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Can fear of going to jail reduce the number of road fatalities? The Spanish experience

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ABSTRACT

The goal of this article is to evaluate the impact of the drastic Spanish Penal Code reform on the number of road deaths in Spain and the time that the effects might last. This is achieved by means of multivariate unobserved component models set up in a state space framework estimated using maximum likelihood. In short, with this reform Spain might be considered to be closing the final gap that kept it apart from other developed countries as far as the road accident rate is concerned. We have found two different types of effects on Spanish road traffic fatalities. Initially, a month before the reform was passed there was a 24.7 percent fall in Spanish road deaths. After the Bill had been passed and for the following thirteen months, the reduction stayed at a constant sixteen percent. This reform has reduced Spanish road fatalities by 534 in all between November 2007 and December 2008 and the effects will foreseeably continue during 2009.

1. Introduction

During the 1980s and 1990s, Spain was one of the countries in Europe with the highest risk indicators in road accidents (Page, 2001). In 1990, 9,302 persons died as a result of over 100,000 injury crashes on Spanish public roads, with mortality rates of 23.2 killed per 100,000 inhabitants and 5.8 deaths per 10,000 motor vehicles (OECD, 2009); these values were only lower than those for other Mediterranean countries such as Greece and Portugal. Conscious of the high economic and social costs caused by the externalities linked to traffic accidents (see Verhoef, 1994 for an analysis of externalities), the various administrative tiers in Spain have made great efforts to mitigate the problem.

Remarkable progress has been made in Spain: from 1990 to 2008, the risk has been reduced by around 70% (OECD, 2009, see Fig. 1).[1] The European Commission's target of a 50% reduction in traffic fatalities between 2000 and 2010 (European Commission, 2001) has been already achieved in Spain, with the number of road deaths reduced by 52.5% during the 2003–2009 period (Dirección General de Tráfico [DGT], 2010b).

The key to this great improvement has been a change in Spanish road user behavior and attitudes prompted by the huge changes seen in road safety policy. Traffic injury prevention has become a priority of government policies, turning Spain into a social laboratory where a raft of measures has been passed (Arranz & Gil, 2009; García-Ferrer, De Juan, & Poncela, 2007; and Gras et al., 2007) over the last 20 years to bring an end to the high road accident rate. With the dawning of the 21st century, the strategies of the Spanish General Directorate of Road Traffic (DGT) were not only ramped up but also became highly punitive in nature with a view to achieving fast, dramatic results.

With this objective in mind, progressively severer measures were implemented, of which the following can be highlighted:

- *use of safety features*: since 1992, seat belt use has been compulsory in front and rear seats (see García-Ferrer et al., 2007), even in urban areas (idem crash helmets for motorcyclists)
- *avoidance of distractions at the wheel:* speaking on cell phones, for example, except when done 'hands-free' and without the use of earphones, headphones or similar (see Gras et al., 2007)
- *drunk driving*: the legal allowed BAC (Blood Alcohol Concentrations) limit has been reduced from 0.8 g/l in 1992, to 0.5 g/l in 2003[2] (considered in Arranz & Gil, 2009)
- *speed monitoring*: with a significant increase in numbers of traffic patrol officers and the development of the fixed speed camera plan in 2005–2007 (studied by Novoa, Pérez, Santamariña-Rubio, Dell'Olmo, & Tobías, 2010) and a new Penalty Points driving license system (PPS), which came into effect in 2006 (see Montoro, Roca, & Tortosa, 2008).

There has also been a sharp increase in the crude reality of road safety campaigns during the 1990 s (especially since 1992) and the

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[1] According to The Spanish General Traffic Directorate (DGT, 2010b), the number of road deaths has fallen back to 1964 levels, despite the traffic scenario being different in the extreme with the number of vehicles having multiplied by seven.

[2] Despite the negative results achieved by similar measures in other countries (see Cox, 2006 for US).

