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Italian "Homicide Road Law":
Evidence of a Puzzle?

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Italian “Homicide Road Law”: Evidence of a Puzzle?

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Abstract

We analyse the effectiveness of Law 41/2016 (the so-called “homicide road law”), introduced in Italy in 2016 with the aim of reducing dangerous driving on Italian roads, through a system of escalating sanctioning, where the severity of the punishment is based on the type of injury caused by the road accident. We first explore theoretically the two-sided effect of Law 41/2016, in terms of general and marginal deterrence. Then, we exploit micro-data on the entire universe of road accidents in Italy in the period before and after Law 41/2016 and measure its effectiveness in reducing the number of fatal outcomes. The estimation results unveil that, after the introduction of Law 41/2016, both the extensive and the intensive margin of deaths in road accidents was not reduced, while, if anything, a weakly significant increase is observed in the extensive margin. The study may contribute to the optimal design of driving regulation both in Italy and in other countries.

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Keywords: Homicide Road Law, Vertical Deterrence, Marginal Deterrence, Escalating Penalties, Hybrid Sanctions.

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1. Introduction

On March 23, 2016, Italian Parliament passed Law 41/2016, the so-called *homicide road law*, aimed at curbing dangerous driving on Italian roads and at reducing death outcomes of road accidents, according to the EU benchmark of a 50% reduction in the number of deaths to be achieved in 2020 with respect to 2010 levels.

Law 41/2016 was the end of a long parliamentary procedure started with the Draft Law 859, in 2013. Draft Law 859 introduced an intermediate type of offence between homicide and negligent homicide, by criminalising dangerous, drug and drunk driving. A driver, guilty of death on the road, could be sentenced up to 21 years and with the permanent revocation of driving licence. Law 41/2016 rejected this approach and introduced a more severe type of negligent homicide, called “road homicide”, for dangerous, drug and drunk driving. The first paragraph of Law 41/2016 sets the pivotal sentence for negligent homicide in a similar manner as previous legislation. However, differently from the Draft Law 859, that considered a unique alcohol threshold in the driver’s blood as in UK, Law 41/2016 introduced intervals. More importantly, it also laid down a complex system of escalating sanctioning, increasing average sanctions and differentiating the severity of the punishment on the basis of the type of injury caused by the road accident.

Our paper analyses the effectiveness of Law 41/2016 and, in particular, its consequences in terms of death outcomes. Despite the extensive clamour raised by the launch of Law 41/2016, at a first glance it has appeared to be counter-productive, as the overall number of deaths increased from the first semester of 2016 (1510 deaths) to the first semester of 2017 (1623 deaths). With this paper, we try to address this puzzle and to investigate, both theoretically and empirically, whether Law 41/2016 has actually been ineffective and, if so, what are the main reasons behind this failure. Specifically, we explore the two-sided effect of Law 41/2016, in terms of general and marginal deterrence, and measure its effectiveness by using micro-data on the entire universe of road accidents in Italy in the period before and after Law 41/2016.

To the best of our knowledge, this is the first study on Law 41/2016. We both provide a theoretical interpretation of the design of Law 41/2016 and present the first empirical analysis of its effectiveness, by taking advantage of the last release of road accidents data, provided by the Italian National Institute of Statistics (ISTAT). In doing so, we contribute to the wide and long-standing law-and-economics literature on deterrence and sanctioning (Polinsky and Shavell, 1979; Shavell, 1992; Mookherjee and Png, 1994; Garoupa, 1997; Polinsky and Shavell, 2000; Basili and Nicita, 2006; Chen and Shapiro, 2007; Owens, 2009; Hansen, 2015) and provide a rigorous measuring of the impact of an important experience in Italian road law policy.

The paper proceeds as follows. Section 2 analyses the notions of vertical deterrence, trade-off between general and marginal deterrence and trade-off between over-deterrence and optimal penalties when recidivism is backed by escalating penalties. These notions are then applied to the analysis of Law 41/2016 (the “homicide road law”) in Section 3, where the econometric analysis is also presented. Section 4 concludes with some policy suggestions.

2. Deterrence, punishment and prevention of crime

Let us assume, from the perspective of a rational agent¹, that he would obtain a gain from committing a harmful act. Let us also assume that he will be caught with a probability $0 < p < 1$ (strictly positive) and that, in this event, he will be sanctioned. The general Beckerian consequence is that the individual “will commit the act if and only if his expected utility from doing so, taking into account his gain and the chance of being caught and sanctioned, exceeds his utility if he does not commit the act” (Polinsky and Shavell, 2000).

