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How many lives can bloody and shocking road safety advertising save? The case of Spain

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ABSTRACT

At the beginning of the 21st century, the punishment strategies used by the Spanish administration were considerably hardened to achieve a reduction in road accidents. This hardening could also be seen in the mass-media public advertising campaigns, with a marked shift from gentle messages to threat-based advertisements.

The goal of this study is to evaluate the effectiveness of this radical change in terms of main road accident indicators and the time that the effects last using multivariate unobserved component models set up in a state space framework applied to monthly series for the 1980–2008 period. The main conclusion is that the effect on reducing road accidents is no greater when citizens are subjected to a greater level of threats in advertising campaigns than would on average be achieved using campaigns with a low level of threats. Secondly, the impact of bloody advertising in Spain is limited to the most serious accidents, those that cause deaths, either on highways or in built-up areas. Moreover, the positive effects progressively decrease as the average lifespan for significant effects of medium and high level campaigns on deaths on highways or in built-up areas was 8 months and almost 12 days. The results show that a reduction in numbers of deaths and injuries is always achieved when the level of harshness in the messages is increased after a period of several years of mild advertising.

1. Introduction

For decades Spain has been one of the European countries recording the highest number of fatal road accidents (Castillo-Manzano, Castro-Nuño, & Pedregal, 2010; Page, 2001) in relation to its population and rate of vehicle ownership. This has changed radically in recent years to the point that the ambitious goal set by European member states of a 50% reduction in the number of deaths in road accidents by the year 2010 (European Commission, 2001) has been achieved a year early.

In recent years, traffic injury prevention has been one of the priorities of the main governmental policies in Spain (Lassarre, 2001). A wide and varied range of collective strategies have been implemented relating to infrastructure improvement or vehicle safety and other legal, punitive, structural, passive safety, deterrence and enforcement measures (DGT, 2008, 2010; OECD, 2009). Of these the implementation of a driving license penalty points system in 2006 (Castillo-Manzano et al., 2010), and the drastic Penal Code reform carried out in 2007 (Castillo-Manzano, Castro-Nuño, & Pedregal-Tercero, 2011), stand out.

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Driving a vehicle is an individualistic action done with the protection of the most absolute anonymity despite the fact that, at the same time, it might result in significant negative externalities[1] (see Lindberg, 2001 for a description of these externalities). In order to include an "individual approach" in road safety policy, in earlier decades Griep (1970) and McGuire (1984) proposed that non-punitive strategies be implemented for inducing a behavioural change in the individual, such as educational or persuasion communication campaigns. Measures of this type are frequently used to address other health risks, such as cigarette smoking (Farrelly et al., 2002; Fishman et al., 2005) and alcohol abuse (Casswell, Ransom, & Gilmore, 1990; Maloney, 1984); occupational accidents (Hale, Guldenmund, & Van Loenhout, 2009; Saarela, 1989) and accidents in the home (Graham & Firth, 1992; MacKay & Rothman, 1982); or to promote healthy behaviour and discourage other unhealthy behaviour in general (Randolph & Viswanath, 2004). With regard to road safety, the use of advertising and propaganda is also a serious topic in the international scientific literature[2] (from pioneer researchers such as Berkowitz and Cottingham, 1960 and Farmer, 1974, to other recent studies, such as De Vrieze, 2001).

In Spain, successive advertising campaigns have been run throughout the last 50 years using a range of marketing techniques. They have progressively been adapted to the way the road accidents have evolved. As described in the following pages, at the beginning of the 1990s, the messages contained in road safety advertising were toughened up considerably in an attempt to bring a halt to the high levels of road accidents that occurred especially at the end of the 1990s, which were amongst the highest in Europe (García-Ferrer, De Juan, & Poncela, 2007).

The purpose of this paper is to evaluate the effectiveness of a type of road safety advertising that has been in use in Spain since 1992: the bloodiest, grisliest and most dramatic type. The aim is to respond to the following questions: Are better results obtained for accident rate indicators using bloodier road safety advertising campaigns? or, is there any direct evidence of the superiority of dramatic and bloody advertisements over other less dramatic advertising for the same message content?, as stated by Donovan, Henley, Jalleh, and Slater (1995). If the answer is 'yes', how long lasting would any effects of this advertising be? Are the effects of this type of advertising only really felt in the short term as Elliott (1993) states? In short, our paper is in the line of research done by Tay (2001) that seeks to quantify the impact of this advertising in terms of the reductions achieved in the main road accident indicators.

According to Grieṕs advertising campaign classification (1970), the literature for evaluating the effectiveness of advertisements in road safety can be split into two categories. Firstly, there are the studies on the effects of the advertising with a general theme (Elliott, 1993; Wong, Leung, Loob, Hung, & Lo, 2004; and for the case of Spain: Alvira-Martín, Blanco-Moreno, & Torres-Rius, 1996; Ramos et al., 2008). And, on the other hand, there is the advertising with a specific theme (see Evans & Graham, 1990 for a child restraint use legislation; Tarawneh, Singh, & McCoy, 1999, for controlling red-light violation; Chaudhary, Alonge, & Preusser, 2005, for increasing seat belt use; Sperber, Shiell, & Fyie, 2009, for a ban on the use of cellular phones by drivers; Lewis, Watson, & White, 2008 and Tay, 2002, for drunk driving and speeding; and in Spain: Pérez, Mari-Dell'Olmo, Tobias, & Borrell, 2007, for road safety campaigns on speed cameras installed in built-up areas; Gras, Cunill, Sullman, Planes, & Font-Mayolas, 2007, for seat belt use). In this case, both types of advertising campaign will be considered with their specific features explained in Section 2.

In general terms, there is a degree of consensus in the literature on the relative effectiveness of *positively framed advertisements*, defined by Sibley and Harré (2009) as those that show drivers, pedestrians and motorists doing "the correct and safe things". Most of these studies conclude that this informative advertising reinforces the implementation of other legal or economic road safety measures (fines and sanctions), increasing enforcement efficiency (Homel, Kearns, & Carseldine, 1988; Tay, 2005a). The impact it achieves on its own can be limited, as when there are no more forceful measures in place this positive advertising has a minor effect on public road user behaviour (Zaal, 1994). Everything points to the viewer becoming saturated given the high level of competition of this advertising with other more visually impacting and striking advertising, resulting in recall quickly diminishing (Randolph & Viswanath, 2004).

In other respects, there is no agreement on the efficacy of *negatively framed advertisements,* (Sibley & Harré, 2009). These are advertising strategies that illustrate the bloody consequences that can result from unsafe/illegal driving by portraying the crash scene and victims (Lewis, Watson, & Tay, 2007). These advertisements involve strong threats of physical harm with drivers or passengers that are injured or killed as a result of risky behaviour (Donovan & Henley, 2003; Elder et al., 2004). These threat-messages are expected to evoke a potential emotional response in the audience (called fear), and to persuade them to adopt safer road behaviour (Caubergue, De Pelsmacker, Janssens, & Dens, 2009; Lewis et al., 2007). This type of advertising uses the techniques habitually employed in marketing to influence the target audience through manipulation of the information included in the advertisements (see a general description of these techniques in Jung, 2009).

There are contradictory findings in the large literature about effects of threat-based advertisements in health advertising in general and in traffic safety advertising in particular (Higbee, 1969; Keller & Block, 1996). These contradictory results were brought to light in a recent meta-analysis (see Phillips, Ulleberg, & Vaa, 2011) of 67 studies that evaluate the effect of road safety campaigns in 12 countries from 1975 to 2007. According to the study's authors, despite this being a topic that is widely dealt with by researchers, their papers generally present "weak methodologies" and there are still no solid conclusions on the consequences of the use of fear. More evaluation of these types of campaigns therefore needs to be done based on more robust methodologies (Phillips et al., 2011).

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[1] In fact, researchers like Stanton and Salmon (2009) suggest that human or driver error contributes to as much as 75% of all road crashes.

[2] See Delaney, Lough, Whelan, and Cameron (2004) for a full review of the literature on the use of mass media campaigns in road safety.

Among the studies that argue that threatening messages are effective are Andsager, Weintraub, and Pinkleton (2001), De Hoog, Stroebe, and De Wit (2005), and Petty and Wegener (1998). In the same line, there are authors who also attribute positive collateral effects to these kinds of road safety advertisements as they encourage more rational behaviour related not only to driving (Fernandes, Soames, & Hatfield, 2007; Tay, 2005b). Meanwhile, at the other extreme of the literature, recent studies such as Lewis et al. (2007), Lewis, Watson and White (2008), Sibley and Harré (2009) can be found that condition the efficacy of threat-advertisements only to certain segments of the target audience, although they do usually ascribe greater effects to them than to positive advertisements, whereas for Tay and Watson (2002), the advertising messages that entail physical threats can result in either strong acceptance or strong rejection.