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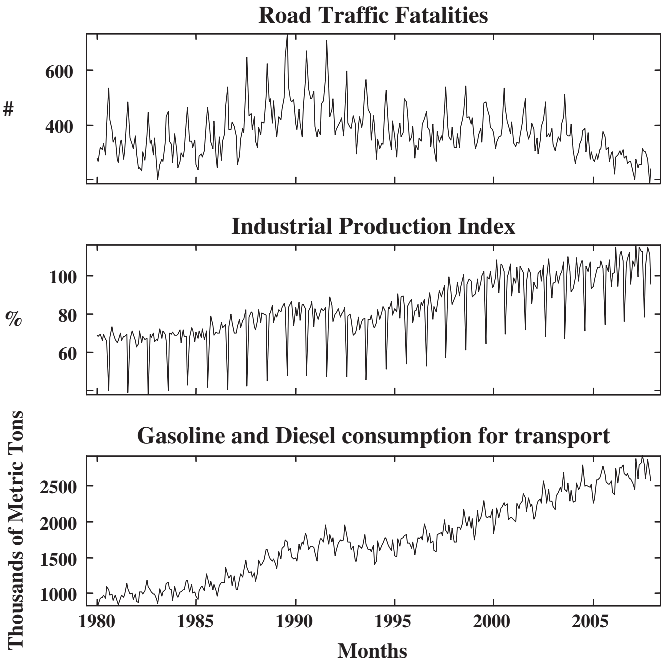

Fig. 1. Endogenous variables in the models.

first decade of this 21st century, including a move from the popular slogan *"don't drive drunk"* sung by Stevie Wonder, to bloody advertisements with brutal images of accidents and eyewitness accounts from real victims.

On top of all this, the most aggressive measure to date has been the reform of the Spanish Penal Code, which came into effect on December 2, 2007. This legal reform is a blow against the impunity of reckless drivers whom it classifies as delinquents at the wheel. Certain actions hitherto regarded as simple traffic violations were upgraded to the category of criminal offenses, including driving at a speed of 60 km/h over the legal speed limit in built-up areas and 80 km/h on highways; driving under the influence of drugs (DUI) or with a BAC of over 1.2 g/l; driving without a license either because of temporary disqualification or because all the points on the license have been lost; reckless driving with disregard for the lives of others; refusing to take a breathalyzer/drugs test; and blocking the traffic. All these offenses can be punished by jail sentences, hefty fines, and community service (generally in hospital A&E departments or attending to road accident victims), apart from disqualification from driving.

In short, Penal Code reform does not address what behavior at the wheel is permitted or not, but provides for significantly tougher penalties for conduct that is not permitted. Its main aim is to boost social willingness to comply with the law, which, according to Vereeck and Vrolix (2007), is the key factor in explaining differences in road safety from one country to another.

The appraisal of the impact of Penal Reform on Road Safety (DGT, 2010a) done at the end of April 2009 showed that the number of inmates imprisoned because of road safety crimes was 2,546. Over half were for DUI offenses or for refusing to undergo the pertinent tests.[3] The deterrence effect of legal measures like these on reckless drivers improves road safety and raises public revenue (Tay, 2010).

Considering monthly series of road accidents from the 1980s to the present day, the goal of this article is to evaluate the impact of this drastic legal reform on the number of road deaths in Spain and the duration the effects might last. For this the effect of other variables that might have influenced Spanish traffic accident rates in the time period analyzed have been isolated, including the level of economic activity, the rate of vehicle utilization, the implementation of other public policies of a legal or punitive nature, and other specific events, including general bad weather conditions. This is achieved by means of multivariate unobserved component models set up in a state space framework estimated using maximum likelihood.

The paper is organized as follows: a description of data and basic methodology appears in Section 2. Section 3 sets out the discussion of our findings and Section 4 summarizes the main conclusions. Finally, we include the references.

2. Description of data and methodology

The key endogenous variable in this study is the number of deaths in road traffic accidents per month from January 1980 to December 2008 (from Spanish Statistics Agency data series available on the agency's website, www.ine.es). Death was defined as occurring within 24 hours of the accident.

The relation of deaths in road accidents to other variables is considered in the context of a full multivariate model in which two additional endogenous variables are included. Firstly, the economic activity is represented by the Industrial Production Index (IPI) and the degree of vehicle utilization by the consumption of gasoline and diesel for transport (see García-Ferrer et al., 2007, about the need for these variables to be included). Time evolution of the three endogenous variables may be seen in Fig. 1.

