E C O N O M I C S B U L L E T I N

Economic Determinants of Driver's Behavior in Minas Gerais

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Abstract

The aim of the paper is to evaluate the behavior of drivers when they face a safe-traffic environment. Some studies suggest that the laws that demand auto makers to produce safer vehicles also stimulate their drivers to drive carelessly, since the cost of driving carefully decreases. Likewise, a safer traffic environment or less dangerous surroundings can stimulate drivers to drive more aggressively and less carefully. This study tries to test whether the undesirable behavior described by Peltzman (1975) is observed on the highways and roads of the State of Minas Gerais, Brazil. Estimates based on data found in the Brazilian Federal Road Police's accident report databank confirm drivers' lack of attention in safer environments. The results suggest that careless behavior in traffic increases when safer conditions prevail.

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1. INTRODUCTION

In 2004, the World Health Organisation (WHO) and the World Bank published a report on the prevention of traffic accidents. The report estimates that 1.18 million people died in 2002 because of traffic accidents. This figure represents 2.1% of all causes of deaths, and places traffic accidents in the 11th position of this ranking.

More than 50% of the accident victims are adults and youths aged between 15 and 44 years. In developing countries, the costs of traffic accidents represent something between 1% and 2% of GDP[1].

The existence of economic costs of accidents often suggests public policies that contribute to a safer traffic: investments in a safer road infrastructure, the application of norms for producing safer vehicles, and traffic control and education. However, what if the investment in road infra-structure also causes an increase in the drivers' perception of safety, inducing them to drive imprudently? For instance, a road with new pavement and signs, and safer vehicles (with safety items such as seat belts, air bags, lateral protection bars) can reduce the effort for a more cautious driving. The objective of this article is to contribute to the understanding of the behaviour of drivers facing safer environments.

In the cases in which such adverse effect of road conditions improvements on the drivers' behaviour with regard to the trade-off speed/attention (prudence) cannot be refuted, investing in a change in the driver's behaviour becomes a priority in order to reduce the number of accidents. As a result, traffic control becomes a key element in increasing the costs of inattentive or careless driving.

Some studies tested this adverse behaviour, but none of them has yet been carried out for Brazilian roads. This paper uses the *Polícia Rodoviária Federal* (Federal Road Police) DATATRAN database from 2004 to 2006, in order to investigate whether drivers in safer environments present aggressive or careless behaviour. In the following section, we perform a brief literature review. Section 3 explains the methodology and data source used, and presents the results. Finally, section 4 concludes.

2. ECONOMIC DETERMINANTS OF THE DRIVERS' BEHAVIOUR

The works that examine the determinants of drivers' behaviour or of traffic accidents basically follow two references: one of them is Becker (1969) and the other is Peltzman (1975). As Loureiro, Sachsida and Moreira (2004) assert, if imprudence is understood as a result of an illegal behaviour of the driver, the framework proposed by Becker (1968) can be used. The illegal behaviour would be related to the cost-benefit analysis carried out by individuals in rational decision-making. Loureiro, Sachsida and Moreira (2004) argue that an individual chooses to go beyond the speed limit, for example, because such action reduces transportation costs (less time on the route), but on the other hand observes an increase of the risks of facing costs for violating the law (traffic fines, loss of driver's licence and even imprisonment). The illegal behaviour therefore results from maximising utility, which could determine traffic accidents.

[1] Some of the costs of traffic accidents are: first aid for victims, hospital expenditures, social security expenditures, vehicle damages, road damages, traffic jams, temporary or permanent production losses etc. The total estimated cost of traffic accidents in Brazil in 2005 was of approximately 6.5 billion Brazilian Reais (3.8 billion Dollars using April´s 2008 average exchange rate) [IPEA/DENATRAN (2006)]. The state of Minas Gerais leads the ranking of the total estimate cost of accidents in federal roads. This position can be explained by the extension of the federal road network in the state, which is the largest in Brazil, and by the great flow of vehicles. The state also serves as a connection from the South to the Northeast of Brazil and to a significant part of the Centre-West.