There was a radical change in the way road safety advertising was done in Spain from 1992 onwards. Therefore, using monthly road accident series from 1980 to 2008, the goal of our research is to determine any possible contribution made by this change in the advertising model to the spectacular reductions recorded in morbidity and mortality from traffic accidents in Spain in recent decades. For this to be done, the effects of other variables that might have influenced Spanish traffic accidents in the time period analysed were isolated. These included the level of economic activity, the rate of vehicle use, the implementation of other public policies of a legal or punitive nature, and other specific events, including general bad weather conditions and strikes by lorry drivers, and other variables that are explained in the following data in Section 3.

Furthermore, the time period during which the shocks last, and therefore the useful lifespan of an advertising campaign before it needs to be replaced, is measured. This is achieved by means of multivariate unobserved component models set up in a state space framework estimated using maximum likelihood. This robust methodology to treat time series has been used previously in other road safety studies, such as García-Ferrer et al. (2007) and Castillo-Manzano et al. (2011).

The article is organised as follows. Section 2 analyses road safety advertising in Spain. Section 3 presents the data and the methodology used. Section 4 presents the empirical results and, finally, Section 5 discusses the conclusions of the study.

2. Road safety advertising campaigns in Spain

The subject of this paper is the so-called Spanish State or Official Advertising concerning road safety, which would fall into the category of Public Service Announcements (PSAs) defined by Caubergue et al. (2009) and King and Reid (1989). In other words, the paid advertisements that the Spanish Government sponsors through one of its bodies, the Spanish General Directorate of Road Traffic (DGT), will be considered. In Spain, the preparation, publication and dissemination of these advertisements is subject to annual contracts signed with private advertising agencies and awarded by public tender.

In general terms, Administrations in all countries use educational techniques in the media to persuade their populations in terms of road safety (see Henderson, 1991 for a review). But this paper only considers mass-media "*DGT* Road Safety Campaigns"[3] more in keeping with commercial advertising, and that differ from other types of educational or instructive actions aimed at training road users (detailed in broad terms by Williams & Wells, 2004).

The definition of *mass-media campaign* (including counter-advertising) used by the World Health Organization (WHO, 2010) is taken as a starting point: "*Mass-media include newspapers and other printed material, radio, television, billboards, etc.*"; and expanded by the Global Road Safety Partnership (2002): "*... part of a set of activities which aim to promote safe road use... being their ultimate goal to reduce crashes and injuries on the road".*

Since its creation in the 1960s, the *DGT* has used the communication carriers or media that are habitually used to disseminate persuasive traffic safety messages in road safety (see Lund & Aarø, 2004, in general):

- Written press: graphics placed in general information and motoring, motorcycling and cycling world specific information publications, with national, regional and local circulations.[4]
- Radio: is used by the *DGT* for broadcasting both commercials and information about the state of the roads. The radio campaign contract is separate from the Annual Road Safety Information Campaign.
- Television: this is by far the best medium for disseminating these campaigns and, for Liedekerken and Van der Colk (1990), the most effective. The *DGT* ramps up the use of TV during critical periods such as Easter, the summer holidays and Christmas. The campaigns that were studied for this paper were run on both public and private Spanish TV channels irrespective of whether they were regional or national in nature, and during specific time slots depending on the target audience (see Bel and Doménech, 2009, for an analysis of the Spanish television advertising market).
- Cinema: advertisements are projected before the start of certain films chosen on the basis of the audience that the message is aimed at, such as young or old drivers, for example.
- Internet: following the trend towards an increased use of the net as a means for disseminating advertising compared to other more traditional means (Dimmick, Chen, & Li, 2004), this initiative was launched in 2000, with the placing of banners on the most visited websites, and links with advice on road safety on the *DGT*'s own institutional website.

[3] In Spain there is also another non-institutional type of road safety propaganda disseminated by private organisations such as the *Mapfre Foundation* Road Safety Institute, the *RACC* Foundation and, more exceptionally, the initiative launched since 2009 by the *Antena 3*, a private communications group, under the slogan "Ponle Freno" ('Put a Brake On It') (full details can be found at www.ponlefreno.com).

[4] In this regard, it should be pointed out that the *DGT* itself created a magazine called "*TRÁFICO Y SEGURIDAD VIAL*" ('Traffic and Road Safety') (previously called "*TRÁFICO*") in 1985 specifically aimed at collectives directly involved in road safety-related topics. The electronic version of the magazine can be consulted at http://www.dgt.es/tráfico/.

Campaigns run by the *DGT* in Spain from 1980 to 2008 were considered. The nineteen-eighties and -nineties were taken as a reference as, from those two decades on, traffic campaigns began to be an essential tool in the road safety context both in Spain and internationally (Tay, 2005b), with an increase in high budget paid advertising campaigns (Donovan, Jalleh, & Henley, 1999). Table 1 summarises all the information relating to the various campaigns run by the *DGT* during the period under study, including the main slogans that have defined each of the annual campaigns and a brief description of the techniques used and the main objectives.

Although there are differences in terms of the marketing strategy and the format used, these campaigns, aimed at the main road users (pedestrians, drivers in general and motorcyclists), address the following topics: avoiding the consumption of dangerous substances when driving, promoting the use of safety devices, encouraging caution and good practice when driving, specific campaigns put in place according to the season (summer months or Easter) or as a result of some new legislation, and showing the dramatic consequences of reckless behaviour behind the wheel.

The ingenuous cartoons used in the first campaigns have given way to more powerful and striking marketing techniques with large quantities of graphic visuals and raw language, with the aim of sensitising and provoking the viewer. There have also been developments in the platform used, as in the 80s billboard posters began to give way to television commercials. These then dominated during the 1990s, while at the beginning of the new century the importance of radio commercials increased.

In the third column of Table 1 the various campaigns have been classified according to the level of physical/emotional threats included to cause fear and persuade the audience (LOW, MEDIUM or HIGH), as well as according to the injury outcome focus (injury to self; injury to others, to driver's family, or the 3rd. person effect. This last was analysed by Lewis et al., 2007). For this, the scales used in the *ad hoc* preliminary studies done by Caubergue et al. (2009), Higbee (1969), King and Reid (1989)and Kohn, Goodstadt, Cook, Sheppard, and Chan (1982) were synthesised.

As can be seen, the 1992 campaign marked an inflection point in the history of Spanish road safety. Up to said year practically all the campaigns used can be identified by their 'soft line' (excepting the 1982 and 1983 campaigns, which were on a medium level). From that time on, the 'hard line' was taken and this represented a radical change, with a new and rather controversial communication style that has lasted practically up to the present day. The *DGT* has, however, adjusted the level of visual and emotional rawness of the commercials broadcast, interspersing years of high levels with years of medium levels of harshness, as can be seen in Table 1.

3. Data and methods

The data used to measure the effect of the PSAs in Spain can be divided into four groups:

(A) Traffic mortality and morbidity endogenous variables: four monthly variables related to accident rates, namely the number of deaths in highway accidents; the number of fatalities in accidents in built-up areas; the remainder of injuries in highway accidents; the remainder of injuries in accidents in built-up areas. In order to use as long a consistent time series as possible, we used the definition of deaths occurring within the first 24 h after the accident instead of the Vienna Convention definition (30 days after the accident). The available time series spans from January 1980 to December 2008 (Source: Spanish National Statistics Institute, INE, Spanish Statistics Agency (2010), http://www.ine.es/ on INEbase).

(B) Dummy exogenous variables: a wide range of variables are included in models to estimate a number of intervention variables and outlier effects seen in the data. The most important, with their definitions, are:

  (b.1) In the first group of estimations (see Table 2) the aim is to test for any positive effects that on average would be obtained by increasing the level of threats in advertising during the period of the analysis, 1980–2008. Two level shift dummies have therefore been included. The first of these, *Medium–high*, has a value of 1 for the years when the advertising had a medium or high level of threats, whereas the second, *High*, has a value of 1 for the years when the advertising had a high level of threats (see Table 1).
  In the second group of estimates (see Tables 3 and 4) the aim is to individually analyse the effects of each of the advertising campaigns with medium and high levels of threats with a series of generic dummies, BDyyyy, where 'yyyy' stands for the year when the campaigns took place. One variable of this type is included in the models in each of the years when a campaign is launched. In order to test the duration of the possible effects, steps of increasing length are tested, starting with one month and ending with one full year. It should be noted that campaigns were launched in consecutive years on many occasions.

  (b.2) EASTER: Traffic campaigns around this vacation period are especially intense in Spain. In fact, authorities launch special police operations to minimise problems on the roads and highways. Accordingly, the moveable feast of Easter variable is defined by assigning different weights to the days in question depending on the expected traffic density (these weights have to add up to one). Maximum weights are assigned to Friday, Palm Sunday, Wednesday and Easter Sunday. Medium weights are assigned to the Saturday before Palm Sunday and Holy Thursday. Weights of zero are assigned to the rest of days.