Formally, a risk neutral rational agent will commit a given criminal action (x) if and only if his expected utility will be at least equal to his reservation utility U^* (participation constraint). Given the private benefit (b) of the criminal action (x), the expected utility (EU) depends on probability of detection (p) and punishment (S), that is:

$$EU(x) = (1-p)U(b) - pU(S) \geq U^*$$

Since EU is a decreasing function with respect to the probability of detection and that of punishment, an increase of each of them increases the deterrence effect.

There are some trade-offs that can arise when different types of crime are punished. Let us consider the main ones, in the following sub-sections.

2.2. The trade-off between general and marginal deterrence

If the expected utility of violating legal rules rises with the social harm generated, it might be optimal for the society to introduce a scheme of sanctions increasing with the social harm associated to the single violation, according to the level of harm produced. This principle is known as *general deterrence* or *general enforcement*. However, the proportionality between sanctions and social harm acts as a sort of signal towards offenders on the distribution of social preferences about harmful actions. This is exactly the principle of *marginal deterrence*².

¹ Rationality means that an agent has transitive and complete preferences on acts (F). Given $x, y, z \in F$; if $x \succcurlyeq y$ and $y \succcurlyeq z$ then $x \succcurlyeq z$; $x \succcurlyeq y$ or $y \succcurlyeq x$.

² See Shavell (1992); Wilde (1992); Mookherjee and Png (1994).

The notion of marginal deterrence is derived from the generally defined principle, expressed by Beccaria (1764), on the proportionality between criminal sanction and harmful action. Since there must be an upper bound on the effectiveness of sanctions that could be imposed on criminals³, the scheme of sanctions will start at the upper bound with the most severe sanction and then it will decrease accordingly to the level of social harm generated.

Let us denote with S the fine designed as a sanction and with D the social harm associated with a given harmful action A . For any given positive probability of detection p , the optimal fine schedule, accordingly to a wide scholarly literature (Becker, 1968; Shavell, 1991; Mookherjee and Png, 1994; Polinsky and Shavell, 2000) is given by: $S^*(x)=D/p$ subject to the constraint of D/p not exceeding the maximal possible fine, if the agent is risk neutral. When the enforcement is general (i.e. when it is not possible to have a specific detection – and thus a specific probability of being caught – for any harmful act), sanctions should rise with the severity of harm up to a maximum.

It is easy to see how a trade-off between marginal deterrence and general deterrence may occur in this case: some less harmful actions may actually be not sanctioned at all, this implying, if they are optimally deterred, a chance of under-deterrence for more serious harmful actions (Polinsky and Shavell 2000). The trade-off between marginal and general deterrence (Shavell, 2003) could be envisaged in the circumstance that an harmful action receives a sanction equal to zero. If we assume that the social harm generated by such an action is greater than zero, then the application of the principle of marginal deterrence implies under-deterrence. On the other hand, if we try to correct the value of the sanction for less harmful actions, we may provide the wrong signal at the upper levels, treating as substantially ‘substitutable’ – from the point of view of the society – two actions producing two different levels of harm. Marginal deterrence is naturally accomplished, if the expected sanction equals the harm for all its levels (Polinsky and Shavell, 2000).

2.3. Optimal sanctions *versus* escalating penalties

The law-and-economics literature on law enforcement has outlined two open issues related to the notion of general and marginal deterrence: the risk of general under-deterrence, when marginal deterrence or *vertical deterrence* is applied; and the risk of over-deterrence, when recidivism or *horizontal deterrence* is sanctioned by escalating penalties.

While the existing literature (Garoupa, 1997; Polinsky and Shavell, 2000) has generally treated separately the two issues, Basili and Nicita (2006) focus on the joint effects generated by

³ It could be an economic upper bound equal to the total amount of income available to the criminal or to a ‘physical’ constraint of non-monetary sanctions, or determined by fairness reasons.

the policy-maker who aims at pursuing both vertical and horizontal deterrence. The assumption of a joint determination of vertical and horizontal deterrence, far to be unrealistic (law enforcement systems generally are explicitly built to pursue the two policy aims), is justified by the fact that a trade-off between the two dimensions is likely to occur: increased sanctions for repeated offenders may in fact decrease marginal deterrence and vice-versa.

