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The Impact of Spending Cuts on Road Fatalities

Abstract: Since 2003, public spending on transportation and water infrastructure in the United States has fallen significantly. However, researchers have generally failed to assess the consequences of these infrastructure-spending cuts on drivers' safety. On one hand, poor roads may cause people to drive more slowly, thus reducing fatalities. Alternatively, poor roads may also cause swerving and sudden changes in direction that increase fatalities. Consequently, this paper seeks to quantify the impact of road quality on traffic accident fatalities using panel data for U.S. states. We find no effect from road quality on road fatalities measured either on a per-capita basis or on a vehicle-miles-traveled basis.

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1. Introduction

Transportation infrastructure is a key determinant of economic productivity. Roads provide businesses with valuable business opportunities, consumers with lower prices and an increased variety of goods and services, and workers with jobs that would otherwise be inaccessible. According to the National Economic Council and the President's Council of Economic Advisers (2014), "A well-performing transportation network allows businesses to manage inventories and transport goods more cheaply, access a variety of suppliers and markets for their products, and get employees reliably to work. American families benefit too: as consumers, from lower priced goods, and as workers, by gaining better access to jobs," (4). Moreover, Ingraham (2015) notes that poor roads have more than an aggregate effect. Ingraham writes that poor roads have a measurable dollar cost for individuals. The worse the road conditions, the higher the private costs for maintaining and operating vehicles. Good roads stimulate production, while bad roads reach into the pockets of individuals.

The reliance on roads, however, may also pose a threat to the safety of residents as well as the economy if not properly maintained and managed. According to the National Highway Traffic Safety Administration, 32,999 people were killed, 3.9 million people were injured and 24 million vehicles were damaged in 2010 in the United States due to motor vehicle accidents. The National Highway Traffic Safety Administration estimates that the economic costs of these crashes totaled $242 billion and that the societal harm totaled $594 billion, making the total cost of motor vehicle crashes $836 billion in 2010. These numbers reflect the extent to which the U.S. economy is reliant on roads and the adverse effects that roads can have on human life.

Nonetheless, transportation funding has fallen in the United States since 2003 for all levels of government as seen in Figure 1. Public spending for transportation and water infrastructure has declined 5 percent at the state and local level and 19 percent at the federal level. There are a number of reasons why states may be struggling to fund roadwork. The gas tax, for one, is becoming an increasingly unreliable source of income (Powers 2014). The gas tax becomes politically difficult to increase when gas is expensive and less effective when cars increase their miles per gallon. Still, there may be detrimental consequences to delaying road funding.

The National Highway Traffic Safety Administration estimates that from 2014 to 2015 road fatalities per 100 million vehicle miles traveled has increased by 5 percent from 1.01 to 1.06 for the first half of the year. Because drivers in the United States traveled over a 2.6 trillion miles in 2013, the effects of a 5 percent increase in vehicle miles traveled are consequential; a 5 percent increase in fatalities per million vehicle miles traveled is an increase of 1,300 fatalities per year. Although the spending cuts began in 2003, the effects of the spending cuts on road quality have become more apparent over time. However, whether or not decreases in road spending and therefore road quality cause increases in road fatalities remains unclear. Consequently, this paper seeks to quantify the impact of road quality on traffic accident fatalities using panel data for each of the states, except Hawaii. Using this approach, we find no effect from road quality on road fatalities measured either on a per-capita basis or on a vehicle-miles-traveled basis.

2. Literature Review

A series of papers have attempted to discover the determinants of traffic fatalities (Cohen and Einav, 2003; Grabowski and Morrisey, 2001, 2004; Freeborn and McManus, 2010, etc.). Common determinants of fatalities analyzed in literature are seat belts, drunk driving, driver age, and gas prices. Because basic economics teaches students that individuals adjust behavior based on the perceived level of risk, the effectiveness of safety legislations, such as seat belt enforcement, has often been questioned. However, there is evidence to suggest that seat belts do in fact provide safety benefits. Cohen and Einav (2003) find that a 1-percentage-point increase in seat belt usage saves 136 lives within a state. Cohen and Einav also find that the stricter the enforcement, the more effective the mandatory seat belt laws are at saving lives.

Nevertheless, seat belt laws are only one of the many elements of traffic fatalities. Additional individual-level factors such as alcohol abuse clinics, gasoline prices, population age, and curfews also affect traffic fatalities. Freeborn and McManus (2010) find that an additional substance abuse clinic in a county decreases alcohol-related vehicle fatalities by 15 percent. Additionally, Grabowski and Morrisey (2004) discover that a 10-percent decrease in gasoline prices increases motor fatalities per 1,000,000 by 2.3 percent.