A series of dummy variables is also included as exogenous to the models, specifically both to accommodate any outliers detected, generally resulting from poor weather conditions (for example JAN 84) or to correct a series of earlier measures and policies prior to the reform of the Spanish Penal Code at the end of 2007, to be specific, and according to findings from earlier studies, compulsory seat-belt use from 1992 (García-Ferrer et al., 2007), and the introduction of the Penalty Points driving license system in 2006 (Castillo-Manzano, Castro- Nuño, & Pedregal, 2010). A declining temporary effect has been considered for the latter, as suggested in the prior literature (see, e.g., Butler et al., 2006; Farchi et al., 2007 on the Irish and Italian cases, respectively).

In other respects, two additional exogenous variables have been included to accommodate the main events on the calendar that would affect the number of accidents: EASTER and TRADING. Whilst the first of these, EASTER, is used to correct the intense traffic in Spain that is the norm during Holy Week (i.e., between Palm Sunday weekend up to and including Easter Sunday weekend), the TRADING variable provides for the number of trading days in a month and, therefore, also reflects the number of weekend days when there is an especially high rate of accidents on highway. TRADING and EASTER were included also in the equations for gas consumption and the IPI. While TRADING proved significant in both cases (see Table 1 below), EASTER was also important for IPI.

Finally, a dummy variable has been included to estimate the effects of the 2007 Spanish Penal Code reform. To be more precise, two specifications have been tried out. Firstly, it was investigated whether the effects started to be felt with the Reform's coming into effect in December 2007 (DEC07 in Table 1 below), or, whether they in fact started to be felt earlier, in November 2007 (NOV07) as a result of the great anticipation that the passing of the Bill through Parliament aroused in public opinion due to the huge amount of attention paid to the legal reform in the media, which meant that the level of expectation was much higher than for other road safety measures. Secondly, the effects were examined to see if they remained constant 13 months after the reform came into effect, or whether, as with other legal reforms (such as the introduction of the PPS driver's license) they had quickly become diluted over time.

[3] This has meant a sharp rise in numbers of inmates in penitentiaries (61.3% more than in 2007). Seventy-five % of all sentences handed down for community service are related to road safety offenses. From December 2007 to April 2009 there were 52,513 convictions for road safety offenses practically bringing the law courts to a standstill.

Table 1
Estimation results for multivariate models with intervention variables. T statistics in parenthesis. σ^2 stands for the innovations variance; Q(12) are the Ljung-Box Q statistics for 12 lags, respectively; Bera-Jarque is a normality test (numbers in parenthesis are P-values); H is a variance ratio homocedasticity test (numbers in parenthesis are P-values).

	Model 1			Model 2		
	Level Shift for DEC07			Transitory Change for DEC07		
	Deaths in highways	IPI	Gas Consumption	Deaths in highways	IPI	Gas Consumption
NOV07	−0.284			−0.218		
	(3.792)			(3.035)		
DEC07	−0.161			−0.059		
	(2.875)			(0.829)		
a_1				−0.176		
				(0.145)		
PPS	−0.168			−0.184		
	(3.086)			(2.999)		
a_2	−0.877			−0.768		
	(8.240)			(5.192)		
EASTER	0.062	−0.058	0.006	0.062	−0.059	0.006
	(3.209)	(13.52)	(14.17)	(3.206)	(13.35)	(14.43)
TRADING	−0.007	0.007		−0.007	0.007	
	(5.132)	(17.53)		(5.140)	(17.51)	
LAW92	−0.102			−0.111		
	(2.281)			(2.395)		
JAN84 (AO)	0.107			0.116		
	(1.586)			(1.710)		
σ^2 *1000	5.711	0.631	0.500	5.911	0.644	0.504
Q(12)	6.712	7.198	5.086	6.382	8.361	5.765
Bera-Jarque	0.269	1.046	3.231	0.155	1.117	2.384
	(0.874)	(0.593)	(0.198)	(0.925)	(0.572)	(0.303)
H	0.752	0.769	0.755	0.828	0.754	0.761
	(0.196)	(0.104)	(0.097)	(0.183)	(0.089)	(0.103)

It is obvious that more variables would be necessary in order to account fully for all the variables that affect deaths on motorways. Such cases might be vehicle-kilometers traveled; stock of vehicles; number of licensed drivers; or extent of the road network. These variables were not explicitly considered in order to avoid collinearity problems among them and with the variables already included. Taking into account variables that share information with those already included would not shed any additional light onto the main objective of the paper (i.e. analyzing the effect of the law change in December 2007).