The intuition behind escalating penalties for repeated offenders is that repetition reveals the information regarding the *type of offender*⁴. The information revealed by recidivist behaviour somehow allows the implementation of specific, rather than generic, enforcement: those who are not deterred in the first instance will continue to violate in the future, thus repeated offences should be deterred by increasing fines (Polinsky and Shavell, 1998). The debate over the economic rationale against recidivism and on adopting escalating penalties to reach that aim is very rich and open (Chen and Shapiro, 2007; Owens 2009; Drago *et al.*, 2011; Hansen, 2015).

“I’d rather be hanged for a *sheep* than a *lamb*”. If we assume that agents’ utility increases with the harm⁵, then the rational choice of agents will be that of jumping from a *lesser* to *higher crime*, if the first crime was not sentenced by maximal sanction. This result may apply for every level of the harm, and it equals, at any period, to an increase in the level of more harmful acts over time, so showing a high interdependence between marginal deterrence (let us define it *vertical deterrence*) and escalating penalties (let us define it *horizontal deterrence*).

Hence, horizontal deterrence may reduce vertical deterrence at any period. A trade-off then occurs between punishing for repeated offences and obtaining marginal deterrence at any period⁶.

We now introduce a simple framework of the trade-off between vertical and horizontal deterrence, based on intuitions of Emons (2003) and Basili and Nicita (2006).

⁴ In the US, a very small percentage between 2-5% of criminals is responsible for 50% or more of crimes (Mulvey, 2011).

⁵ The assumption, here, is that utility increases both with the harm and with the repetition of the same harm. If sanctions are not increasing with repetition, we assume that, if an agent selects a given action in $t=1$, he will repeat the same choice in $t>1$. However, we assume that if sanctions increase with repetition, then for any given amount of sanction at any time, a higher harm implies a higher utility.

⁶ There is a fact that unequivocally confirms the vicious circle between escalating penalties for repeated infringers and marginal deterrence, that is the policy commonly called *Three-Strikes You’re Out*. Three strikes laws, “the largest penal experiment in American history” (Zimring *et al.*, 2001), were introduced in Washington and Wisconsin, in 1994 in California, and in 1997 twenty-two other states and also the Federal Government adopted it. The introduction of three-strike laws induced decreasing levels of criminal rates and participation, but indisputably produced a shift of criminal activities toward more violent crimes. In November 2012, California changed the three strikes law, in particular requiring that the third strike is a violent felony (while previously any felony was considered), with the third sentence possibly reduced by a court to the equivalent second-strike sentence, in some cases. These changes contributed to the reduction of three-strike offenders in California state prisons by 10% between December 2012 (8,900 three-strike inmates) and June 2013 (8,000).

Consider a potential criminal agent who lives two periods – the present and the future, or $t=1,2$. In $t=1$ and $t=2$, the agent can choose illegal actions x and y receiving respectively a benefit b and c , with $c>b$, from his criminal behaviour, that produce social harm $h>0$ and $k>0$, such that $h>b$, $k>c$ and $k>h$. Fines for illegal action x is s_1 and s_2 , and z_1 and z_2 for y . The agent's utility is $U=U(0, x_t, y_t)$ in each period. The agent has $W>0$ initial wealth: if the fine exceeds the agent's wealth, he goes bankrupt and the government sizes the remaining assets. Given the probability p , such that $0<p<1$, of detection, that is assumed independent of the specific action selected and time, the agent maximizes his expected utility under the budget constrain. The framework represents an agent that faces a decision problem with different strategies (options):

- (i) Agent can choose not to commit an illegal act, i.e. (0,0) strategy, with a resulting expected utility equals to 0;
- (ii) Agent commits an illegal action in $t=1$ but none in $t=2$, or vice versa, with a strategy (1,0), or (0,1), so that $U=\text{Max}\{[b-ps_1], [c-pz_1]\}$;
- (iii) Agent can infringe law in both periods, i.e. (1,1)-strategy, such that $EU=\text{Max}\{[b-ps_1], [c-pz_1]\} + \{[b-p((1-p)s_1+ps_2)], [c-(p(1-p)(s_1)-pz_2)], [c-(p(1-p)(z_1)-pz_2)]\}$.

This simple model shows that, if both vertical and horizontal deterrence are concerned, a trade-off could emerge.