Grabowski and Morrisey (2001) discuss why motor fatalities are higher amongst the teens and elders. Grabowski and Morrisey explain young drivers lack skill, take high risks, face peer-pressure, and have high rates of alcohol impairment while elderly driver face vision impairment, cognitive deterioration and losses in psychomotor skills. Foss and Evenson (1999) show that crashes resulting in fatality and injury are 23 to 25 percent lower in states that enact curfews for teens before midnight.

The literature on license renewal, however, has more mixed results. Nelson et al. (1992) and Levy et al. (1999) both showed that there was lower-fatal crash involvement for elders who were in states that required vision tests at the license renewal. However, Kelsey et al. (1985) did not find any significant difference in crash rates between elderly drivers who received vision tests and those who did not.

However, other papers suggest that macroeconomic performance has an important influence on risky behavior and therefore traffic fatalities. Much of this research focuses on income level and income inequality. Anbarci, Escaleras and Register (2009) show that income level has a negative relationship with traffic fatalities. Developed countries are generally safer that developing countries. Not surprisingly then, developing countries have significantly higher road fatality rates. Anbarci, Escaleras and Register report that although developing countries possess only 40 percent on the motor vehicles worldwide, they contribute to 85 percent of total road traffic fatalities annually. Anbarci, Escaleras and Register note, however, that this higher death rate may partly result from lower quality infrastructure.

Moreover, Anbarci, Escaleras and Register show that income inequality has an effect on traffic fatalities. Income inequality affects casualties in lower income countries because there is competition for roadway space between pedestrians, bicyclists, motorcyclists, and cars. Typically, more inequality leads to more competition for road space and, consequently, more fatalities. On the other hand, when everyone is able to afford a car, the competition no longer becomes car versus pedestrian or bicycle, but large versus small cars.

Kahane (2003) shows that the fatality of a driver falls by about 5 percent for every 1 percent increase the weight of his or her car relative to the other car involved. Cooley et al. (1973) found that the incidence of injury for a driver increases by 2.5 percent for every 100-pound decrease in the weight of his or her car relative to the other car involved. In addition, Anbarci, Escaleras and Register end up demonstrating that the relatively wealthy tend to drive heavy vehicles.

This paper differs from previous studies in that this paper tests the effects of road quality on traffic fatalities. While road quality may have important effects on road safety and therefore road fatalities, we are unable to locate any rigorous tests of this relationship. The effect of road quality on traffic fatalities is ambiguous. Better quality roads may not necessarily reduce road fatalities. Poor roads could cause people to drive more slowly, thus reducing fatalities. Or, poor roads could cause swerving and sudden changes in direction that increase fatalities.

3. Data and Methods

This analysis uses Federal Highway Administration (FHWA) data and U.S. Census data from 1998 to 2008 to track changes in the National Highway System's International Roughness Index (IRI) and changes in the fatalities per 100 million vehicle miles traveled (VMT) and per 100,000 people for 49 of the U.S. States. The IRI ranged from 0 to 220. Roads with an IRI above 170 were considered roads with substandard or poor road quality and roads with IRI below 95 were considered to have good road quality. The fatalities per 100 million vehicle miles traveled ranged from 0.2 to 3.1. The fatalities per 100,000 ranged from 0.6 to 26.7. Hawaii was not included in the analysis due to missing data on traffic fatalities and vehicle miles traveled.

The controls used in the analysis include the real median per capita income, the unemployment rate, the real annual average gas prices, the average annual temperatures, the average annual precipitation, the vehicle miles traveled per capita, and the density. Gas prices were obtained from U.S. Energy Information Administration, the unemployment rates obtained from the Bureau of Labor Statistics, the real median per capita incomes were obtained from the U.S. Census, the average annual temperature and participation was obtained from the National Oceanic and Atmospheric Administration, the vehicle miles traveled per capita was obtained from the FHWA and the U.S. Census, and the population density was obtained from the U.S. Census.

To determine the effect of road quality on road fatalities, we regress road fatalities on road quality controlling for state level fixed effects. Because tests found evidence of autocorrelation (report test statistic and p-value here), we clustered standard errors on the cross-section (i.e., state). We measure road fatality rates on a per-capita basis (per 100,000 in population) and on a vehicle-miles-traveled basis (per 100 million vehicle miles traveled). We measure road quality as both the percentage of good roads and as the percentage of bad roads. We also use dummy variables for each year to control for year fixed effects. Finally, we control for real gas prices, real per-capita income, average annual temperature, average annual precipitation, unemployment rate, vehicle miles traveled per capita, and population density.

