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The complex relationship between increases to speed limits and traffic fatalities: Evidence from a meta-analysis

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ABSTRACT

Speed plays an important role in road safety as it affects accident risk and severity. Among safety policies implemented to control driving speed, speed limits are the most highly developed. Since the 1970′s, numerous studies have focused on the effectiveness of speed limits, but even today there is still no clear consensus as to the impact that raising the speed limit has on traffic fatalities. With the aim of consolidating knowledge on this topic, a meta-analysis has been carried out of a set of econometric studies assessing the effects on traffic fatalities of increasing speed limits in the US. Two sub-samples were obtained, taken from the traffic fatality measures considered by studies (*fatality count* and *fatality rate normalized per vehicle miles traveled*), and two approaches were analyzed: rural interstates (where speed limits were increased in 1987 and 1995), and a statewide approach (all roads network). Our findings show that by count traffic fatalities went up on both rural interstates and statewide level, although the effect was higher on rural interstates. In other respects, statewide fatality rates could be improved in relative terms by raising legal speed limits, although the effect would be weak.

1. Introduction

Of all the strategies available to control speed, speed limits are the most widely used to manage traffic speed (Aarts and van Schagen, 2006; Archer et al., 2008; Augeri et al., 2015). It is true that in some countries there are highways where no legal speed limits exist as such, including Germany, with *recommended speed limits* on the *Autobahns* (Manner and Wünsch-Ziegler, 2013) and the US state of Montana, where *reasonable and prudent speed limits* were in place from 1996 to 1999 (Yowell, 2005). However, there is a consensus in the highway safety community as to the need and appropriateness of applying legal speed limits on all types of roads, as drivers may not always subjectively choose the optimum speed from the social point of view (Elvik, 2002, 2012).

The research has addressed the relationship between modifications to the maximum speed limit and road safety in depth, with studies dealing with both the effect of a rise in the maximum permitted speed limit (Imprialou et al., 2016; Ritchey and Nicholson-Crotty, 2011; van Benthem, 2015) and a reduction in the limit (De Pauw et al., 2014; Islam and El-Basyouny, 2015; Kloeden et al., 2007). Similarly, many other studies focus on improvements to road safety through the setting of variable or dynamic speed limits depending on traffic or atmospheric conditions (Islam et al., 2013; Yu and Abdel-Aty, 2014; Zhibin et al., 2014) or temporary speed limits imposed to save energy, for example (Castillo-Manzano et al., 2014) or reduce air pollution levels (Elvik, 2013).

As part of this relationship between speed limits and road safety, the present research seeks to conduct a meta-analysis of the influence that increases to maximum speed limits have on traffic fatalities, based on a quantitative systematic review of the empirical evidence in this field of research.

If we focus only on scholars who have addressed the impact of raised speed limits on road safety, there are studies of a range of countries, such as Finland (Peltola, 2000), Australia (Sliogeris, 1992), New Zealand (Scuffham and Langley, 2002), Israel (Friedman et al., 2007; Richter et al., 2004), and China (Wong et al., 2005). However, most are of the United States (US) and focus either on the national level (Grabowski and Morrisey, 2007; Ritchey and Nicholson-Crotty, 2011; Shafi and Gentilello, 2007), an individual state (Bartle et al., 2003; Ledolter and Chan, 1996; Upchurch, 1989), or a group of states (Baum et al., 1990; Farmer et al.,1999; Patterson et al., 2002).

The reason for this predominance lies in the relevant legal changes

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to the maximum permitted speed limit implemented in the US since 1974. Speed limit regulations have traditionally come under state responsibility. However, in March 1974, all states adopted a maximum 55 mph limit set by Congress on the countrywide level with the National Maximum Speed Law. This measure was aimed at offsetting the rise in oil prices (Friedman et al., 2009; Shafi and Gentilello, 2007) caused by the embargo put in place by the Organization of Petroleum Exporting Countries -OPEC- (Grabowski and Morrisey, 2007). Two changes were subsequently made to the law to raise the speed limit. First, in 1987, Congress enacted the Surface Transportation and Uniform Relocation Act, which allowed states to put up speed limits from 55 mph to 65 mph on rural interstates (Greenstone, 2002). Second, in 1995 Congress repealed the National Maximum Speed Law with the passing of the National Highway System Designation Act, devolving powers to individual states to set their own speed limits (Retting and Cheung, 2008; Vernon et al., 2004). This Repeal enabled many states to quickly move to raise speed limits from 65 mph to 70 mph or more on both rural and urban interstates (Albalate and Bel, 2012; Friedman et al., 2009; Retting and Teoh, 2008). As Farmer (2016) highlights, even states like Texas have followed this trend toward higher speed limits in recent years, with an increase to over 80mph on specified segments of interstate roads (see IIHS, 2017a, 2017b and The Insurance Institute for Highway Safety website for a broader treatment of the topic: http://www.iihs.org/iihs/topics/laws/speedlimits?topicNamen = speed).