In fact, the higher is vertical deterrence in $t=1$ (*small* s_1), the higher should be the penalty for increased offences of the same type in $t=2$ (*large* s_2). However, the lower is the gap between b and c , the wider is the range of value $[s_1 < z_1 < s_2 + (c-b)/p^2]$ for which the sanction for the more serious harm approaches the critical threshold that induces repeated offenders to jump towards the more serious harmful action y . On the other side, in order to reduce this effect, it is necessary to fix the fines in $t=1$, so that they equal the maximum fine $s^* \geq (b/p)$ and $z^* \geq (c/p)$. Crucially, this condition could assure non-repetition of illegal actions, but it also implies renouncing to obtain any vertical deterrence⁷.

3. Law 41/2016 or Homicide Road Law

On 23 March 2016, a new driving law (Law 41/2016) called “*homicide road law*” was come into force in Italy to contrast the high number of deaths, accidents with injured person (whether they be drivers, passengers or pedestrians). Law 41/2016 increased the penalties for dangerous, drug and drunk driving by introducing the crime of road homicide (art. 589-bis of Italian Penal Code) and personal road injury (art. 590-bis) thus replacing the offence of vehicular manslaughter and personal injury laid down by previous legislation.

⁷ Details are in Basili and Nicita (2006).

The law sets criminal convictions on the basis of the type of injury suffered by the victim:

- (i) detention from 3 months to 1 year for non-serious injuries (under previous legislation: detention from 3 months to 1 year and monetary sanction);
- (ii) detention from 1 year and 6 months to 3 years for serious injuries (under previous legislation: detention from 3 months to 1 year and monetary sanction);
- (iii) detention from 3 to 5 years for serious injuries under moderate drunk driving (under previous legislation: detention from 6 months to 2 years and monetary sanction);
- (iv) detention from 4 to 7 years for serious injuries under dangerous or drug and drunk driving (under previous legislation: detention from 1 months to 3 years);
- (v) detention up to 7 years for multiple injuries (under previous legislation: detention up to 5 years);
- (vi) detention from 2 years to 7 years for traffic infringements that induce a death (under previous legislation: detention from 2 to 7 years);
- (vii) detention from 5 to 10 years for death under moderate drunk driving (under previous legislation: detention from 2 to 7 years);
- (viii) detention from 8 to 12 years for death under dangerous or drug and drunk driving (under previous legislation: detention from 3 to 10 years);
- (iv) detention up to 18 years for multiple deaths (under previous legislation: detention up to 15 years).

The law sets prohibition of equivalence between mitigating and aggravating circumstances and sets aggravating circumstances (escape, not insured or driving without driving licence), which may lead to an increase in conviction of 1/3. The *homicide road law* also sets revocation of driving licence, instead of the driving ban laid down by previous legislation, from 3 to 20 years for sentenced or recidivist drivers, and up to 30 years if the offender escapes after an accident.

The new law renounces to monetary sanctions, which were from 500 to 2.000 euros under previous legislation, and introduces escalating penalties up to 12 years. It is manifest a “crushing” of punishments, because of the small interval of possible penalties, from 3 to 12 years, for serious consequences. Compare, for example, a serious injury induced by dangerous driving and a death outcome: sanctions are, in the former case, imprisonment between 4 to 7 years, and, in the latter, imprisonment between 2 and 7 years.

Law 41/2016 sets escalating penalties for accidents induced by dangerous or drug and drunk driving, but it also leaves it unchanged the punishment of traffic infringements inducing vehicular manslaughter, that were laid down by previous legislation. Crucially, dangerous or drug and drunk driving is only a small part of the events producing serious accidents and

apprehension in the act of committing a crime, and the frequency of aggravating circumstances such as escape and driving without insurance or driving licence are negligible. From 25 March 2016 to 4 June 2017, the Polizia Stradale Italiana (Traffic Police) detected 843 fatal accidents but only 456 of them were considered vehicular homicide, 388 (85%) of which were vehicular manslaughter. Finally, there were only 28 apprehensions in act of committing a crime with respect to 27.655 injury accidents (Scuola Superiore di Polizia, 2017).

More in general, Law 41/2016 seems to be associated to a reversal in the (otherwise decreasing) trend of deaths on the road, which increased from 1.510 in first semester of 2016 to 1.623 in the first semester of 2017. Other confounding factors may explain this aggregate evidence. Thus, in the next section, we measure the effectiveness of Law 41/2016 thorough a systematic econometric analysis.

3.2. Data Evidence

As a preliminary, explanatory, analysis we use aggregate data on the number of deaths involved in road accidents, measured over homogenous time intervals (semesters and quarters). ISTAT provides individual level data on single accidents over the 2010-2016 period. In particular, for the years 2010-2013, a representative sample of 222.888 accidents is provided along with individual weights; for the years 2014-2016 the entire population of 52.7361 accidents occurred in Italy is provided; for 2017, ISTAT provides only aggregate estimates of the number of deaths for the first semester of the year.