Of all the alternative methodological approaches for analyzing crash-frequency data (see Lord & Mannering, 2010), a multivariate unobserved components model class known as the basic structural model (Harvey, 1989) will be used to evaluate the new law (see García-Ferrer et al., 2007; Castillo-Manzano et al., 2010; Castillo-Manzano, López-Valpuesta, & Pérez, 2008 for an analysis of the advantages of this methodology on transportation research studies.):

$$\mathbf{z}_t = \mathbf{T}_t + \mathbf{S}_t + f(\mathbf{I}_t) + \mathbf{v}_t \tag{1}$$

$\mathbf{z}_t$, $\mathbf{T}_t$, $\mathbf{S}_t$ and $\mathbf{v}_t$ denote the m dimensional output time series and trend, seasonal and irregular components, respectively. $f(\mathbf{I}_t)$ measures the effects of explanatory variables in matrix $\mathbf{I}_t$ through linear Transfer Functions (TF). Eq. (1) is in fact a set of observation equations in a state space system, which has to be completed using the standard transition or state equations. The state equations qualify the dynamic behavior of the components, and a full model may be built via block concatenation of the individual components. The transition equations for trend and seasonal component models are a Local Linear Trend and the Trigonometric Seasonal component in Eq. (2), where $\mathbf{F}_t$ and $\mathbf{S}_{it}'$ are additional states necessary to define the components, $\mathbf{I}$ and $\mathbf{0}$ are the identity matrix and a square block of zeros of dimension m, $\mathbf{w}_j$ and $\mathbf{w}_j'$ ($j=0, 1, \ldots, 6$) are multivariate Gaussian white noise processes, serially independent and independent of each other, and ω_i ($i=1, 2, \ldots, 6$) are the fundamental frequency of the seasonal component and its harmonics for monthly series with an annual seasonal period.

$$\begin{cases} \text{Trend :} & \begin{pmatrix}\mathbf{T}\\ \mathbf{F}\end{pmatrix}_{t+1} = \begin{pmatrix}\mathbf{I} & \mathbf{I}\\ 0 & \mathbf{I}\end{pmatrix}\begin{pmatrix}\mathbf{T}\\ \mathbf{F}\end{pmatrix}_t + \begin{pmatrix}\mathbf{I} & 0\\ 0 & \mathbf{I}\end{pmatrix}\begin{pmatrix}\mathbf{w}_0\\ \mathbf{w}_0'\end{pmatrix}_t \\ \text{Seasonal :} & \mathbf{S}_t = \sum_{i=1}^{6}\mathbf{S}_{it}; \qquad i = 1, 2, \ldots, 6 \\ & \begin{pmatrix}\mathbf{S}_i\\ \mathbf{S}_i'\end{pmatrix}_{t+1} = \begin{pmatrix}\cos\omega_i\mathbf{I} & \sin\omega_i\mathbf{I}\\ -\sin\omega_i\mathbf{I} & \cos\omega_i\mathbf{I}\end{pmatrix}\begin{pmatrix}\mathbf{S}_i\\ \mathbf{S}_i'\end{pmatrix}_t + \begin{pmatrix}\mathbf{I} & 0\\ 0 & \mathbf{I}\end{pmatrix}\begin{pmatrix}\mathbf{w}_i\\ \mathbf{w}_i'\end{pmatrix}_t, \quad \omega_i = \frac{2\pi i}{12}\end{cases} \tag{2}$$

The first order standard linear TF model formulation is shown in Eq. (3), which is the usual way to handle outlier effects in time series, where $I_{i,t}$ ($i=1, 2, \ldots, k$) are a set of impulse variables appropriately defined in order to perform the intervention analysis, ω_i and a_i ($i=1, 2, \ldots, k$) are a set of parameters to be estimated, and B is the lag operator, so that $B^m x_t = x_{t-m}$.