For the case of Brazil, with a theoretical basis on Becker (1968), Mendes (2002) tested the effectiveness of the new Traffic Code enacted in 1997 through an ARIMA model with intervention. The author used the aggregate series of the rate of mortality per capita in traffic accidents in Brazil. The results showed that the impact on the mortality decrease was only temporary and small if compared to similar regulations applied in other countries. This supports the idea that drivers perform a cost-benefit analysis of careless driving, because the reduction in mortality occurred only in the first year of the implementation of the law, during which there were high punishment expectations. After the first year in force, the inefficiency in the law's application pointed to a lower cost of driving aggressively or carelessly. Therefore, the reduction would not have been permanent. It is important to stress that the author did not use any type of control for the increase in the number of licensed drivers and in the vehicles in circulation.

Also from Becker (1968), Loureiro, Sachsida and Moreira (2004) performed an empirical test based on a sample of drivers from Brasília (DF). According to the authors, some actions, such as using a mobile phone or smoking when the vehicle is in movement, are determinants of traffic accidents in the analysed sample.

In 1968, a vehicle safety regulation approved by the National Highway and Traffic Safety Administration (NHTSA) came into force in the United States. This regulation introduced the requirement of devices such as seat belts, tempered glass windshields, padded panel instruments, double break systems and energy-absorbent steering wheel columns.

Peltzman (1975), taking advantage of such 'experiment', tested the effects of the vehicle safety regulation in the United States, and concluded that these changes had not decreased the number of casualties on the roads. The results of the empirical test suggest that the vehicle safety rules failed to reduce the number of accidents. In a safer environment, drivers started to be less concerned about driving safely. This happened because, with safer vehicles, the probability of death due to careless or aggressive behaviour is theoretically reduced. More specifically, the results point to a reduction in the number of deaths among passengers and more accidents without victims, and on the other hand more deaths among pedestrians and a larger number of accidents. The net effect was that of an aggregate increase in the number of deaths in traffic after the enactment of the regulation. Since then, the hypothesis that drivers behave more aggressively (or in a careless way) in response to an increase in the safety of the environment to which they are exposed became known as 'Peltzman effect'.

Traynor (1993) tested the Peltzman hypothesis with specific data from the *Integrated Traffic Reporting System (SWITRS)* of the state of California. This database contains information on all collision reports made by the California road police. The reports show information on the location, the drivers' behaviour, road conditions and the gravity of the accident. Using this database, the author isolated specific aspects of the drivers' conducts which cause accidents. It was thus possible to conclude that, in part, the cause of careless or aggressive driving had occurred after the establishment of the safety regulation.

There are papers that empirically reject the hypothesis proposed by Peltzman (1975). Russel and Nesbit (2007) observe that the results in the literature on this subject are not conclusive. This occurs because of a problem of obtaining data related to the accidents. According to the authors, studies generally use the number of traffic injuries and deaths as a proxy for (un)safe driving. Thus, drivers' behaviour would be measured in an indirect fashion, generating doubts about the achieved results.

In that article, Russel and Nesbit (2007) tested the Pelzman effect for the safety changes promoted in the National Association for Stock Car Auto Racing (NASCAR) competitions. They measured the presence of the drivers' adverse effect through the estimation of the relation between the number of accidents in seasons 1972–1993 and the

probability of injuries, conditioned to the pilot's involvement in an accident. The result was a negative and statistically significant effect for the variable 'probability of injuries', which suggests that, in a safer environment, NASCAR drivers got involved in more accidents, since the cost of driving aggressively is smaller.

Grabowski and Morrisey (2002) performed an econometric analysis with data on traffic accidents in United States public roadways, using the Analysis Reporting System, in the period 1985–2000. The research results indicated that the seat belt law was efficient in reducing the number of casualties. Yet, no evidence was found that the law that prohibits driving under the influence of alcohol had a similar effect. Another important result suggests that a more rigid control in renewing the driver's licence for people older than 60 years could be efficient.