As a first exploratory step over a period as long as possible, we aggregate individual data at a semester level and plot the aggregate number of deaths of the first semester of each year in Figure 1. As one can notice, the general trend is decreasing from 2010. However, as already mentioned, while the trend would suggest a further reduction of deaths both in 2016 and 2017, real observed data show an increase in the number of deaths for both years.

[insert Figure 1 about here]

This aggregate pattern is then investigated in a set of simple OLS regressions, run on quarterly data (hence, we must exclude estimated data for 2017, which are provided only on a semester basis). Specifically, we consider a simple specification, where the number of accidents with at least one injured, the number of deaths, the number of deaths per accident and the number of injured per accident are used, alternatively, as a dependent variable, and a dummy variable for Law 41/2016 is the main regressor. Formally, we consider the following model:

$$y_t = \alpha + \beta \text{Law 41/2016}_t + \text{Seasonal FE} + \text{Trend} + \varepsilon_t$$

where α is the model constant, *Law 41/2016* is a dummy variable equal to 1 for each quarter after April 1st 2016 and 0 otherwise, *Seasonal FE* captures variation across quarters of the year, *Trend* is a linear trend on a yearly basis and ε_t is the residuals.

[insert Table 1 about here]

The estimation results are reported in Table 1. Over the four regressions considered, from column [I] to [II], we find that the introduction of Law 41/2016 is not associated with a negative and significant effect on accidents, deaths and injuries, while, if anything, a positive effect on the total number of accidents is detected at a 10% level of statistical significance (model [I]). Clearly, many omitted variables may confound these estimates, ranging from variance in weather conditions, roads maintenance, a changing demography of drivers and vehicle fleet, and time specific effects (over single days of the week, quarters and years) related to variations in holidays, economic activities and other unobservable, which may influence, in turn, traffic intensity.

To address this, we exploit also the individual dimension of the ISTAT data and run a micro-econometric regression analysis by taking advantage of the large set of information provided on single accidents. In doing this, we restrict our analysis to the 2014-2016 period, in order to use the full universe of road accidents (with at least one injured) occurred in Italy in the period under study.

The data on deaths involved by road accidents both are counts (i.e. non-negative integers) and present a zero-inflated distribution. To conduct our micro-econometric empirical study, we implement a hurdle model, in which a logit model and a negative binomial regression are combined in a two-part model.

Formally, we consider a random variable D of deaths counts in a set of n accidents detected over the 2014-2016 period and a set of exogenous variables $\mathbf{x}_i$. The hurdle model has a hierarchical structure, where the first equation describes the process generating the zeros (i.e. the event $d_i = 0$ versus $d_i > 0$) and the second equation describes the process accounting for positive values (i.e. $d_i > 0$). In simple terms, a binomial probability model governs the binary outcome of whether d_i has a zero or a positive value, while, if $d_i > 0$, the “hurdle is crossed” and the conditional distribution of the positive values is governed by a zero-truncated negative binomial model. Hence, the probability function of the observed count response is given by:

$$f(d_i | \cdot) = \Pr(D_i = d_i) = \begin{cases} \pi_i, & d_i = 0 \\ (1 - \pi_i) \frac{\exp(-\lambda_i) \lambda_i^{d_i}}{d_i! (1 - \exp(-\lambda_i))}, & d_i > 0 \end{cases}$$

where π_i and λ_i are, respectively, the canonical parameters for the binary and the (truncated at zero) count processes. Given a vector of regressors, $\mathbf{x}_i$, π_i and λ_i can be modelled, respectively, as $\text{logit}(\pi_i) = \mathbf{x}_i \boldsymbol{\alpha}$ and $\text{NB}(\lambda_i) = \mathbf{x}_i \boldsymbol{\delta}$, where $\boldsymbol{\alpha}$ and $\boldsymbol{\delta}$ are vectors of fixed regression parameters. Hurdle models differ from traditional zero-inflated models in having a joint probability function for the two model parts. In particular, the hurdle model is based on a mixture of the two binary and count processes' distributions. This implies a single log-likelihood function maximization problem and rules out model identification issues (Cragg, 1971; Mullahy, 1986).