Two possible focuses can be highlighted regarding US studies that measure the effect on road safety of increases to the speed limit. On the one hand, some studies propose an analysis of the consequences of increased speed limits solely on the roads on which the new legislation is implemented (see, for example, Gallaher et al., 1989 for the state of New Mexico; Haselton et al., 2002 for the state of California; and Pfefer et al., 1991 for the state of Illinois). In contrast, other studies such as Garber and Graham (1990), Lave and Elias (1994) and McCarthy (1994a, 1994b) have put forward the argument that the effects of an increase to the speed limit should be studied on all the roads in the network and not only the roads where the new limit has been applied (in a statewide approach).

This broader approach is based on the influence of two results of raising speed limits: the allocation of surveillance resources and changes in driver behavior. Regarding the former, according to Lave and Elias (1994) a rise in the speed limit can lead to the reallocation of surveillance patrols from speed enforcement to other accident prevention activities that may be more effective in reducing fatalities (e.g., enforcing drunk-driving laws). On the other hand, two different and contradictory effects of increases to speed limits have to be taken into account with regard to driver behavior. The first, the so-called "diversion effect" (Lave and Elias, 1994; Rock, 1995; Wagenaar et al., 1990), assumes that drivers will divert toward roads and highways where the permitted driving speed is higher, so road safety improves on roads that are not affected by the increase to the limit. The second effect is the "speed spillover effect" (Brown et al., 1990; Garber and Graham, 1990), according to which drivers get used to driving at higher speeds, even on roads where the maximum speed limit has not changed. This "speed adaption or generalization" effect (Rock, 1995) would therefore lead to a decline in road safety on roads not affected by the increase to the speed limit.

As far as the findings of these studies are concerned, major discrepancies can be observed in the estimations obtained by the wide range of studies on the topic, irrespective of the geographic areas and roads under study. Comments will be made on these in the following paragraphs.

First, several studies conclude that there is no doubt that increases to speed limits have a harmful effect on road safety. The following can be cited as examples: Ossiander and Cummings (2002) for the state of Washington; Bartle et al. (2003) for the state of Alabama; Baum et al. (1991) for a set of 40 states and Ashenfelter and Greenstone (2004) for a set of 21. A study by Ledolter and Chan (1996) should also be highlighted for having found an increase in fatal accidents both on the roads affected by the rise in the speed limit and on the network of road that form the US road system.

Other authors found the opposite. Examining each of the US states individually, Lave and Elias (1994), for example, observed a fall in the fatality rate when analyzing a set of roads in the majority of states where the maximum speed limit had been increased. Houston (1999) reached the same conclusion when examining the road network in each of the 50 states.

Lastly, some studies found no clear evidence of a link between road safety and increases to speed limits. For example, Garber and Graham (1990) found inconclusive evidence from all 40 states where the measure had been adopted to increase the speed limit to 65mph. In the same line, Yowell (2005) was unable to confirm the existence of a clear correlation between speed limit and fatality rate in 27 analyzed states. Lastly, on the individual state level, McCarty (1994b) concluded that no great changes to road safety were apparent in California after the speed limit was raised.

Bearing all the above considerations in mind and following Ritchey and Nicholson-Crotty (2011), it can be stated that, despite many years of research, there is still no clear consensus in the literature as to the impact that increased legal speed limits have on traffic safety. The contribution that the present study therefore makes is to shed some light on the debate in the highway safety community on the relevance and real effects of increasing speed limits on road safety, measured in our case by fatalities. We therefore use a meta-analysis to give a quantitative systematic review of empirical evidence on the topic.

To achieve this goal, the present study is organized as follows. After this introduction, a section is included on the methodology used for the meta-analysis. Next, there is a results and discussion section, and lastly, some conclusions are given. Finally, two appendixes offer a broader technical explanation of the meta-analysis and a description of the sample.

2. Data and method

2.1. Methodology

Following Glass et al. (1981) and Castillo-Manzano and Castro-Nuño (2012), meta-analysis is a methodology that consists of the integration and scientific analysis of results obtained in prior analyses of a specific topic with the aim of conducting a synthetic quantitative estimation of all of these together. According to Borenstein et al. (2009), this enables questions to be answered that cannot be addressed by a traditional systematic review, applying the same methodological rigor as required in experimental research (Rosenthal, 1995).

Following Lipsey and Wilson (2001), to do this, the technique obtains what is called a *Summary Effect* of the estimates taken from a sample of chosen studies using a combination of a range of statistical procedures.[1] The degree of accuracy of the estimates is the information offered by the statistics for each of the estimates (Chalmers et al, 2002).

The Methodological Appendix at the end of the paper provides a broader treatment of methodological issues related to meta-analysis.

2.2. Study search and selection

The meta-analysis of the current paper has been conducted following the international PRISMA and QUORUM protocols established for both systematic reviews and meta-analysis studies (see Moher et al., 2010; and Urrutia and Bonfill, 2010 for a more extensive explanation). All the articles that might potentially meet defined eligibility criteria

[1] The Summary Effect (SE) is the pooled outcome of a meta-analysis, obtained through a statistical combination of estimates derived from primary studies (Borenstein et al., 2009).