  (b.3) TRADING: The number of trading days in a month. This variable was also considered in modelling IPI and petrol and diesel consumption.

Table 1
Public road safety advertising in Spain from 1980 to 2008. *Source*: Dirección General de Tráfico (DGT) (1980–2008).

Date	Brief description (main goal)	Level of threats
1980	Use of simple sketches and posters aimed at drivers reducing alcohol consumption, encouraging seat-belt use and cutting down speed. Photographs of road accidents appear	Low
1981	Graphics and TV commercials aimed at pedestrians, motorcyclists and drivers; promotion of good driving practices. Use of religious symbology	Low
1982	Use of basic graphics and TV commercials to promote road safety and respect for other drivers. Caution with certain medication. Visualisation of negative effects of accidents; small doses of tragedy	Medium
1983	More elaborate graphics that recreate real situations. Famous people appear in TV commercials, degree of rawness in images of crashes. Respect for highway code, caution when driving during certain times of year, vehicle check	Medium
1984	TV commercials with famous people, families and children who give reminders about respect for highway code, caution and vehicle maintenance. Education in road safety	Low
1985	Use of graphics and TV commercials with celebrities such as Stevie Wonder and crash test dummies to show effects of lapses in concentration and alcohol consumption	Low
1986	Use of graphics and TV commercials with crash test dummies to give tips on safe driving, vehicle maintenance and respect for highway code	Low
1987	Celebrities, simple TV commercials and graphics to encourage caution on long and short trips and cutting down of speed	Low
1988	Posters and a small number of simple TV commercials with no images of accidents or blood. Aimed at increasing road safety, avoiding alcohol consumption and caution on long and short trips	Low
1989	A squirrel represents the *DGT* and offers advice and reminds people what the correct way to guarantee road safety is	Low
1990	Some posters and TV commercials in the form of adventure film trailers to promote seat-belt and crash helmet use, cutting down of speed and avoidance of alcohol consumption in a pleasant way	Low
1991	Posters in the form of comics and TV commercials with famous people to prevent lapses in concentration and excess speed at the wheel	Low
1992	The shocking reality of accidents just after they have happened is shown. Extreme real stories are restaged attempting to reproduce a range of traffic accidents as faithfully as possible using close-ups of cars with blood	High
1993	Two types of TV commercial. The first of these are repeats from the previous campaign, which are highly dramatic and have large doses of realism. The second show the physical and psychological damage suffered by people involved in the accidents	High
1994	Colourful posters and TV commercials with eye-witness accounts from affected people who talk about how their lives were changed after the accidents (spinal cord injuries, tetraplegia, etc.). Reminders are also given about administrative, penal and economic sanctions handed out for careless or reckless driving	High
1995	Some simple posters and TV commercials which show the collateral effects of accidents on the families of those affected	High
1996	Crashes, people being struck by vehicles, deaths with grieving families after showing unsafe driving under the effect of alcohol, non-use of seat-belts or with lapses in concentration and recklessness	High
1997	Predominantly TV commercials showing conflicting behaviour. There are two people in the same car. The first is reckless whereas the second, who has some sentimental link with the first, advises him/her to modify his/her behaviour	Low
1998	Commercials in which a series of anonymous people recount their personal experiences of different aspects of road safety	Low
1999	Commercials aimed at all social forces working together to bring down the accident rate. Both comic formats and images of tragedies are used; stories of daily life with happy endings thanks to the people involved behaving properly	Medium
2000	TV and radio commercials that compare material and physical damage from natural (unavoidable) disasters and (avoidable in the majority of cases) traffic accidents. The comparison of the results is terrifying, with very shocking images	High
2001	Commercials with disabled people and the viewers are given three choices to explain the reason why they are disabled, with a traffic accident being one of them. Special attention is paid to showing the crude reality of the effects of lapses in concentration and to encouraging rest stops when driving	High
2002	Commercials with pedestrians and cyclists being knocked down, deaths and injuries after accidents. At the end the commercial can be rewound in order for things to be done differently	High
2003	Small number of TV commercials which show the heart-rending effects of accidents and a high number of radio commercials. The campaign was basically targeted at showing the advantages of correct seat-belt use even in the city	High
2004	High numbers of commercials on TV and radio that first show the crude reality of the effects of accidents caused by recklessness and then allow the actors to rectify their conduct to show that this can be avoided	High
2005	High numbers of commercials on TV and radio that encourage safe and careful driving. Positive messages are used but alongside shocking images	High
2006	High numbers of commercials on TV and radio that crudely show the effects on children and young people. Information about points on driving licence	High
2007	High numbers of positive commercials, posters and radio commercials occasionally with famous people. Very shocking	High
2008	High numbers of TV and radio commercials that intersperse post-accident effects and positive images. Selling the idea that there has been a huge drop in the accident rate	High

(b.4) Three legal changes: Firstly, LAW92, representing a level shift due to a change in the law introduced in June 1992 by which rear seat belts became compulsory (see e.g. García-Ferrer et al., 2007). This may cause an interesting collinearity problem, since this change overlaps with the hardening of advertising campaigns. Secondly, the introduction of the Penalty Points driving license system in 2006 (PPS; Castillo-Manzano et al., 2010) which will be modelled as a transitory change in accordance with Butler et al. (2006) and Farchi et al. (2007) on the Irish and Italian cases, respectively. Finally, a dummy variable has been included to estimate the effects of the 2007 Spanish Penal Code reform. To be more precise, although the reform came into force in December 2007 (DEC07), the effects started to be felt earlier, in November 2007 (NOV07), given the huge impact that the passing of the Bill through Parliament had in the media.

Table 2
Estimation results for models with intervention variables and a test for Medium–high and High campaigns. One and two asterisks indicate statistical significance at 1% and 5% levels, respectively. σ^2 represents innovations variance; $Q(12)$ are the Ljung-Box Q statistics for 12 lags; Bera-Jarque is a normality test (*P*-values in brackets); H is a variance ratio homocedasticity test (*P*-values in brackets).

	Deaths on highways	Deaths in built-up areas	Injuries on highways	Injuries in built-up areas
PPS	−0.191*	0.084	−0.151*	−0.183*
PPS denominator	−0.813*	0.819	−0.568*	−0.610*
EASTER	0.058*	0.025	0.051*	−0.015
TRADING	−0.007*	−0.002	−0.006*	−0.001
LAW92	−0.156*	−0.034	−0.173*	−0.144*
NOV07 (AO)	−0.272*	−0.161	0.047	0.056
DEC07 (LS)	−0.196*	−0.099	−0.077**	−0.023
JAN84 (AO)	0.103**		0.096**	0.082**
NOV93 (AO)	−0.115**		−0.133*	
Medium–high	**−0.036**	**−0.073****	**−0.021**	**−0.029**
High	**0.002**	**−0.054**	**0.025**	**0.024**
σ*1000	6.714	16.552	3.329	2.532
$Q(12)$	7.004	12.985	11.554	12.688
Bera-Jarque	0.921	0.091	0.733	2.679
	(0.631)	(0.953)	(0.692)	(0.273)
H	0.964	0.781	0.783	0.873
	(0.431)	(0.134)	(0.152)	(0.225)

Table 3
Estimation results for univariate models with intervention variables. One and two asterisks indicate statistical significance at 1% and 5% levels, respectively. σ^2 represents innovations variance; $Q(12)$ are the Ljung-Box Q statistics for 12 lags; Bera-Jarque is a normality test (*P*-values in brackets); H is a variance ratio homoscedasticity test (*P*-values in brackets). The numbers in brackets in the coefficients affecting the BDyyyy variables represent the duration of the effect in months.