In our regression context, the logit–negative binomial hurdle model can be specified as follows:

$$\begin{cases} \Pr(D_i > 0 | \text{Law 41/2016}_i, \mathbf{x}_i, T_t) = \alpha_0 + \beta \text{Law 41/2016} + \boldsymbol{\alpha} \mathbf{x}_i + \boldsymbol{\varphi} T_t + \varepsilon_i \\ \Pr(D_i = d_i | \text{Law 41/2016}_i, \mathbf{x}_i, T_t) = \delta_0 + \mu \text{Law 41/2016} + \boldsymbol{\delta} \mathbf{x}_i + \boldsymbol{\vartheta} T_t + \eta_i, \end{cases} \quad d_i \geq 1$$

where α_0 and δ_0 are the model constants, T_t is a vector of time fixed effects (capturing variation across days of the week, quarter of the year and year), *Law 41/2016* is a dummy variable equal to 1 for those accidents occurred under Law 41/2016 and 0 otherwise, β and μ are the vectors of interest. Standard errors are heteroskedasticity robust. It is useful to interpret the logit equation and the negative binomial equation as models of, respectively, extensive and intensive margins of fatal accidents. In particular, with logit equation we are able to estimate the effect of Law 41/2016 on the probability that an accident involved some death outcomes. With the negative binomial equation, we estimate the effect of Law 41/2016 on the number of deaths involved in a given accident, where only accidents with some deaths are considered. This strategy allows a more refined measuring of the death consequences of road accidents than single-equation models, which conflate the two processes and provide only average effects.

[insert Table 2 about here]

The estimation results of the hurdle model are reported in Table 2. We run four two-equation models by including sub-vectors of covariates progressively. In model [Ia/Ib], we consider only the dummy variable *Law 41/2016*. In model [IIa/IIb], we also include time effects (day of the week, quarter and year effects). In model [IIIa/IIIb], we add controls for the external environment (type of road: one lane, two lane, etc.; quality of road: paved, unpaved, etc.; weather conditions on the road: dry, wet, icy, etc.; general weather conditions: clear, foggy,

snowy, etc.). In model [IVa/IVb], finally, we include a vector of controls on the main vehicle involved (type of vehicle: private car, motorcycle, truck, etc.; age of the vehicle, i.e. years from registration; age of the driver; sex of the driver)⁸.

The estimation results unveil that, after the introduction of Law 41/2016, both the extensive and the intensive margins of death outcomes in fatal road accidents, in Italy, were not reduced. If anything, a weakly significant positive effect is observed in the extensive margin full model [IVa], where the variable Law 41/2016 is associated with a positive parameter whose statistical significance is slightly above the 10% threshold.

3.3. Discussion

The data analysis makes it evident that Law 41/2016 was ineffective, this arguably making the EU target of reducing road deaths to 50% in 2020 difficult to meet in Italy.

Our interpretation of this empirical result is that increasing punishments fails to prevent injuries and deaths. If it so, the negligible effect of Law 41/2016 is likely to have structural consequence on the pattern of road accidents.

Law 41/2016 is a standard severity-based law relaying on increasing incarceration to deter crimes. Recent literature and empirical studies about deterrence unveil that “prison is an important option for incapacitating and punishing those who commit crimes, but the data show long prison sentences do little to deter people from committing future crimes” (Nagin 2013). People show high sensitivity with respect to small increases in probability of detection, but low sensitivity to tightened severe punishment. Economic theory explains this fact by considering the hyperbolic rate of inter-temporal discount, which makes an individual less sensitive to far future, with respect to near one, so that “the marginal deterrence effect of increasing already lengthy prison sentences is modest at best” (Durlauf and Nagin, 2011). Moreover, Law 41/2016 narrows the interval of punishments and thereby makes it more likely a sort of “jump” in crime severity, thereby weakening vertical deterrence. If more severe punishment does not affect the anticipated costs of illegal or criminal actions, then a policy based on increasing punishments fails to reduce crimes. On the contrary, increasing certainty, i.e. an increase in the likelihood of being caught and punished, and/or the perception that illegal behaviors will be detained and sentenced are more likely to be more effective. From this point of view, a wider presence of police officers may arguably improve both certainty of punishment and drivers beliefs. A well-known example of police deployment strategy are *hot spots*, where “the rationale for

⁸ Alternative model specifications with different vectors of controls (e.g., including the geographical location of the accident) produce very similar results. These additional estimated are not reported for reasons of space but are available upon request.

concentrating police in crime hot spots is to create a prohibitively high risk of apprehension and thereby to deter crime at hot spot in the first time” (Durlauf and Nagin, 2011, p. 35). There are many examples of application of the certainty punishment strategy (e.g., in Boston, Chicago, Richmond, among other major US cities), with the most famous case being the Project Hope, a Hawaii probation enforcement program, which are all based on the attempt to identify the group of individual at a highest risk of committing crimes, to be then punished more fiercely.