Inspired by Traynor (1993), and consequently by Peltzman (1975), this article chooses to consider the influence of road, weather and vehicle conditions on the behaviour of drivers who were involved in accidents in federal roads or in parts of those located in the state of Minas Gerais. We suppose that, similarly to a regulation that compels the use of seat belts, variations in traffic conditions can be understood as incentive changes, which ultimately would contribute to the attitudes chosen by the drivers.

3. EMPIRICAL ANALYSIS

3.1. Database and methodology

The descriptions of rescues from traffic accidents in federal roads are electronically made by federal road policemen in the system BR-BRASIL, from the Office of Statistics of the Federal Road Police Department. The reports contain information on: location of the accident, weather and road conditions, vehicle situation, duration of the drivers licenses, presumable cause of the accident, gravity of the accident (without victims, with injured victims, with casualties) and other relevant factors. The DATATRAN system receives input from BR-BRASIL. This database of traffic accidents reports is only available as of January 2004.

Our main estimates are made with information from all the accidents that took place in Minas Gerais in the period from January 2004 to August 2005.

We adapted the econometric model proposed by Traynor (1993) to the variables available in the DATATRAN database. The econometric model used is the *Logit*. The drivers' effort to drive safely is defined by the following equation in the *Logit* model:

$$EFFORT = f(UNSAFE, z) \tag{1}$$

The variable *EFFORT* represents the effort or behaviour of the driver at the moment of the accident as evaluated by the road policeman after the accident; *UNSAFE* indicates the level of safety in the driving environment, and z is the set of other factors that can affect the variable *EFFORT*.

The dependant variable, *EFFORT*, was divided in two *dummies*: aggressive driving *(AGRESS)* and inattentive driving *(INATTENTIVE)*. Aggressive driving occurs when the driver's behaviour leads him to drive without keeping a safe distance from other vehicles, to pass when forbidden, to drive at incompatible speed or to disobey traffic signs. In the same way, inattentive driving relates to lack of attention or sleepiness.

The first independent variable of the model is the lack of road safety (*UNSAFE*). This variable corresponds to the sum of unsafe characteristics that existed at the moment of the

accident. The characteristics are: rain or fog, night time, lack of physical division between opposite lanes, road outline (curves), lack of horizontal or vertical signs, and tire conditions (bald or not). Dummy variables for each one of these characteristics present value one when occurring or zero when not occurring. As a result, the variable lack of safety *(UNSAFE)* is the sum of the *dummy* variables, which can have a value from zero to six. It is expected that *UNSAFE* has a negative sign.

Disaggregating *z*, the model used is presented like this:

$$EFFORT = f(\alpha + \beta_0 UNSAFE + \beta_1 ROAD + \beta_2 YOUNG + \beta_3 INCOME) + u \qquad (2)$$

The dummy variable *ROAD* was used only for the complete sample. This variable informs the conditions of federal roads of Minas Gerais in the location of the accident, that is, it serves as a control for road conditions. It equals one when the quality of the road stretch is poor and zero when it is good or regular. It is expected that it has a negative relationship with both *AGRESS* and *INATTENTIVE*.

The third variable used represents the effect of the driver's experience (*YOUNG*). It equals one if all the drivers involved in the accident were 24 years old or younger, or zero otherwise.[2] According to Traynor (1993), it is expected that this variable presents a positive relationship with the variable *AGRESS* and a negative relationship with the variable *INNATENTIVE*, since usually younger drivers and those with shorter licence periods do not have driving experience on roads and highways, and drive more aggressively.

Traynor (1993) used a specific variable to measure the cost of driving time. It was represented by the variable *INCOME*, which is the income per capita of the municipality where the accident occurred. In this paper we use the income per capita of the municipality where the accident occurred only for the sample of accidents between January 2004 and August 2005.

In the study by Traynor (1993) three samples were used. The first one was a random group of accidents in January 1978. The second one used only accidents with victims in the same one-month period. Finally, the third sample included only accidents with casualties in 1978. In all of those samples, the *UNSAFE* coefficient was statistically significant at the 99% confidence level, and in every equation the coefficient for this variable was negative, as expected. These results, according to the authors, corroborate Peltzman's hypothesis. When facing unsafe environments, drivers are less inclined to drive aggressively and inattentively.

