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Analyzing road safety in the United States

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ABSTRACT

This paper reviews road safety performance in the United States. The paper develops a framework for assessing dimensions of road safety, and analyzes the importance of economic factors, travel patterns, demographics, road/traffic/vehicle technology, driver behavior, and public policy. Issues and challenges for future road safety research are discussed.

1. Introduction

More than a million people are killed on the world's roads each year. In the United States, road fatalities averaged more than 40,000 annually for the past 40 years. To be sure, during that 40-year period, the number of vehicle miles traveled (VMT) increased by 125 percent, so the rate of fatalities per 100 million VMT fell from 3.4 in 1975 to 1.1 in 2010, a drop of 67 percent. Even so, in 2010 someone was killed in the United States because of a highway accident on average about every 15 min. In 2007, motor vehicle traffic accidents were the leading cause of death for children, youth and young adults from ages eight through 34 (Subramanian, 2011). Annual monetary costs of accidents are estimated at more than $300 billion per year.[2] There also are persistent concerns about motorcycle and large truck safety (Transportation Research Board, 2010a; U.S DOT, 2010).

The United States also is falling behind in efforts to improve highway safety compared to other countries. Prior to the mid-1960s, the United States had the world's safest roads. By 2002, the U.S. had fallen to sixteenth place in deaths per registered vehicle, and to tenth in terms of deaths per vehicle miles traveled (Evans, 2004). As a recent Transportation Research Board Special Report stated, "In recent decades nearly every high-income country has made more rapid progress than has the United States in reducing the frequency of road traffic deaths and the rate of deaths per kilometer of vehicle travel. As a result, the United States can no longer claim to rank highly in road safety by world standards." (Transportation Research Board, 2010b).

This paper begins with a discussion of challenges in analyzing road safety performance. Next, we present a framework for thinking about the dimensions of highway safety, along with some principal findings from the extensive research literature. We then address four questions regarding highway safety in the United States:

1) What factors have contributed to changes in U.S. highway fatality rates?
2) How much do we know about the relative contributions of these factors?
3) How does the U.S. experience compare to the experience in other developed countries?
4) What are the implications for U.S. highway safety policy?

In addressing these questions, the paper will also address what is known about highway safety, where there are gaps or weaknesses in the research, some of the challenges in addressing these gaps, and the implications for public policy.

2. Challenges in evaluating highway safety policies

Highway safety performance involves a multitude of factors, not limited to driver behavior, vehicle design, and traffic engineering.[3] Changing demographics and changing travel patterns have

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[3] In this paper we use "traffic engineering" to refer to activities related to the construction and use of infrastructure related to traffic networks, including road design and geometry, signage, and signaling and control mechanisms. See Mannering and Washburn (2012).

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contributed to the reduction in the overall highway fatality rate. Public policy has also played an important role. But it is difficult to determine how effective an individual policy has been and thus to determine which policies have been the most effective at improving safety.

2.1. Collecting and understanding basic safety data

Accidents are rare events in travel; accidents involving fatalities are rarer still (Davis, 2000; Evans, 2004).[4] Even just trying to measure the number of accidents is problematic, given widespread underreporting, especially of low severity events (Elvik & Mysen, 1999, pp. 133–140; Hauer & Hakkert, 1988, pp. 1–10; Jeffrey et al., 2009). Crash severity can be measured a number of ways, including the extent of vehicle or property damage or the number and degree of injuries or fatalities.[5] In addition, the problem of analyzing accident data presents challenges of using statistical techniques (which generally are based on random processes) to study essentially deterministic events (consistent with the process of accident investigation and reconstruction).[6] These data challenges have two major implications. First, clear effects in data sets must be interpreted with care; biases in data availability and definitions matter. Second, we tend to focus on fatal accidents and rates because this is the most comprehensive and reliable data.[7] In this paper, the focus is on the risk of highway travel as measured by the highway fatality rate – fatalities per million vehicle miles traveled. The highway fatality rate is an imperfect measure of risk in part because it fails to account for injuries, property damage, or the other consequences of highway accidents. However, such rates do measure the most serious adverse consequence of highway accidents and are more consistent across jurisdictions within the United States and across other countries.

Another challenge in assessing the effectiveness of government policies to improve highway safety is the difficulty in determining the cause or causes of highway accidents. The contrast with assessing the causes of airline accidents is striking. With airline accidents, investigators will typically have both a flight data recorder and a cockpit voice recorder to help reconstruct the accident. With highway accidents, there is no equivalent of a cockpit voice recorder. While some vehicles store pre-accident information that could be accessed as part of an accident investigation, that information is not nearly as detailed as that found in a flight data recorder. Moreover, no guidelines have been established for the circumstances under which such information could be used, who might use it, and how it could be used and interpreted. With airline accidents, a highly trained and experienced team of specialists from the National Transportation Safety Board investigates each major accident with a consistent set of procedures. With highway accidents, the information is typically recorded by law enforcement officers from the local jurisdiction who have limited training in accident investigation and limited time to investigate the accident because of other pressing responsibilities at the accident scene. Moreover (as noted above), many accidents go reported.