Related to this, another successful example is the UK road policy. The UK moved from 3.450 deaths and 310.000 injury accidents in 2001 to 1.792 deaths and 179.592 injury accidents in 2016. These positive results are the consequence of a strict application of a certainty-based strategy, according to which a high effort is exerted by the police to sanction any infringement and to make manifest its presence by patrols, street-cameras, radar and hot spots. Fines and demerit points, in addition, are applied at large.

4. Concluding remarks

In 2016, in Italy there were 3.283 deaths and 249.175 injured persons on the roads. The annual social cost of accidents with injury was 18,8 billion of euros (Ministero delle Infrastrutture e dei Trasporti, 2017), while the total cost comes to touch 25 billion of euros, which equals about 1.5% of GNP.

The *homicide road law* has a severity-oriented strategy to prevent crimes that has proved to fail, so urging some substantial amendment. Current literature and empirical research contest the interplay of certainty and severity in producing deterrence and suggest certainty-oriented strategies to prevent crimes.

The evidence provided in this paper suggests moving toward a completely different approach to road safety, based on a synergic use of deterrence and control and encompassing a larger array of activities, such as:

- (i) restoring vertical deterrence;
- (ii) full application of the demerit point system (also introducing some possible variants as suggested in Basili *et al.* (2015));
- (iii) increasing the presence of patrol on the road and disclosing road-cameras and radars;
- (iv) punishing dangerous drivers, in particular on highways, by immediately stopping and sanctioning them for breaking traffic law at the closest tollbooth;
- (v) revocation of driving license for longer periods, even considering permanent and unlimited suspension in the case of causing death;

(vii) introducing more effective hybrid sanctions, i.e. permanent revocation of driving license, so making horizontal and vertical deterrence effective and contrasting recidivism more fiercely.

We believe that further research is needed to systematically analyze how driving law may influence illegal behaviors. At the same time, however, our results seem to point to a clear consequence of increasing non-monetary sanctioning, i.e. a some sort of “crushing effect” with more dangerous and recidivist drivers bunching on the most severe violations, thereby increasing injuries and fatal outcomes on the road. Hence, the experience of Italian *homicide road law* may contribute to the optimal design of driving legislation in other countries as well as in other regulation domains.

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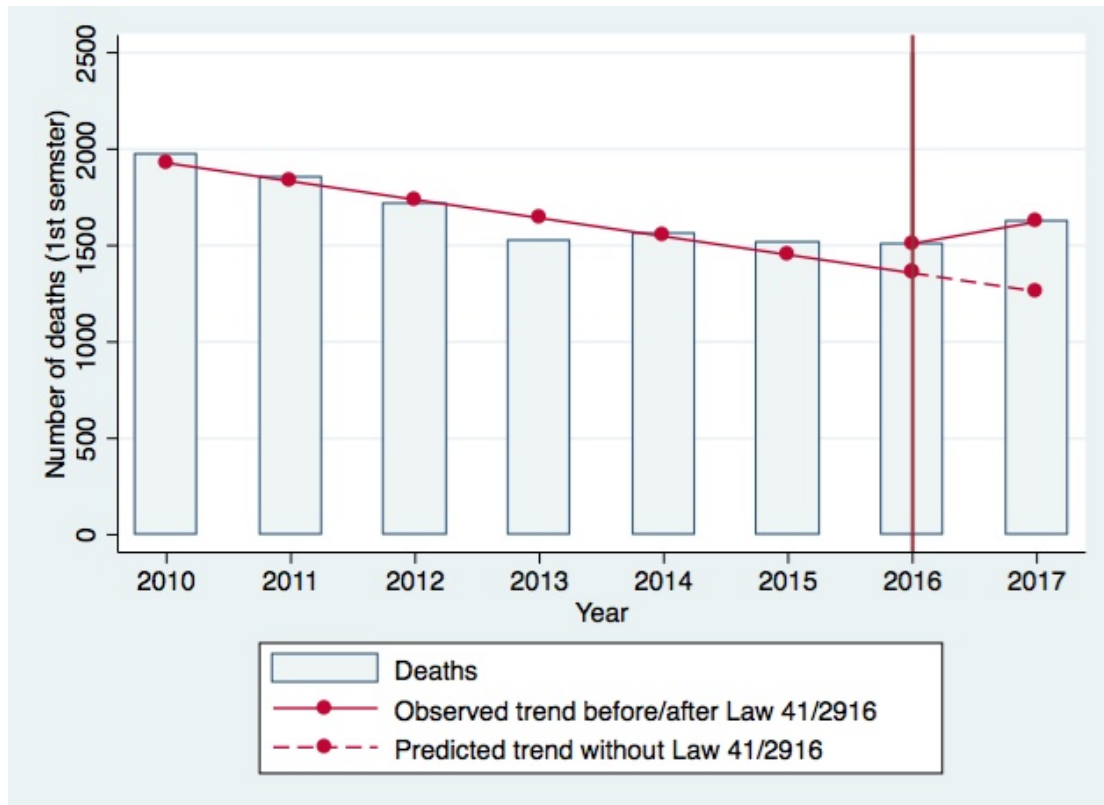
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Figure 1. Total number of deaths in road accidents, 2010-2017 (first semester of each year).