It is to be stressed that it was impossible to obtain details on the behaviour of the drivers that did not get involved in accidents; only those who had accidents were analysed. Yet, as Traynor (1993) observes, the exclusive use of observations in which accidents occurred would not generate a bias in the results, since accidents can occur regardless of the safety conditions and/or the driver's safe behaviour.

3.2. Results

The results for the sample of accidents that occurred in Minas Gerais from January 2004 to August 2005 for both dependent variables *INATTENTIVE* and *AGRESS* are shown in Table I.

All the estimated parameters in the equation were statistically significant at the 99% confidence level. As expected, the coefficient of the variable *ROAD* is negative, indicating

[2] In Traynor (1993), this variable identified the male drivers with less than 25 years. However, our data base does not allow us to identify the driver that caused the accident, and therefore we used the criterion that "all of the drivers involved in the accident must be 24 years old or younger" in order to give value one to the observation for *YOUNG*.

that, in roads with poor conditions, drivers are more attentive. In addition, the estimated coefficient for *UNSAFE* was negative, showing that, in augmenting the unsafe characteristics of driving (curves, lack of physical division between opposite lanes, rain, bald tire, bad signs), the probability of the accident occurring because of inattentiveness diminishes. The results thus confirm Peltzman's hypothesis.

The estimated parameter for *YOUNG* was negative, also as expected. Younger drivers have proven to be less inattentive. Finally, the coefficient of the variable INCOME, that measures the cost of the driver's time, was positive. Hence, individuals with higher income tend to cause accidents because of inattentiveness.

Table I – Logit Model Results

Logit	Inattentive	Agress
Road	-0.41913 *	-0.71438 *
	-7.23	-1.23
Unsafe	-0.60956 *	0.30318 *
	-3.19	1.96
Young	-0.29789 *	0.20180 *
	-5.78	5.06
Income	0.00004 *	0.00002 *
	2.51	1.61
Constante	-0.94 *	-1.75 *
	-2.38	-4.48

(*) significant at 0.10 level, (**) significant at 0.05 level and (***) significant at 0.01 level.
z-values are presented below the estimated coefficients (robust standard-errors were used).
Observations = 24967

For the equation with the variable *AGRESS*, all the parameters were also statistically significant at the 99% confidence level. The negative coefficient for ROAD shows that the probability of the accident happening because of aggressive driving is smaller in roads with bad conditions, confirming Peltzman's hypothesis.

The variable *YOUNG* presents negative coefficient in this equation. Younger drivers, although less inattentive, have proven to be more aggressive. The coefficient for the *UNSAFE* parameter is positive in this regression, indicating a bigger chance of the accident occurring because of aggressive driving in unsafe driving conditions. This result can indicate an excess of confidence of the drivers in potentially dangerous situations. The coefficient for income per capita, *INCOME*, was also positive in the equation estimated with the dependent variable *AGRESS*, that is, drivers with higher income tend to be more aggressive because, for them, the opportunity cost of driving is higher.

4. CONCLUSIONS

The hypothesis that the drivers are more inattentive and aggressive when on roads with good conditions was confirmed. Drivers also tend to be more inattentive when weather and traffic conditions are favourable. As expected, the probability of getting involved in an accident among young drivers is higher because of aggressive driving and lower because of lack of attention. Yet, differently from the expected result, drivers are more aggressive in unsafe traffic conditions.

In general, these results support Peltzman's hypothesis. Therefore, the study of human behaviour is relevant to achieve success in reducing the number of accidents. Statistical data

on accident reduction obtained through engineering projects (crash tests) are imprecise, as they ignore the adverse effect that was considered here. Safer roads and more resistant vehicles diminish the expected cost of accidents, providing an incentive for more aggressiveness and inattentiveness among drivers. Yet, this study does not corroborate the idea that building better roads and installing additional vehicle safety devices produce a negative effect, so as to cancel that positive effect.[3]

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[3] This matter can be the subject of further research. In addition, as suggested by Traynor (1993), tests can be made on the existence of assymetrical information among the drivers on the costs of accidents.