$$f(\mathbf{I}_t) = \sum_{i=1}^{k}\frac{\omega_i}{(1 + a_i B)} I_{i,t} \tag{3}$$

The SS form used in this article for a single TF is shown in Eq. (4), where x_t and y_t are an additional state variable and the global effect of the outlier, respectively. The TF by itself may model transitory changes (TC with $a_i<0$: effects that disappear after some time); additive outliers (AO with $a_i=0$: effects on just one observations); and Level Shifts (LS with $a_i=1$: permanent effects).

$$\begin{cases} x_{t+1} = -a_i x_t - a_i\omega_i I_{i,t}: & \text{Transition Equation} \\ y_t = x_t + \omega_i I_{i,t}: & \text{Observation Equation}\end{cases} \tag{4}$$

The final SS version has to include all the additional terms by block concatenation. This form is shown in Eq. (5), where $\mathbf{\Gamma}$ and, $\mathbf{D}$ are new matrices that affect the intervention variables and accommodate all the additional parameters.

$$\begin{cases} \mathbf{x}_{t+1} = \Phi \mathbf{x}_t + \Gamma \mathbf{I}_t + \mathbf{E}\mathbf{w}_t: & \text{Transition Equations} \\ \mathbf{z}_t = \mathbf{H}\mathbf{x}_t + \mathbf{D}\mathbf{I}_t + \mathbf{v}_t: & \text{Observation Equations} \end{cases} \quad (5)$$

Given model (5), the well-known Kalman filter (KF; Kalman, 1960) produces the optimal estimates of the first- and second-order moments (mean and covariance) of the state vector, conditional on all the data in a sample in the sense of minimizing the mean squared errors (MSE). An algorithm that is used in parallel with the KF but is not as well-known in certain contexts is the fixed interval smoothing (FIS) algorithm, which allows for an operation similar to that of the KF but with a different set of information.

The application of the recursive KF/FIS algorithms requires knowledge of all the system matrices $\mathbf{\Phi}$, $\mathbf{\Gamma}$, $\mathbf{E}$, $\mathbf{H}$, $\mathbf{D}$, $\mathbf{Q}$ and $\mathbf{R}$. This is not usually possible, but there are a number of possible ways to handle this estimation problem; the maximum likelihood (ML) method is the most common in the time domain because of its good theoretical properties. Under the Gaussian assumption, the log-likelihood function can be computed using the KF via 'prediction error decomposition' (Harvey, 1989; Pedregal & Young, 2002).

3. Results and discussion

Two multivariate models with three endogenous variables were estimated: (a) assume the effect of the law change in December 2007 was a permanent change (i.e., a level shift); (b) assume such effect was a transitory change. One finding rather interesting is that the effect was anticipated by the general public, since a significant additive outlier was detected unambiguously in November 2007.

Table 1 shows the estimated parameters of the intervention variables for each equation of both models. Additional tests for outliers were carried out after each estimation and included in Table 1.

All models are correct from the point of view of diagnostics checking. Residuals of the three equations are Gaussian, homoscedastic, and have no serial correlation. In addition, the TC effect of the legal change is insignificant (Model 2), while the effect treated as LS is significant (Model 1). Moreover, the residual variance of Model 1 is marginally lower than Model 2 in the three equations, implying that Model 1 offers a better explanation of the data.

Results in Table 1 are completed with Table 2, where the relationship between the endogenous variables is shown. Such relations, in the case of multivariate unobserved components models, are measured through the correlations among components for the three variables. In this way, the relations among variables are contemplated in a different manner to other standard techniques, since it may be the case that most of the correlation concentrates at certain components, while the rest are more or less independent.

Table 2 shows that the relation between deaths in highways and IPI (measured by the correlations between four components, i.e. first row) are weaker than deaths in highways and gas and diesel consumption for transport (second row). This implies that the level of economic activity has less influence on fatal accidents than the use of cars. The relationships between trends are weak, or at least much less strong than the slopes (the rate of change of trends) or the seasonal components (with the exception of seasonal components between deaths and IPI); and the correlations among irregular components are especially low. This latter fact means that any shock of any of the variables has little influence on the rest.