	Deaths on highways	Deaths in built-up areas	Injuries on highways	Injuries in built-up areas
PPS	−0.190*	0.117	−0.163*	−0.182*
PPS denominator	−0.802*	0.657	−0.534*	−0.614*
EASTER	0.061*	0.026	0.053*	−0.015
TRADING	−0.007*	−0.001	−0.006*	−0.001
LAW92	−0.153*	−0.063	−0.180*	−0.142*
NOV07 (AO)	−0.262*	−0.15	0.057	0.057
DEC07 (LS)	−0.190*	−0.09	−0.080**	−0.024
JAN84 (AO)	0.112**		0.092**	0.099**
NOV93 (AO)	−0.142**		−0.136*	
BD1982	−0.061** (7)	−1.476	−0.054** (7)	
BD1983	−0.121** (3)		−0.058** (3)	
BD1992	−0.068** (12)	−1.688		
BD1993			−0.101* (3)	
BD1994	−0.099** (11)			
BD1995		−0.097** (12)		
BD1996	−0.168	−1.35* (12)		
BD1999	−0.073** (8)	−0.091** (9)		
BD2002			−0.065* (9)	
BD2003		−0.152** (5)		
BD2004	−0.075** (9)		−0.074* (9)	
BD2005			−0.098* (9)	
σ*1000	5.613	15.221	2.912	2.393
$Q(12)$	7.579	11.561	10.589	11.621
Bera-Jarque	2.521	1.538	1.194	3.392
	(0.283)	(0.562)	(0.550)	(0.183)
H	0.753	0.733	0.847	0.864
	(0.108)	(0.108)	(0.269)	(0.258)

(b.5) There are other outliers, often related to bad weather conditions (for example JAN84), and other causes that have been detected by statistical tools (such as NOV93). The procedure to look for such outliers consists of selecting the residuals outside four times standard deviation and including them as potential candidates in the models under different specifications (LS, TC as explained above, or additive outliers AO for sudden changes that affect just one observation). The outliers are included in final models with the specification that provides the best fit when they are statistically significant.

Table 4
Reduction of casualties in percentages and absolute numbers (from Table 3).

	Deaths on highways		Deaths in built-up areas		Injuries on highways	
	%	Casualties saved	%	Casualties saved	%	Casualties saved
BD1982	−5.91	115	−11.57	89	−5.25	1633
BD1983	−11.39	80	–	0	−5.63	622
BD1992	−6.57	328	−19.02	114	–	0
BD1993	–	0	–	0	−9.60	1430
BD1994	−9.42	440	–	0	–	0
BD1995	–	0	−9.24	89	–	0
BD1996	−15.46	61	−12.62	139	–	0
BD1999	−7.04	219	−8.69	69	–	0
BD2002	–	0	–	0	−6.29	2809
BD2003	–	0	−14.10	60	–	0
BD2004	−7.22	236	–	0	−7.13	3082
BD2005	–	0	–	0	−9.33	4304
TOTAL		1479		560		13,880

(C) Other exogenous variables. We initially considered two types:

(c.3) Typically weather conditions are quoted in the literature as important determinants of car safety, although sometimes discarded because of the lack of representative and reliable data (see e.g., García-Ferrer et al., 2007 and Kilpeläinen & Summala, 2007). In the present paper, the weather variables effect is included indirectly by outlier detection (see paragraph b.5, above) because no representative time series at a monthly sample interval are available, since the study is developed for a 500,000 km^2 country with several climate regimes and 200,000 km of roads. The effect of weather might be detectable for smaller areas, but not for the whole country.

(c.4) The media selected for publicising the campaigns. A dummy variable that differentiated between media was initially tried out, but no significant differences were found.[5]

(D) Other endogenous variables: Part of the literature argues that both the rate of vehicle use and the level of economic activity are important determinants of the number of road accidents (see Castillo-Manzano et al., 2010 and García-Ferrer et al., 2007). In this article, economic activity is represented using the Industrial Production Index (IPI) and the degree of vehicle use based on the consumption of petrol and diesel for transport. Despite the fact that in some studies these variables or similar are considered exogenous, here they are addressed differently, since the models developed subsequently consist of the three endogenous variables, each of accidents in turn, together with IPI and petrol consumption (see Table 5).

The relationship of each of the accident series to other variables is considered in the context of a full multivariate model in which IPI and petrol consumption variables are included as endogenous variables jointly. Therefore, four multivariate models are estimated with three endogenous variables (each of the accident series in turn with IPI and petrol consumption) and the exogenous variables included in paragraph B) above. Time profiles of injuries on highways, IPI and petrol consumption can be seen in Fig. 1.

The models used in this paper are of the class of multivariate Unobserved Components (UC) models that allow for the decomposition of a time series into economically meaningful, though unobserved, components. In contrast to other models more often used to treat time series, such as the ARIMA or DRAG models, UC models offer the possibility of explicitly breaking down time series into components like trend, cycle, seasonal and irregular effects, as well as linear and non-linear relationships with other exogenous variables, like the examples shown in this paper. When models are multivariate (several endogenous variables), relationships between variables may be explored at the level of the raw variables or at a disaggregated level, i.e. by component.

See Eq. (1).

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

$\mathbf{z}_t$, $\mathbf{T}_t$, $\mathbf{S}_t$ and $\mathbf{v}_t$ denote the m dimensional endogenous 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).

One appropriate set up in which the UC analysis may be carried out is the State Space framework in which the dynamic system is split into two types of equations, i.e. *State* and *Observation* equations. The discrete-time, stochastic *State Equations* reflect all the dynamic behaviour of the system by relating the current value of the states to their past values as well as the deterministic and stochastic inputs, while the *Observation Equations* define how the state variables are related to the observed data (as a matter of fact, Eq. (1) is the observation equation of the UC model, see below). There are a number of different formulations of these vector–matrix equations, but the one favoured here is as follows:

[5] Results are available from the authors upon request.

Table 5
Diagnostics check of equation corresponding to IPI and petrol consumption in model for injuries on highways.

	IPI	Petrol and diesel consumption for transport
$\sigma^{*}1000$	0.695	0.539
$Q(12)$	6.299	7.111
Bera-Jarque	0.886	5.756
	0.642	0.056
H	0.890	0.856
	0.299	0.264

$$\begin{cases} \mathbf{x}_{t+1} = \mathbf{\Phi x}_t + \mathbf{\Gamma I}_t + \mathbf{w}_t : & \text{state equations} \\ \mathbf{z}_t = \mathbf{H x}_t + \mathbf{D I}_t + \mathbf{v}_t : & \text{observation equations} \end{cases} \quad (2)$$

where $\mathbf{x}_t$ is an n dimensional stochastic state vector; $\mathbf{I}_t$ is a k dimensional vector of dummy exogenous variables; $\mathbf{w}_t$ and $\mathbf{v}_t$ are n and m dimensional vectors of Gaussian system disturbances, i.e. zero means white noise inputs with covariance matrix $\mathbf{Q}$ and $\mathbf{R}$ and independent of each other; and $\mathbf{\Phi}$, $\mathbf{\Gamma}$, $\mathbf{H}$ and $\mathbf{D}$ are the so-called system matrices, some elements of which are known while others need to be estimated.

Given model (1), 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 minimising the mean squared errors (MSE). An algorithm that is used in parallel with the KF but which 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 information set.

The estimation of the unknown parameters in the system matrices $\Phi, \mathbf{\Gamma}, \mathbf{H}, \mathbf{D}, \mathbf{Q}$ and $\mathbf{R}$ may be tackled in several ways, being maximum likelihood (ML) the most common because of its good theoretical properties. Under the Gaussian assump-

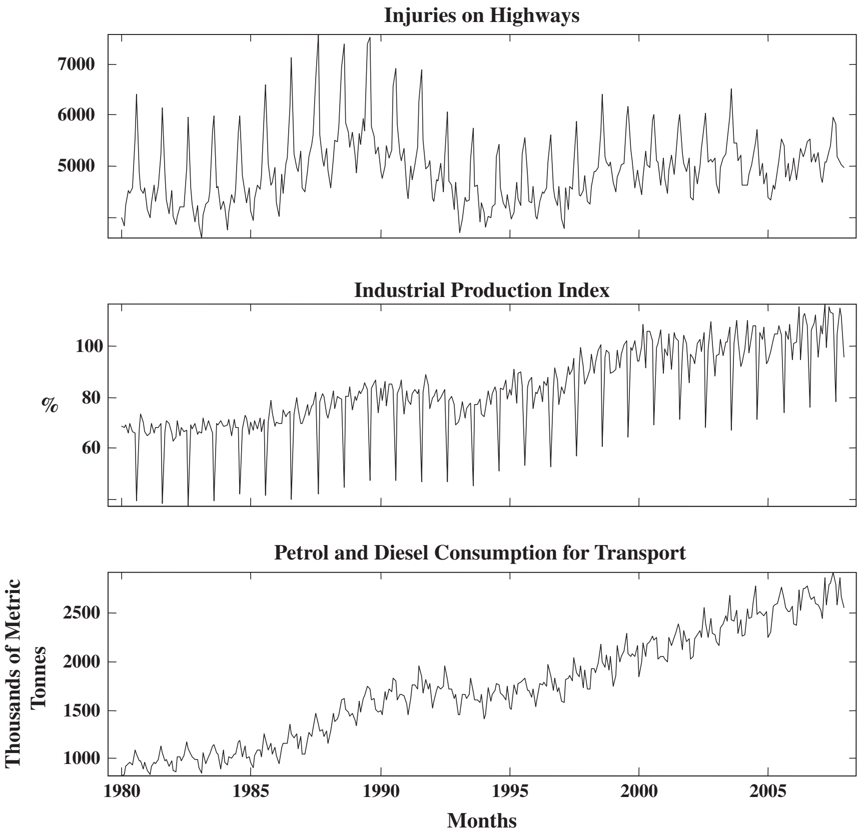

Fig. 1. Injuries on highways, the Spanish industrial production index and petrol and diesel consumption for transport.

tion, the log-likelihood function can be computed using the KF via 'prediction error decomposition' (see details in Harvey, 1989; Pedregal & Young, 2002).