4. Results

Table 1 shows the means, standard deviations, minimum values, and maximum values for the various variables included in the study. The mean for fatalities per VMT is 1.15 deaths per 100 million VMT. The mean percentages of good and bad roads is 6.5 percent and 57.4 percent respectively. The mean inflation-adjusted gas price in 1977 dollars is 1.47 dollars. The mean inflation-adjusted income per capita in thousands of 1977 dollars is 16.167 or 16,167 dollars. The mean average annual temperature and average annual precipitation is 58.12 degrees Fahrenheit and 37.01 inches respectively. The mean unemployment rate is about 5 percent. The mean VMT per 100,000 is 471 million VMT per 100,000 or 4,710 miles annually per person. Lastly, the mean density in terms of 1,000 people per square mile is 0.185 or 185 people per square mile.

Regression results on road fatalities are shown in Tables 2 and 3. Table 2 reports results on traffic fatalities per million vehicle miles travelled. Table 3 reports results on traffic fatalities per 100,000 in population. For both tables, Columns 1 and 2 show the effect of good and bad roads on road fatalities without controls, while columns 3 and 4 show the effect of good and bad roads on road fatalities with controls. In column 1 of both Tables 2 and 3, we see that neither the percentage of good roads nor the percentage of bad roads has a significant impact on the fatalities per capita or fatalities per VMT. When we add controls to the regression, then the percentage of good roads is still statistically insignificant as shown in column 3 of both Tables 2 and 3. Likewise, the percentage of bad roads is also has a statistically insignificant effect on road fatalities (see

Columns 2 and 4 of Tables 2 and 3). The significant control variables include the real gas price and the vehicle miles traveled per person.

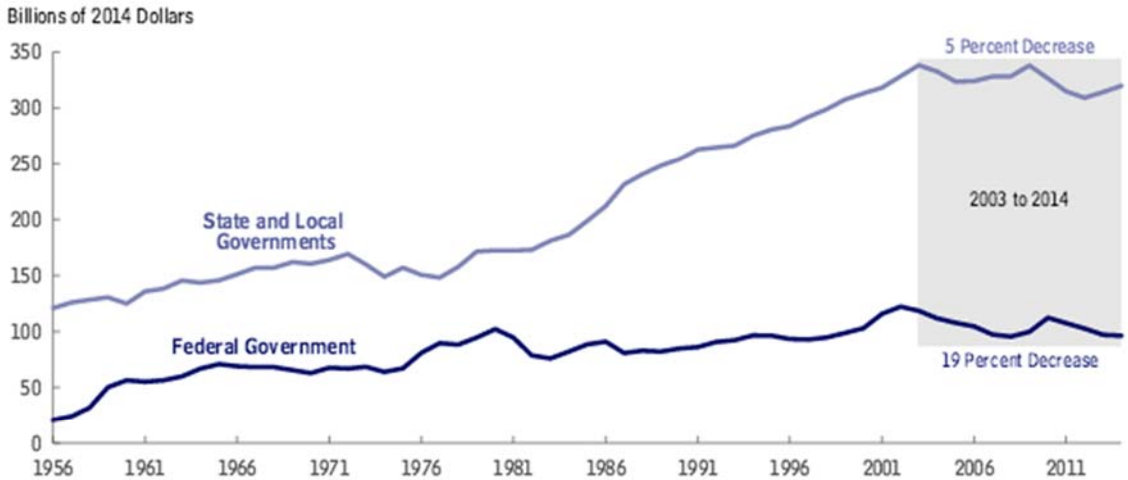
The results show that a one dollar increase in the real dollar value of gas decreases fatalities per 100 million VMT by about 0.97, or 25,220 lives saved in the United States, and decreases the fatalities per 100,000 by about 4.0, or 12,800 lives saved in the United States. The total lives saved or lost are based on the fact that in 2014 the United States had a population of about 320 million and drove a total of 2.6 trillion miles. The VMT per capita does not significantly impact the fatalities per 100 million VMT. However, every additional mile per capita results in an increase in the fatalities per 100,000 by about 1.85, or 1,730 lives lost in the United States.

5. Conclusion

There are number of possible reasons why states are delaying their transportation funding. The gas tax, for one, is becoming an unreliable source of income with volatile gas prices and fuel-efficient cars. However, states need not worry that deteriorating roads will result in more traffic fatalities. The general results of the analysis indicate that the percentage of good roads and the percentage of bad roads in state do not significantly affect fatalities per 100 million VMT and per 100,000 persons. As aforementioned, this analysis hypothesized that the expected results of the experiment were ambiguous. Poor roads could have caused swerving, which would have increased fatalities. On the other hand, poor roads could also have caused reductions in speed, which may have helped to reduce fatalities. However, the results do not support either hypothesis. Instead, the study suggests that drivers' safety is ultimately unaffected by road roughness.

