidents with at least two vehicles. However, we exclude all accidents with more than two cars from the sample since causation issues are often quite complex in accidents with multiple vehicles.

Altogether, we had data on a total number of 2.435 accidents in which 4.870 cars and 7.590 passengers were involved. We constructed our dataset on the individual passenger level and have data on the passenger, the driver of the accidental car, the properties of the car and the surrounding circumstances of the accident. Instead of discussing all utilized control variables here in length we concentrate on those in the centre of interest and refer to table I with respect to the remaining ones.

For each involved person we have data on the suffered injuries. For every single passenger the so-called ISS-score is available, which bases on the Abbreviated Injury Scale (AIS). The AIS is a well established anatomical scoring system to assess trauma severity (see e.g. Copes et al. 1988) with 7 injury categories (0: none, 1: minor, 2: moderate, 3: serious, 4: severe, 5: critical, 6: nonsurvivable). The AIS-score is available for 6 different body regions. The ISS-score is calculated according to $ISS = A^2 + B^2 + C^2$ where A, B, C are the AIS scores of the three most injured body regions. The ISS might take scores from 0 to 75. If any of the three scores is a 6, the score is automatically set at 75.

[1] For a more detailed description of the GIDAS-database visit: http://www.gidas.org/.

We also have data on the passive and active safety systems the passengers used or which protected them. As far as passive systems are concerned we have information on whether the individual passenger used his seat belt. Moreover, we know whether the car, hosting a certain passenger, was equipped with an anti-lock brake system (ABS), an electronic stabilization system (ESP) and a traction control system (TCS).[2]

Table I: Variable description

Variable	Variable description	Range
ISS	Passenger's injury level on ISS-scale	0-75
CAUS	Car driver caused the accident	Dummy
FEMALE	Female car driver	Dummy
AGE	Car driver's age (in years)	Numeric
ALC	Car driver consumed alcohol	Dummy
COLL	Collusion speed	Numeric
EXP	Experience of car driver (in years)	Numeric
AGEC	Car's age (in years)	Numeric
WEIGHT	Car's weight (in kg)	Numeric
POWER	Car's engine power (in ccm's)	Numeric
ESP	Car was equipped with electronic stabilization program	Dummy
TCS	Car was equipped with traction control system	Dummy
ABS	Car was equipped with anti-lock brake system	Dummy
BELT	Passenger used seat belt	Dummy
TOWN	Accident happened in town	Dummy
RAIN	Accident happened when raining	Dummy
HAIL	Accident happened when hailing	Dummy
SNOW	Accident happened when snowing	Dummy
FOG	Accident happened when foggy	Dummy
NIGHT	Accident happened during night	Dummy
TWI	Accident happened during twilight	Dummy
WIND	Accident happened under constant wind	Dummy
SQUAL	Accident happened under squally wind	Dummy
WET	Accident happened on wet road	Dummy
LUBR	Accident happened on lubricious road	Dummy
SLIP	Accident happened on slippery road	Dummy
CAUSE(X)	Accident was caused by X (X=1,..,19; e.g. overtaking)	Dummy

[2] We decided not to include activated airbags into the analysis, since they activate only in the case of comparatively severe accidents. Thus, an airbag activation dummy would factually be identical to a severity dummy, which is likely to have a injury-increasing effect. In fact, activated airbags deliver a significantly positive coefficient when adding them to the regression analysis.

4. Empirical analysis

Our estimation strategy consists of pooling all passenger data and running cross-section regressions with the injuries, as measured by the ISS (MAIS) indicator, as endogenous variable. In a first step we study in how far the safety systems, the passengers in the car not causing the accident were protected by, contributed to lowering their injuries. Whenever they did so, we in fact deal with an externality since the driver of the car causing the accident is also responsible for covering the costs of the victims.

In order to study which safety systems in fact cause externalities, we estimate the following OLS-regression:

$$ISS_i = c + \alpha_1 \cdot BELT_i + \beta_1 \cdot ESP_i + \beta_2 \cdot ABS_i + \beta_3 \cdot TCS_i + \sum_{j=1}^{J} \gamma_j \cdot C_{j,i} + \varepsilon_i$$

where c, α_1,β_1, β_2, β_1 and γ_j are the parameters to be estimated and ε is the unexplained residual. The remaining variables are defined as reported in table I (C_j stands for the J additional control variables used in the regression). The estimation results are shown in table II.

Table II: Estimation results

Variable	Coefficient	Std. Error*	t-Statistic	Prob.
Constant	1.89***	0.654	2.89	0.0049
TOWN	-0.66***	0.167	-3.97	0.0001
COLL	0.02***	0.003	5.36	0.0000
AGE	0.01***	0.005	2.94	0.0033
CAUSE(2)	2.04*	1.113	1.83	0.0673
CAUSE(3)	1.10***	0.337	3.28	0.0011
FOG	-1.73***	0.486	-3.56	0.0004
SLIP	-0.77**	0.302	-2.56	0.0106
FEMALE	0.40**	0.154	2.58	0.0101
ESP	-0.27***	0.102	-2.65	0.0081
ABS	-0.37***	0.138	-2.68	0.0075
BELT	-1.27**	0.615	-2.06	0.0391
Observations	3326			
R-squared	0.067498			
Adjusted R-squared	0.064403			
S.E. of regression	3.565191			
Sum squared resid	42122.87			
Log likelihood	-8941.448			
F-statistic	21.80741			
Prob(F-statistic)	0.000000			

*We report White-corrected standard errors.

Besides the regression constant, we find eight control variables to be significant, all of which have the expected sign. Injuries turn out to be less severe when the accident happens in town, when it is foggy or when the street is slippery. In all these cases the drivers of the cars not causing the accident seem to drive more slowly and more carefully. Whenever the accident was caused by excessive speed or a driver's faulty reaction the damages turn out to be significantly higher. The same holds true when the collusion speed is high. Damages turn also out to be higher with elderly and female drivers.

However, our focus is on the variables describing in how far the passengers were protected by an active or passive safety system. While we find seat belts, antilock brake systems and electronic stabilization programmes to contribute significantly to lowering the damages in the car not causing the accident, we find no such effect for traction control systems. Thus, our empirical results are in favour of the hypothesis that not only seat belts but also antilock brake systems and electronic stabilization programmes tend to cause positive externalities.

5. Conclusions

Based on a newly constructed dataset we present empirical evidence in favour of the hypothesis that passive and active car safety systems do not only protect passengers of cars causing accidents. They also lower damages when a car is innocently involved in an accident. Thus, regulation of traffic safety might also be justified without having to rely on arguments of distorted preferences or asymmetric information.

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