The multivariate unobserved components model in Eq. (1) fits naturally in the SS framework in Eq. (2), since the observation equations show the decomposition of the time series into its components, and the state equations specify the components' dynamics. A description of the full SS system is shown in Eq. (3), see Harvey (1989), Pedregal and Young (2002).

$$\mathbf{x}_{t+1}=\begin{bmatrix}\mathbf{T}\\ \mathbf{F}\\ \hline \mathbf{S}_1\\ \mathbf{S}_1^*\\ \mathbf{S}_2\\ \vdots\\ \hline f_1\\ \vdots\end{bmatrix}_{t+1}=\left[\begin{array}{cc|cccc|cc}\mathbf{I} & \mathbf{I} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \cdots & \mathbf{0} & \cdots\\ \mathbf{0} & \mathbf{I} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \cdots & \mathbf{0} & \cdots\\ \hline \mathbf{0} & \mathbf{0} & \mathbf{I}\cos\omega_1 & \mathbf{I}\sin\omega_1 & \mathbf{0} & \cdots & \mathbf{0} & \cdots\\ \mathbf{0} & \mathbf{0} & -\mathbf{I}\sin\omega_1 & \mathbf{I}\cos\omega_1 & \mathbf{0} & \cdots & \mathbf{0} & \cdots\\ \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{I}\cos\omega_2 & \cdots & \mathbf{0} & \cdots\\ \vdots & \vdots & \vdots & \vdots & \vdots & \ddots & \vdots & \vdots\\ \hline \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \cdots & -a_1 & \cdots\\ \vdots & \vdots & \vdots & \vdots & \vdots & \cdots & \vdots & \ddots\end{array}\right]\mathbf{x}_t+\begin{bmatrix}\mathbf{0} & \mathbf{0}\\ \mathbf{0} & \mathbf{0}\\ \hline \mathbf{0} & \mathbf{0}\\ \mathbf{0} & \mathbf{0}\\ \mathbf{0} & \mathbf{0}\\ \vdots & \vdots\\ \hline -a_1b_1 & \mathbf{0}\\ \mathbf{0} & \ddots\end{bmatrix}\mathbf{I}_t+\begin{bmatrix}\mathbf{w}_0\\ \mathbf{w}_0^*\\ \hline \mathbf{w}_1\\ \mathbf{w}_1^*\\ \mathbf{w}_2\\ \vdots\\ \hline \mathbf{0}\\ \mathbf{0}\end{bmatrix}_t \quad (3)$$

$$\mathbf{z}_t=\mathbf{T}_t+\mathbf{S}_t+f(\mathbf{I}_t)+\mathbf{v}_t=\left[\mathbf{I}\quad \mathbf{0}\mid \mathbf{I}\quad \mathbf{0}\quad \mathbf{I}\quad \mathbf{0}\quad \cdots\mid \mathbf{H}_f\right]\mathbf{x}_t+\mathbf{D}\mathbf{I}_t+\mathbf{v}_t \quad (3)$$

A comparison of systems (2) and (3) allows the identification of the system matrices. Apart from the previous elements, new elements appear in Eq. (3): **I** and **0** are an identity matrix of dimension m and a squared block $m \times m$ zeros; $\mathbf{F}_t$ is a block of trend 'slopes' or trend rates of change; $\mathbf{S}_{it}$ ($i = 1, 2, \ldots, P/2$) are the seasonal harmonics of frequencies $\omega_i = 2\pi i/P$, such that $\mathbf{S}_t = \sum_i^{P/2}\mathbf{S}_{it}$, with P being the fundamental frequency (12 observations per year in the case of monthly data with annual seasonality); $\mathbf{S}_{it}^*$ ($i = 1, 2, \ldots, 6$) are additional blocks of states necessary for the definition of seasonal terms; **D** and $\mathbf{H}_f$ are $m \times k$ and $m \times l$ matrices that implement the TF terms in the system.

The specification of TF effects deserves further comment. All TFs considered here are of order one, since only outlier corrections are considered. The general formulation of a single TF is given in Eq. (4), where B is the lag operator, so that $B^m x_t = x_{t-m}$.

$$f_{pt} = \frac{b_p}{(1 + a_p B)} I_{pt} \quad (4)$$

For Transitory Change outliers (TC), $a_p < 0$, i.e., the effect disappears after some time. Additive outliers (AO) implies $a_p = 0$, i.e., the effect is observed in just one observation. Finally, Level Shifts (LS) means that $a_p = -1$, i.e., the effect is permanent.

A TF generic term of this type is introduced into system (3) in the following way: assume that the single TF term f_{1t} in Eq. (3) affects the second exogenous variable and is transmitted to the third endogenous. Calling d_{ij} and h_{ij} the generic element in the 'ith' row and 'jth' column of matrices **D** and $\mathbf{H}_f$ respectively, then $d_{32} = b_1$ and $h_{31} = 1$.

4. Results

Eight multivariate models with three endogenous variables each were estimated. Specifically, each of the models comprises one main endogenous variable, i.e., one of the four safety indicators in turn; two other endogenous variables (the Spanish IPI and the consumption of petrol and diesel for transport) and an ample set of dummy type exogenous variables presented in the previous section and introduced into the models as TF effects. There were also some further outliers found for the IPI series, namely Easter, trading day effects and a transitory change due to the events in Spain during September, 1992. The outliers in petrol consumption were connected with Easter and trading day effects.

The first group of multivariate models aims to evaluate any positive effects that on average would be obtained by increasing the level of threats in the advertising. In order to facilitate the reading of Table 2, a brief list of variable names is included below (full definitions in section 3):

(1) PPS: Penalty Point System dummy. As the effect is considered transitory, a denominator is included in the model (see section 3).
(2) EASTER and TRADING: Easter and trading effects.
(3) LAW92: 1992 Law that introduced important changes.
(4) NOV07 and DEC07: Reform of the Spanish Penal Code in 2007.
(5) JAN84 and NOV93: Bad weather dummies in 1984 and 1993.
(6) Medium–high and High: advertising campaign dummies.

The results obtained for the first equation of each model are given in Table 2. Bearing in mind that the models are semi-logarithmic (i.e., the endogenous variables are used in natural logarithms, while the exogenous dummy variables are binary variables taking values 0 and 1), the percentage influence of exogenous variables are calculated by $[\exp(\textit{coefficient}) - 1] \times 100$ in Table 2. Models were run on the MATLAB™ platform with code developed by the authors.

Table 2 shows that the effects of dummy variables are rather different depending on the type of endogenous variable considered:

1. Deaths on highways: every single exogenous variable is significant in this case, except the dummy variables that differentiate medium–high publicity campaigns from high. The most influential variables are the legal changes, i.e., the Penalty Point System driving licence (with a reduction of 17.4% in deaths in the initial month of application) and the penal code change in November (23.8%) and December 2007 onwards (17.8%).
2. Deaths in built-up areas: contrary to (1), above, none of the dummy variables are significant here, implying that the determinants of deaths are rather different. However, the only significant variable was the dummy related to medium–high content campaigns, with a 7% reduction in deaths.
3. Injuries on highways: the case is similar to deaths on highways, but with more moderate results. Most of the variables are significant, albeit with lower values, with the exception of the effect of the 1992 Law. Campaigns are not important as far as reducing casualties is concerned.
4. Injuries in built up areas: the case here is similar to that above but with more moderate results still. Once again, campaigns are not significant.

One clear conclusion from Table 2 is that all the legal changes, as well as Easter and Trading effects, are unambiguously more relevant on highways than in built-up areas, and the effects are clearer still in the case of deaths. The second clear conclusion is that advertising campaigns have no clear effects on reducing casualties when considered in an aggregated form, i.e., simply differentiating between campaigns with medium–high and high content.

To sum up, the models in Table 2 are useful for quantifying the effect of legal changes and other effects, but show that the level of violence in advertising content is not important when campaigns are considered in an aggregated forrm. In order to further test this, the models in Table 3 seek a deeper insight by considering the campaigns individually. These are referred to as BDyyyy, where yyyy stands for the year of the campaign.

One key issue in this paper is that, based on *a priori* grounds and previous estimates, a transitory effect of advertising campaigns was expected with a duration that would differ from case to case. This problem was tackled by estimating models with increasing lengths of campaign effects, one month at a time, and selecting that which had the best statistical significance of parameters. In addition to the parameter estimates, this procedure renders the duration in months of each campaign as an output (this duration is given in brackets on the parameter side of each BDyyyy variable in Table 3).