With limited information, it may be difficult to determine all of the factors that might have contributed to the accident and what role these factors played in the accident. The role of some possible factors, such as fatigue and distractions, can be particularly difficult to determine. While it may be possible to determine that seatbelts were not being used at the time of an accident, it is more difficult to determine whether a fatality would have been prevented in a specific accident had the seatbelts been used. Similarly, it may be possible to estimate whether a vehicle was exceeding the posted speed limit, but it is more difficult to determine whether the specific accident would have been prevented had the vehicle been going more slowly. While the Blood Alcohol Content (BAC) of a driver killed in an accident can be determined through tests, it is more difficult to determine exactly what role the impairments from alcohol consumption played in the accident. Missing BAC data can also be a problem. BAC test data are only available for about 40 percent of drivers, pedestrians, and pedalcyclists as a result of alcohol tests not being administered or test results not being reported to the Fatality Analysis Reporting System (FARS) (NHTSA, 2002). The missing BAC data is filled in using a statistical technique known as multiple imputation (Subramanian, 2002). In essence, many of the BAC values in the FARS database are constructed rather than the result of direct BAC measurements of accident victims.

Another challenge is that traffic accidents often have multiple causes and there can be interactions among factors such as restraint use, alcohol consumption, speeding, fatigue, and distractions. Such interactions are not well understood and are likely to be important. Still another challenge, as already discussed, is that demographics, travel patterns, and other changes also affect highway safety. This problem of accounting for non-policy factors is, of course, common in policy analysis, but the nature of many highway safety policy interventions can make accounting for these factors particularly difficult. Many interventions are tried as demonstration projects of varying duration and applied to limited geographic areas. In such situations, data for that geographic area and time period on demographic and travel pattern changes may be difficult to obtain. There can be a tendency to simply compare measures of safety before and after the intervention without attempting to control for other factors. Another tendency in these situations is to evaluate such programs on secondary measures, such as reductions in average speeds on the highways or the number of citations given for BAC over the limit, rather than on primary measures such as reductions in speed-related accidents or alcohol-related accidents.

Some interventions can also affect travel patterns which can make their evaluations difficult. For example, it appears that one effect of the national 55 mph speed limit and the accompanying enforcement strategies was that some drivers diverted from rural interstates to parallel non-interstate roads. When rural interstate speed limits were raised after 1987, some of those drivers apparently returned to the interstates, so that while the fatalities on those interstates often increased, the overall fatalities, considering both the interstates and the parallel non-interstate roads actually dropped (Lave & Elias, 1994). Studies that focused only on what

[4] In this paper, we use the term "accidents" rather than "crashes". Some researchers prefer the term "crashes" as they feel "accident" conveys unpredictable, chance occurrences. See Evans (1991, p. 8).

[5] Categorizing injuries is difficult. The most widely accepted scale is the Abbreviated Injury Scale (AIS) (Association for the Advancement of Automotive Medicine, 2006). The AIS scale classifies injuries by body part and by severity on six point scale; if there are multiple injuries, it is common to use the Maximum Abbreviated Injury Scale (MAIS), which is the injury of the greatest severity. Since the AIS requires a doctor's examination and data submission, it is not available for the majority of accidents. However, in its place, an alternative classification that can be and is often used at the crash scene by public safety officials is "KABCO", where K = killed, A = incapacitating injury, B = non-incapacitating injury, C = possible injury, and O = no injury. Another data set that includes useful injury data is the National Automotive Sampling System Crashworthiness Data System (NASS CDS), which reports data from accidents that required vehicle towing due to damage. For background and details on the KABCO and NASS CDS classifications, see National Safety Council (2007).

[6] For discussion of these issues, see Hauer (1980, 1982), Davis (2004). Methodological alternatives to these issues are discussed in Lord and Mannering (2010) and Lord and Bonneson (2005, pp. 88–95).

[7] In the United States, the Fatality Analysis Reporting System (FARS) is the most widely used fatality database. It is maintained by the National Highway Traffic Safety Administration (NHTSA), part of the U.S. Department of Transportation. FARS is a census of all U.S. fatal crashes since January 1, 1975, and is based mainly on police submissions providing details on crash characteristics, vehicles, and driver characteristics and behavior. See NHTSA (2011a).