Note. Authors' elaboration on data from ISTAT (2018).

Table 1. Time series estimates, quarterly data.

	[I]	[II]	[III]	[IV]
	Accidents with injured	Total deaths	Deaths per accident	Injured per accident
	Coeff. (std.err.)	Coeff. (std.err.)	Coeff. (std.err.)	Coeff. (std.err.)
Law 41/2016	2496.523 * (1392.429)	-39.959 (89.082)	-0.001 (0.001)	0.000 (0.011)
Constant	Included	Included	Included	Included
Seasonal FE	Yes	Yes	Yes	Yes
Trend	Yes	Yes	Yes	Yes
<i>F</i>	35.75	9.38	4.26	2.50
Prob> <i>F</i>	0.000	0.001	0.007	0.061
R ²	0.890	0.680	0.492	0.362
Period	2010-2016	2010-2016	2010-2016	2010-2016
No. obs.	28	28	28	28

Note. Significance level: * = 10%, ** = 5%, *** = 1%.

Table 2. Hurdle-model estimates, individual data.

	[Ia]	[Ib]	[IIa]	[IIb]	[IIIa]	[IIIb]	[IVa]	[IVb]
	Accident with death (yes/no)	No. of deaths, if accident with death	Accident with death (yes/no)	No. of deaths, if accident with death	Accident with death (yes/no)	No. of deaths, if accident with death	Accident with death (yes/no)	No. of deaths, if accident with death
	Coeff. (std.err.)	Coeff. (std.err.)	Coeff. (std.err.)	Coeff. (std.err.)	Coeff. (std.err.)	Coeff. (std.err.)	Coeff. (std.err.)	Coeff. (std.err.)
Law 41/2016	0.008 (0.023)	-0.116 (0.105)	0.033 (0.383)	-0.085 (0.186)	0.033 (0.038)	-0.080 (0.192)	0.057 (0.048)	-0.205 (0.233)
Constant	Included	Included	Included	Included	Included	Included	Included	Included
Type of main vehicle, 21 dummies	No	No	No	No	No	No	Yes	Yes
Age of main vehicle, 59 dummies	No	No	No	No	No	No	Yes	Yes
Age of driver, 10 dummies	No	No	No	No	No	No	Yes	Yes
Sex of driver, 1 dummy	No	No	No	No	No	No	Yes	Yes
Type of road, 4 dummies	No	No	No	No	Yes	Yes	Yes	Yes
Quality of road, 3 dummies	No	No	No	No	Yes	Yes	Yes	Yes
Weather condition of road, 5 dummies	No	No	No	No	Yes	Yes	Yes	Yes
General weather conditions, 7 dummies	No	No	No	No	Yes	Yes	Yes	Yes
Day of the week FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Seasonal FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
<i>chi2</i>	0.13		433.73		1220.01		2989.08	
Prob> <i>chi2</i>	0.713		0.000		0.000		0.000	
AIC	0.189		0.188		0.186		0.178	
Estimation	Logit	Neg. Bin.	Logit	Neg. Bin.	Logit	Neg. Bin.	Logit	Neg. Bin.
Period	2014-2016	2014-2016	2014-2016	2014-2016	2014-2016	2014-2016	2014-2016	2014-2016
No. obs.	527361		527361		527361		402188	

Note. Significance level: * = 10%, ** = 5%, *** = 1%. Standard errors are heteroskedasticity robust.