The results obtained for the first equation of each model are given in Table 3 (which is the most significant), while some diagnostic checks for the other two equations in the case of injuries on highways are shown in Table 5.

Table 3 shows that all the effects apart from the campaigns themselves have similar values to the models in Table 2. The key point in Table 3 is that the effects of campaigns start to become clearer when they are broken down for analysis in this way. In addition, Table 4 converts all the key coefficients in the models referring to the campaign effects in Table 3 into percentage reductions for each campaign and numbers of casualties. The results vary depending on the endogenous variable:

1. Deaths on highways: there is an inverse relationship between intensity of the effect and campaign duration. The most effective campaigns are those of 1992 and 1994, in which lives saved totalled 328 and 440, respectively. It is interesting to note, however, that the campaigns of 1983 and 1996 were the most striking as far as the impact on reduction is concerned, with a 11.4% reduction during 3 months and 15.5% during just 1 month, respectively (these were the least effective in terms of reductions in casualties, just 80 and 61). Duration and effectiveness have been clearer since 1992. The number of total lives saved in the period was 1479.
2. Deaths in built-up areas: some important effects can also be seen here, and in general the effects are longer-lasting than in the previous case. The most effective campaigns in this case were those in 1996 and 1992, with reductions of 139 (12.62%) and 114 (19%) casualties. The remaining campaigns involve reductions from 8.7% in 1999 to 14.1% in 2003. Duration decreases in the most recent campaigns. Deaths prevented numbered 560 from 1982 to 2005.
3. Injuries on highways: the effects are more moderate in percentage terms than in the previous cases, ranging from 5.2% in 1982 to 9.6% in 1993. An interesting point in this case is that the effectiveness of campaigns, judging by the reduction in the number of casualties, increases constantly over time from 1993 onwards. There was a fall in the number of injuries of 13,880 for the whole period.
4. Injuries in built-up areas: there is no evidence that the campaigns have had any effect. None are significant.

All models seem appropriate from the point of view of diagnostics checking, as shown at the bottom of Tables 2, 3 and 5. The residuals are Gaussian according to the Jarque–Bera test, are homoscedastic according to the ratio of variances test (H test), and have no serial correlation problems, judging by the Ljung-Box Q tests.

5. Conclusions

During the 1980s and 1990s, Spain was one of the countries in Europe with the highest risk indicators in road accidents. With the purpose of achieving a reduction in these, traffic injury prevention has become a priority of government policies. At the beginning of the 21st century the strategies used by the *DGT* were considerably hardened and punishment measures were ramped up in order to achieve quick results. As a result, remarkable progress has been made in Spain: from 1990 to 2008 the risk has decreased by about 70% (OECD, 2009).

This hardening can also be seen in the evolution of mass-media road safety advertising campaigns run by the *DGT* (PSAs). By way of example, in 1992 there was a shift from the popular slogan *"don't drive drunk"*, as sung by Stevie Wonder, to large-scale raw sights and sounds with brutal images of accidents and eye-witness accounts from real victims, which has lasted up to the present day.

The goal of this article is to evaluate the impact of the radical change seen in the focus of PSAs in Spain since 1992 according to the main road accident indicators (deaths and injuries, on highways and in built-up areas) and the time that the effects last. The analysis is done using multivariate unobserved component models set up in a state space framework using monthly data series from 1980 to 2008.

This analysis comes under the framework of the academic debate on the effectiveness of threat-based advertisements (Sibley & Harré, 2009). One of our study's contributions is to respond to academic demands (see Phillips et al., 2011) for more evaluation of these types of campaigns using robust methodologies. To be specific, multivariate unobserved component models (also called state space models) have been used. As already explained in Section 3, these provide interesting advantages over other more frequently-used models for treating time series in road safety, such as the ARIMA and DRAG models.

Apart from the methodology used, this paper is also original with respect to the case study. To be precise, it is the first study that analyzes the effects of road safety advertising in Spain with such a broad time horizon, almost thirty years. In fact, we have only found one precedent (Alvira et al., 1996), which is limited to analysing a single year, 1991, which happens to be the year before the dramatic changes in the PSAs.

The fact that we have worked with such an extended time period has also enabled us to to follow the recommendation of both Phillips et al. (2011) and Delaney et al. (2004) to examine the longer-term effects of mass media campaigns since, according to these authors, the vast majority of studies focus on evaluating short-term effects, i.e., the more inmediate changes that occur in the wake of a new campaign.

The first conclusion that can be drawn from our analysis is that in general terms the effect on reducing road accidents is no greater when citizens are subjected to a greater level of threats in advertising campaigns than would on average be achieved using campaigns with a low level of threats (see Table 2). It could therefore be said that citizens are being subjected to unnecessary levels of cruelty. These results would be consistent with earlier studies, such as Soames Job (1988), which consider that threat-based advertising campaigns are ineffective in the long-term, apart from having high costs in terms of time, effort and monetary resources. In the same line, Lewis et al. (2007), Lewis et al. (2008), and Sibley and Harré (2009), condition the effectiveness of threat-advertisements only on certain segments of the target audience, and always accompanied by other more incisive types of measures (law enforcement, fines, highly visible police activity).

In short, our results indicate that higher levels of fear and violence in road safety publicity campaigns (considered in an aggregated form, i.e., simply differentiating between campaigns with medium–high and high content) have no clear effects on reductions in casualties in the medium and long term. Also, in comparative terms, these effects seem to be less long-lasting than other road safety policies of a markedly punitive and penalising nature, such as the penalty points system, the compulsory use of seatbelts (see Castillo-Manzano et al., 2010) and tougher criminal legislation (see Castillo-Manzano et al., 2011).

The results of this research show that there is an exception to this rule, which is the effect on "deaths in built-up areas". When the threat level is increased in this particular case there is a 7% reduction compared to what would be achieved with a low threat level campaign. However, the fact that the "High" variable is not significant indicates that it is not necessary to use excessive threat levels, as on average the same results are achieved with medium level campaigns as with high level campaigns. This result is especially relevant if it is taken into account that earlier studies showed the deaths in built-up areas variable to be quite immune to punitive strategies, such as the compulsory use of seat-belts (García-Ferrer et al., 2007) or the coming into force of the Points System driver's license (Castillo-Manzano et al., 2010). This hypothesis is once more observed in the lack of significance of all the explanatory variables for the "deaths in built-up areas" variable (see Table 2, column 3). According to previous studies, this can be attributed to the different pattern of behaviour displayed by road accidents in rural areas and on highways (Híjar, Carrillo, Flores, Anaya, & López, 2000) compared to built-up areas (Jones et al., 2008) because of factors such as traffic congestion, the lower legal speed limit, the difference in the effect of weather conditions and, especially, the shorter time that it takes for the accident victims to receive medical attention (Sánchez-Mangas, García-Ferrrer, De Juan, & Martín-Arroyo, 2010, for Spain). To summarise, according to Castillo-Manzano et al. (2010), deaths in built-up areas are a problem that requires specific solutions, which could include specific, harsher advertising campaigns for this category of accidents.

After drawing these general conclusions, each of the 17 annual advertising campaigns that had medium or high effects was analysed separately. It was observed that grisly advertising is useful for mitigating this public health problem in certain cases. Specifically, the results (see Tables 3 and 4) show that a reduction in numbers of deaths and injuries is always achieved when the *DGT* increases the level of harshness in the messages after a period of several years of mild advertising. This suggests that this prior 'fallow' period of campaigns which send gentle messages to the public in their advertising, are an absolute necessity for the efficacy of the gory advertising to be maintained.

In this respect, our results seem to confirm that when the dosis of cruelty and fear in the advertisements is progressively increased, reductions in road accidents reach a saturation point similar to that described by Lewis et al. (2007) (*a curvilinear function or inverted "U"*). Once this saturation point is reached, any increases in the level of fear become excessive and might result in the target audience avoiding and rejecting the advertisements. Following Tay and Watson (2002), the level of fear could be reduced from this point on without significantly affecting acceptance rates but with reduced levels of rejection.

Thirdly, the effects of the bloody advertising can be seen to be progressively waning. To be specific, the last period of bloody advertising analysed for 1999–2008 has little effect. Most of the effect is concentrated in the first year, 1999, (after 2 years of mild advertising from 1997 to 1998) and in 2004. It would therefore seem that the audience has become immune to the repeated use of blood and realism. This result concurs with Hastings, Stead, and Webb (2004) and Soames Job (1988).

One other interesting result for planning the length of these campaigns is that all those that had positive effects generally lasted under a year. This would confirm Elliot's (1993) hypothesis on the short-term effects of repeated exposure to fear messages. Be that as it may, the average lifespan for significant effects of medium and high level campaigns on deaths on highways or in built-up areas was 8 months and almost 12 days, which is more than the average 6 months suggested by King and Reid (1989). It would therefore seem that the policy pursued by the *DGT* to completely change its campaign each year is both a good one and necessary.