Table 2
Estimated correlations between components.

Pairs of variables	Trend	Slope	Seasonal	Irregular
Deaths in highways – IPI	−0.464	0.619	−0.387	0.098
Deaths in highways - Gas consumption	−0.496	0.926	0.866	0.146
IPI - Gas consumption	0.454	0.847	−0.782	0.559

On the basis of all the previous findings the reform of the Spanish Penal Code at the end of 2007 can be concluded to have had a very positive effect, reducing Spanish road fatalities by 534 between November 2007 and December 2008 (14.9% plus the 24.7% in November 2007). This figure is much higher than the 372 that resulted from the introduction of the PPS in July 2006 (with an initial impact of 15.5% in July 2006). Moreover, judging strictly by the fit or the residual variance of the models, the effects of the reform of the Spanish Penal Code have remained unchanged during the 14 months from November 2007 to December 2008, and so look set to continue in 2009. This demonstrates that these effects are more persistent than those felt when the PPS driver's license was introduced, for example, which almost all studies in a range of countries have shown to be temporary and to soon diminish (Butler et al., 2006 for Ireland and Farchi et al., 2007 for Italy).

This would coincide with the Bjørnskau and Elvik (1992) hypothesis that only a significant increase of enforcement level might have an effect on traffic mortality, because partial or less harsh measures lead to adaptable behavior among road users. According to Tay (2005), the deterrence effects of a higher law enforcement is to increase the perceived certainty of apprehension and punishment, reducing the number of serious crashes on the roads.

Fig. 2 shows visually what has been stated numerically. It not only shows the recorded trend in road fatalities during the 2003–2009 period but also the "PPS correction" and "PPS and 2007 law correction" lines, which indicate the number of fatalities that *would have* occurred in the absence of the policies and reforms. It can be clearly seen how the PPS effect decays in time as the dotted line and the thin line approach each other, while the distance between them widens abruptly again in November 2007 due to the change in the Penal Code system.

4. Conclusions

During the 1980 s and 1990 s, Spain was one of the countries in Europe with the highest risk indicators in road accidents (Page, 2001) with rates only lower than those for other Mediterranean countries, such as Greece and Portugal. However, such remarkable progress has been made in Spain during the first decade of the 21st century that the European Commission's target of a 50% reduction in traffic fatalities between 2000 and 2010 (European Commission, 2001) has been already achieved in Spain, with the number of road deaths reduced by 52.5% during the 2003–2009 period (DGT, 2010b).

The key to this great improvement has been a change in Spanish road user behavior and attitudes prompted by the huge changes seen in road safety policy. Traffic injury prevention has become a priority of

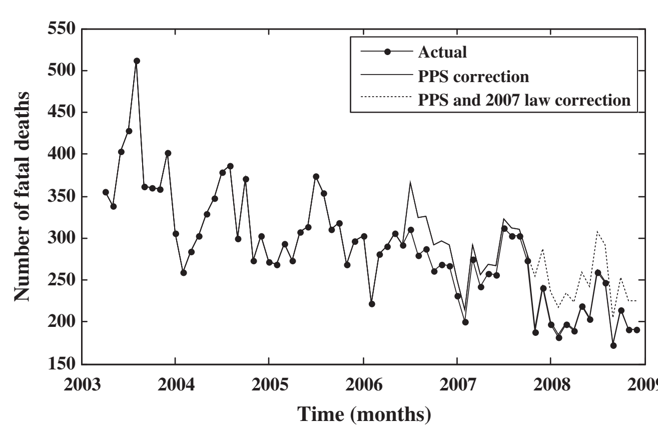

Fig. 2. Effect of Penalty Point System and 2007 Penal Code change on the reduction in fatalities.

government policies and progressively severer measures have been implemented, turning Spain into a social laboratory where a raft of measures has been passed.

The most aggressive strategy on road safety to date has been the reform of the Spanish Penal Code, which came into effect on December 2, 2007. This legal reform is a move to thwart the impunity of reckless drivers whom it classifies as delinquents at the wheel. Certain actions hitherto regarded as simple traffic violations were upgraded to the category of criminal offenses, with designated sanctions for offenders considerably toughened.