Moreover, it can be concluded from the results that the effects of bloody advertising is limited above all to the most serious accidents, those that cause deaths, either on highways or in built-up areas, and that it has little effect on injuries on highways and barely any at all on injuries in built-up areas.

In other respects, although there are 4 years when the reduction in road mortality is spread evenly between deaths on highways/deaths in built-up areas, there are also two other blocks where the reduction is concentrated exclusively in one or the other of these two types of public thoroughfare (1983, 1994, and 2004 for deaths on highways; 1995 and 2003 for deaths in built-up areas). By visualising the campaigns it is easier to explain this phenomenon, as it would appear to depend on the topics that are recreated each year in the advertising, on the context that surrounds the message, and, above all, on the type of public thoroughfare chosen for staging the advertisement (accidents on motorways or other main roads and collisions in built-up areas).

Finally, the above results help with planning the design of the Spanish *DGT*'s advertising strategy in the short- and medium-term. As Table 1 shows, high-threat content has been used continuously in PSAs from 1999 to the present day. However, the results in Table 3 show that 2004 was the last truly representative year as far as a reduction in road deaths was concerned using this strategy, although barely significant and slight effects on injuries on highways can be found for 2005. As a result, it can be understood that the fear-inducing model has completed another life-cycle and that at the present time the most rational stratagem would be to establish another 'fallow' or rest period with low-threat message content since, as Table 2 shows, on average this has similar effects to those achieved by medium or high campaigns, except for deaths in built-up areas. Furthermore, the high costs of staging and developing high-level campaigns are an unnecessary luxury (see Table 2) which should be reconsidered at this time in order to alleviate the tight budget restraints that the *DGT* is currently experiencing, in keeping with those in all other Spanish public organisations, given the economic circumstances in which the main Euro, and especially the Mediterranean, economies have committed to harsh reductions in their current public deficits.

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References

Alvira Martín, F., Blanco Moreno, F., & Torres Rius, M. (1996). El empleo de diseños de series temporales en la evaluación de intervenciones públicas. *Un ejemplo aplicado. Revista Española de Investigaciones Sociológicas, 76*, 173–192.

Andsager, J. L., Weintraub, Austin. E., & Pinkleton, B. E. (2001). Questioning the value of realism: Young adults' processing of messages in alcohol-related public service announcements and advertising. *Journal of Communication, 51*, 121–142.

Bel, G., & Domènech, L. (2009). What Influences Advertising Price in Television Channels?: An Empirical Analysis on the Spanish Market. *Journal of Media Economics, 22*, 164–183.

Berkowitz, L., & Cottingham, D. R. (1960). The interest and value of fear arousing communications. *Journal of Abnormal Social Psychology, 60*, 37–43.

Butler, J. S., Burke, J. P., Healy, D. G., Stephens, M. M., McManus, F., & McCormack, D. (2006). Trends in RTA related spinal injuries: The post penalty points era. *Irish Journal of Medical Science, 175*, 20–23.

Casswell, S., Ransom, R., & Gilmore, L. (1990). Evaluation of a mass-media campaign for the primary prevention of alcohol-related problems. *Health Promotion International, 5*, 9–17.

Castillo-Manzano, J. I., Castro-Nuño, M., & Pedregal, D. J. (2010). An econometric analysis of the effects of the penalty points system driver's license in Spain. *Accident Analysis and Prevention, 42*, 987–1420.

Castillo-Manzano, J. I., Castro-Nuño, M., & Pedregal-Tercero, D. J. (2011). Can fear of going to jail reduce the number of road fatalities? The Spanish experience. *Journal of Safety Research, 42*, 223–228.

Caubergue, V., De Pelsmacker, P., Janssens, W., & Dens, N. (2009). Fear, threat and efficacy in threat appeals: Message involvement as a key mediator to message acceptance. *Accident Analysis and Prevention, 41*, 276–285.

Chaudhary, N. K., Alonge, M., & Preusser, D. F. (2005). Evaluation of the Reading, PA night-time safety belt enforcement campaign: September 2004. *Journal of Safety Research, 36*, 321–326.
De Hoog, N., Stroebe, W., & De Wit, J. B. F. (2005). The impact of fear appeals on processing and acceptance of action recommendations. *Personality and Social Psychology Bulletin, 34*, 24–33.
De Vrieze, N. (2001). Effectiveness of road safety campaigns. In P. Barjonet (Ed.), *Traffic Psychology Today* (pp. 207–217). Boston/London: Kluwer Academic Publishers.
Delaney, A., Lough, B., Whelan, M., Cameron, M. (2004). A review of mass-media campaigns in road safety. Monash University. Accident Research Centre. Australia.
Dirección General de Tráfico (DGT) (1980–2008). Campañas de divulgación 1980–2008. <http://www.dgt.es>. Accessed April 2010.
Dirección General de Tráfico (DGT), (2010). Balance de Seguridad Vial 2009. Ministerio del Interior. Gobierno de España. Spain.
Dimmick, J., Chen, Y., & Li, Z. (2004). Competition between the internet and traditional news media: The gratification-opportunities Niche dimension. *Journal of Media Economics, 17*, 19–33.
Dirección General de Tráfico (DGT) (2008). Plan Estratégico de Seguridad Vial 2005–2008. Ministerio del Interior. Gobierno de España. Spain.
Donovan, R. J., Henley, N. C., Jalleh, G., Slater, C. (1995). Road safety advertising: An empirical study and literature review. Donovan Research. Federal Office of Road Safety. Canberra.
Donovan, R. J., & Henley, N. (2003). *Social marketing: Principles and practice*. Melbourne, Australia: IP Communications.
Donovan, R. J., Jalleh, G., & Henley, N. (1999). Executing effective road safety advertising: Are big production budgets necessary? *Accident Analysis and Prevention, 31*, 243–252.
Elder, R., Shults, R., Sleet, D., Nichols, J., Thompson, R., & Rajab, W. (2004). Effectiveness of mass-media campaigns for reducing drinking and driving and alcohol-involved crashes: A systematic review. *American Journal of Preventive Medicine, 27*, 57–65.
Elliott, B. (1993). Road safety mass-media campaigns: A meta-analysis. Report No. CR 118, Elliott and Shanahan Research. Federal Office of Road Safety, Sydney.
European Commission (2001). White Paper—European Transport Policy for 2010: Time to Decide. Office for Official Publications of the European Communities, Luxembourg.
Evans, W., & Graham, J. D. (1990). An estimate of the lifesaving benefit of child restraint use legislation. *Journal of Health Economics, 9*, 121–140.
Farchi, S., Chini, F., Rossi, P. G., Camilloni, L., Borgia, P., & Guasticchi, G. (2007). Evaluation of the health effects of the new driving penalty point system in the Lazio Region, Italy, 2001–2004. *Injury Prevention, 13*, 60–64.
Farmer, P. (1974). The Edmonton Study: a Pilot Project to demonstrate the effectiveness of a Public Information Campaign on the subject of drinking and driving. In Israelstam, S., Lambet, S. (Eds.), *Alcohol, drugs and traffic safety*. Addiction research foundation, Toronto, pp. 831–843.
Farrelly, M. C., Healton, C. G., Davis, K. C., Messeri, P., Hersey, J. C., & Haviland, M. L. (2002). Getting to the truth: Evaluating national tobacco countermarketing campaigns. *American Journal of Public Health, 92*, 901–907.
Fernandes, R., Soames, Job R. F., & Hatfield, J. (2007). A challenge to the assume generalizability of prediction and countermeasure for risky driving: Different factors predict different risky driving behaviours. *Journal of Safety Research, 38*, 59–70.
Fishman, P. A., Ebel, B. E., Garrison, M. M., Christakis, D. A., Wiehe, S., & Rivara, F. P. (2005). Cigarette tax increase and media campaign cost of reducing smoking-related deaths. *American Journal of Preventive Medicine, 29*, 19–26.
García-Ferrer, A., De Juan, A., & Poncela, P. (2007). The relationship between road traffic accidents and real economic activity in Spain: Common cycles and health issues. *Health Economics, 16*, 603–626.
Global Road Safety Partnership (2002). Road Safety Publicity Campaigns, Switzerland.
Graham, H. J., & Firth, J. (1992). Home accidents in older people: Role of primary health care team. *British Medical Journal, 305*, 30–32.
Gras, M. E., Cunill, M., Sullman, M. J., Planes, M., & Font-Mayolas, S. (2007). Predictors of seat belt use amongst Spanish drivers. *Transportation Research Part F, 10*, 263–269.
Griep, D. J. (1970). Propaganda and alternative countermeasures for road safety. *Accident Analysis and Prevention, 2*, 127–140.
Hale, A. R., Guldenmund, F. W., & Van Loenhout, C. (2009). Evaluating safety management and culture interventions to improve safety: Effective intervention strategies. *Safety Science*. doi:10.1016/j.ssci.2009.05.006.
Harvey, C. (1989). *Forecasting structural time series models and the Kalman Filter*. Cambridge: Cambridge University Press.
Hastings, G., Stead, M., & Webb, J. (2004). Fear appeals in social marketing: Strategic and ethical reasons for concern. *Psychology and Marketing, 21*, 961–986.
Henderson, M. (1991). Education, publicity and training in road safety: A literature review. Monash University. Accident Research Centre. Report No. 22. Australia.
Higbee, K. L. (1969). Fifteen years of fear arousal: research on threat appeals: 1953–1968. *Psychological Bulletin, 72*, 426–444.
Híjar, M., Carrillo, C., Flores, M., Anaya, R., & López, V. (2000). Risk factors in highway traffic accidents: A case control study. *Accident Analysis and Prevention, 32*, 703–709.
Homel, R., Kearns, I., & Carseldine, D. (1988). Drink-driving countermeasures in Australia. *Alcohol, Drugs and Driving, 4*, 113–144.
Jones, A. P., Haynes, R., Kennedy, V., Harvey, I. M., Jewell, T., & Lea, D. (2008). Geographical variations in mortality and morbidity from road traffic accidents in England and Wales. *Health and Place, 14*, 519–535.
Jung, H. M. (2009). Information manipulation through the media. *Journal of Media Economics, 22*, 188–210.
Kalman, R. E. (1960). A new approach to linear filtering and prediction problems. *ASME Transactions. Journal Basic Engineering, 83*, 95–108.
Keller, P. A., & Block, L. G. (1996). Increasing the persuasiveness of fear appeals: The effect of arousal and elaboration. *Journal of Consumer Research, 22*, 448–459.
Kilpeläinen, M., & Summala, H. (2007). Effects of weather and weather forecasts on driver behavior. *Transportation Research Part F, 10*, 288–299.
King, K. W., & Reid, L. N. (1989). Fear arousing anti-drinking and driving PSAs: Do physical injury threats influence young adults. *Current Issues in Research in Advertising, 13*, 155–175.
Kohn, P. M., Goodstadt, M. S., Cook, G. M., Sheppard, M., & Chan, G. (1982). Ineffectiveness of threat appeals about drinking and driving. *Accident Analysis and Prevention, 14*, 457–464.
Lassarre, S. (2001). Analysis of progress in road safety in ten European countries. *Accident Analysis and Prevention, 33*, 743–751.
Lewis, I., Watson, B., & Tay, R. (2007). Examining the effectiveness of physical threats in road safety advertising: The role of the third-person effect, gender, and age. *Transportation Research Part F, 10*, 48–60.
Lewis, I., Watson, B., & White, K. M. (2008). An examination of message-relevant affect in road safety messages: Should road safety advertisements aim to make us feel good or bad? *Transportation Research Part F, 11*, 403–417.
Liedekerken, P.C., Van der Colk, H. (1990). Highway driving speed reduction and public information campaigns in the Netherlands. V TI Rapport 365A, Swedish Road and Traffic Research Institute, Sweden.
Lindberg, G. (2001). Traffic insurance and accident externality charges. *Journal of Transport Economics and Policy, 35*, 399–416.
Lund, J., & Aarø, L. E. (2004). Accident prevention. Presentation of a model placing emphasis on human, structural and cultural factors. *Safety Science, 42*, 271–324.
MacKay, A. M., & Rothman, K. J. (1982). The incidence and severity of burn injuries following project burn prevention. *American Journal of Public Health, 72*, 248–252.
Maloney, S. K. (1984). Getting messages on the air: Findings from the 1982 alcohol abuse prevention Campaign. *Health Education and Behaviour, 11*, 273–292.
McGuire, W. J. (1984). Public communication as a strategy for inducing health-promoting behavioral change. *Preventive Medicine, 13*, 299–319.
OECD (2009). International traffic safety data and analysis group. IRTAD ANNUAL REPORT. <http://www.irtad.net> (accessed April 2010).