Through the use of multivariate unobserved component models set up in a state space framework estimated using maximum likelihood and monthly road accident series in Spain from 1980 to the current day, our purpose was to evaluate the impact of this drastic legal reform on the number of road deaths in Spain.

The findings mean that the reform of the Spanish Penal Code at the end of 2007 can be concluded to have had a very positive effect, reducing Spanish road fatalities by 534 between November 2007 and December 2008 (14.9% plus the 24.7% in November 2007). Furthermore, these figures are higher than the reduction in fatalities achieved by other previously-implemented road safety measures, such as the PPS which, after coming into effect in July 2006, achieved a reduction of 372 road fatalities and had an initial impact of 15.5% during said month.

With respect to the duration of these positive effects, the impact of the reform of the Spanish Penal Code has remained unchanged during the 14 months from November 2007 to December 2008, and this looks set to continue in 2009. This is a longer time than the effects of other earlier measures, such as the PPS (Castillo-Manzano et al., 2010), lasted. This would coincide with authors like Tay (2005): the deterrence effects of higher law enforcement are to increase the perceived certainty of apprehension and punishment, reducing the number of serious crashes on the roads.

Another interesting aspect is the time when the effects were first felt after the reform had been passed. In this respect, earlier papers (including Smith, 1986; Henstridge, Homel, & Mackay, 1997; Albalate, 2008) consider that a certain waiting-time is required after a reform of this type is passed for the greatest effects to be felt. But in this case, it can be seen that that this measure has been such a great deterrent that the impact of the Spanish Penal Code reform was noted even before it came into effect; even though the measure did not come into force until December 2, 2007, the effects were first felt in November.

The political debate over the Bill and the extensive and daily attention that the media paid to the content of the imminent legal reform (primarily in widespread general news broadcasts and the written press), together with it being presented with a high degree of visual harshness in the DGT's advertising campaigns over the weeks prior to its coming into force, had a huge impact on Spanish public opinion, resulting in an "announcement effect" that led to a 24.7% reduction in the road traffic fatalities during November.

Obviously, newspapers and periodicals have been carefully studied to ensure that there has been no other cause or meteorological phenomenon, such as a truck drivers strike or a heat wave in November that might explain such a decrease. Moreover, there is evidence that early effects of this type have also been felt in other countries when other road safety strategies have been implemented. This was the case in Italy, where Benedettini and Nicita (2009) observed a strong "announcement effect" with a significant decrease in the number of road accidents resulting from the mere announcement of the Italian Government Bill two years before the law that passed the Italian PPS in 2003 effectively came into force. These authors attribute this early adoption to expectation regarding increases in the level and penalization of offenses that said announcement caused in drivers, sparking a kind of "wait and see" behavior that to a certain extent could be explained by a "mental accounting process" like that detected by Sunstein (1999).

In the same line as Benedettini and Nicita (2009), our findings suggest that Spanish drivers interpreted that the road safety administration was going to considerably raise the level of law enforcement as a result of the media impact produced by the much harsher sentences and fines foreseen in the legal change. This underscores the importance of the media in changing the public's perception as a first step to changing behavior in the field of public health, as highlighted by previous researchers such as Noar (2006).

In other respects, with this reform Spain might be considered to be closing the final gap that kept it apart from other developed countries as far as the road accident rate is concerned. Evidence of this is the fact that Spain achieved a road fatality rate of 5.9 deaths per 100,000 inhabitants at the end of 2009, similar to that of other countries like Denmark (5.5) and Canada (6.3), and far below the figure achieved by leading countries like Korea (12.0) or the United States (11.0), and less than other Mediterranean countries in the area, such as Greece (13.8), Italy (7.9), Portugal (7.9), and France (6.9), from which Spain has finally managed to draw away (OECD, 2010). In fact, Spain tops the list for the steepest reduction in road fatalities during 2000–2009 (in 33 countries published by the International Transport Forum, ITF), with a decrease of 8.0% (after Portugal, which recorded a decrease of 8.5%; OECD, 2010).

To conclude, our paper contributes empirical evidence that in countries with a high road accident rate, as was the case of Spain, punitive measures are a faster way of obtaining positive results than those that are more educational in nature.

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