Page, Y. (2001). A statistical model to compare road mortality in OECD countries. *Accident Analysis and Prevention, 33*, 371–385.

Pedregal, D. J., & Young, P. C. (2002). Statistical approaches to modelling and forecasting time series. In M. P. Clements & D. F. Hendry (Eds.), *A companion to economic forecasting* (pp. 69–104). Oxford: Blackwell.

Pérez, K., Mari-Dell'Olmo, M., Tobias, A., & Borrell, C. (2007). Reducing road traffic injuries: Effectiveness of speed cameras in an urban setting. *American Journal of Public Health, 97*, 1632–1637.

Petty, R. E., & Wegener, D. T. (1998). Attitude change: multiple roles of persuasion variables. In D. T. Gilbert, S. T. Fiske, & G. Lindzey (Eds.), *The handbook of social psychology*. Boston: McGraw-Hill.

Phillips, R. O., Ulleberg, P., & Vaa, T. (2011). Meta-analysis of the effect of road safety campaigns on accidents. *Accident Analysis and Prevention, 43*, 1204–1218.

Ramos, P., Díez, E., Pérez, K., Rodríguez-Martos, A., Brugal, M. T., & Villalbí, J. R. (2008). Young people's perceptions of traffic injury risks, prevention and enforcement measures: A qualitative study. *Accident Analysis and Prevention, 40*, 1313–1319.

Randolph, W., & Viswanath, K. (2004). Lessons learned from public health mass-media campaigns: Marketing health in a crowded media world. *Annual Review of Public Health, 25*, 419–437.

Saarela, K. L. (1989). A poster campaign for improving safety on shipyard scaffolds. *Journal of Safety Research, 20*, 177–185.

Sánchez-Mangas, R., García-Ferrrer, A., De Juan, A., & Martín-Arroyo, A. (2010). The probability of death in road traffic accidents. How important is a quick medical response? *Accident Analysis and Prevention, 42*, 1048–1056.

Sibley, C. G., & Harré, N. (2009). The impact of different styles of traffic safety advertisement on young drivers' explicit and implicit self-enhancement biases. *Transportation Research Part F, 12*, 159–167.

Soames Job, R. F. (1988). Effective and ineffective use of fear in Health Promotion Campaigns. *American Journal of Public Health, 78*, 163–167.

Spanish Statistics Agency (Instituto Nacional de Estadística, INE). Transport and communications. Roads network, vehicles, drivers and accidents. Spain. <http://www.ine.es> Accessed April 2010.

Sperber, D., Shiell, A., & Fyie, K. (2009). The cost-effectiveness of a law banning the use of cellular phones by drivers. *Health Economics*. doi:10.1002/hec.1546.

Stanton, N. E., & Salmon, P. M. (2009). Human error taxonomies applied to driving: A generic driver error and its implications for intelligent transport systems. *Safety Science, 47*, 227–237.

Tarawneh, T. M., Singh, V. A., & McCoy, P. T. (1999). Investigation of effectiveness of media advertising and police enforcement in reducing red-light violations. *Transportation Research Record, 1693*, 37–45.

Tay, R. (2001). Methodological issues in evaluation models: The New Zealand road safety advertising campaign. *Road and Transportation Research, 10*, 29–39.

Tay, R. (2002). Exploring the effects of a road safety advertising campaign on the perceptions and intentions of the target and non-target audiences to drink and drive. *Traffic Injury Prevention, 3*, 195–200.

Tay, R. (2005a). General and specific deterrent effects of traffic enforcement. Do we have to catch offenders to reduce crashes? *Journal of Transport Economics and Policy, 39*, 209–223.

Tay, R. (2005b). Drink driving enforcement and publicity campaigns: Are the policy recommendations sensitive to model specification? *Accident Analysis and Prevention, 37*, 259–266.

Tay, R., & Watson, B. (2002). Changing drivers' intentions and behaviours using fear-based driver fatigue advertisements. *Health Marketing Quarterly, 19*, 55–68.

Williams, A., & Wells, J. (2004). The role of enforcement programs in increasing seat belt use. *Journal of Safety Research, 35*, 175–180.

Wong, S. C., Leung, B. S. Y., Loob, B. P. Y., Hung, W. T., & Lo, H. K. (2004). A qualitative assessment methodology for road safety policy strategies. *Accident Analysis and Prevention, 36*, 281–293.

World Health Organization (WHO) (2010). <http://www.who.int/tobacco/training/sucess_stories/media/en/index.html> Accessed April 2010.

Zaal, D. (1994). Traffic law enforcement: A review of the literature. Monash University. Accident Research Centre. Report No. 53. Australia.