Appendix

Public Spending on Transportation and Water Infrastructure, by Level of Government, 1956 to 2014 **Figure 1**



Source: Congressional Budget Office based on data from the Office of Management and Budget, the Census Bureau, and the Bureau of Economic Analysis.

Note: Dollar amounts are adjusted to remove the effects of inflation using price indexes for government spending that measure the prices of materials and other inputs used to build, operate, and maintain transportation and water infrastructure.

Table 1.

Variables	Mean	Std. Dev.	Min	Max
Fatalities Per VMT (1)	1.151	0.483	0.153	3.064
Percentage of Good Roads (2)	0.065	0.057	0.000	0.298
Percentage of Bad Roads (3)	0.574	0.191	0.107	0.979
Real Gas Price (4)	1.474	0.667	0.600	3.360
Real Income Per Capita (5)	16.167	2.433	11.108	22.977
Average Annual Temperature (6)	58.117	8.756	24.000	72.500
Annual Precipitation (7)	37.010	14.332	6.240	72.400
Unemployment Rate (8)	4.887	1.356	2.200	10.100
VMT Per Capita (9)	4.712	0.901	2.762	9.711
Density (10)	0.185	0.253	0.001	1.174

(1) Number of Fatalities Per 100 Million VMT in state i for year t

(2) Percentage of Lane Miles with International Roughness Index Below 95 Over Total Lane Miles in state i for yea

(3) Percentage of Lane Miles with International Roughness Index Above 170 Over Total Lane Miles in state i for year t

(4) Inflation Adjusted Price of Gasoline in 1977 Dollars in state i for year t

(5) Inflation Adjusted Per Capita Income in 1977 Thousands of Dollars in state i for year t

(6) Average temperature measured in Fahrenheit degrees for state i

(7) Annual precipitation measured in inches for state i in year t.

(9) Seasonally adjusted unemployment rate for state i in year t

(10) Population per square mile in thousands in state i for year t

Sources: http://www.fhwa.dot.gov/policyinformation/statistics, https://www.eia.gov/, http://www.bls.gov/, http://www.census.gov/, and http://www.noaa.gov/

Table 2. - The Effect of Road Quality on Traffic Fatalities Per 100 Million VMT

Dependent Variable	Traffic Fatalities Per 100 Million VMT			
Independent Variables	Simple Regression on Percentage Good Roads	Simple Regression on Percentage Bad Roads	Multiple Regression with Percentage Good Roads	Multiple Regression with Percentage Bad Roads
Percentage of Good Roads	0.084		0.102	
	(0.126)		(0.112)	
Percentage of Bad Roads		-0.498		-5.480
		(0.482)		(0.481)
Real Gas Price (1977 U.S. Dollars)			0.969**	0.973**
			(0.376)	(0.376)
Real Income Per Capita (1977 U.S. Dollars)			0.009	0.010
			(0.015)	(0.015)
Average Annual Temperature (Fahrenheit)			0.009	0.008
			(0.006)	(0.005)
Average Annual Precipitation (Inches)			-0.003	-0.003
			(0.003)	(0.003)
Unemployment			0.006	0.006
			(0.016)	(0.016)
VMT Per Capita (Miles)			0.142	0.134
			(0.114)	(0.113)
Density (Population per square mile)			1.363	1.440
			(1.053)	(0.991)
Year FE	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
N	539	539	539	539
R^2				
Within	0.252	0.254	0.287	0.290
Bewteen	0.085	0.130	0.094	0.103
Overall	0.068	0.088	0.030	0.036

***,**,* Significant at the 1%, 5%, and 10% confidence level respectively

Sources: http://www.fhwa.dot.gov/policyinformation/statistics, https://www.eia.gov/, http://www.bls.gov/, http://www.census.gov/, and http://www.noaa.gov/

Table 3. - The Effect of Road Quality on Traffic Fatalities Per 100,000 Persons

Dependent Variable	Traffic Fatalities Per 100,000 Persons			
Independent Variables	Simple Regression on Percentage Good Roads	Simple Regression on Percentage Bad Roads	Multiple Regression with Percentage Good Roads	Multiple Regression with Percentage Bad Roads
Percentage of Good Roads	0.659		0.949	
	(1.049)		(0.914)	
Percentage of Bad Roads		-1.460		-1.738
		(1.887)		(1.787)
Real Gas Price (1977 U.S. Dollars)			4.015**	4.091**
			(1.633)	(1.602)
Real Income Per Capita (1977 U.S. Dollars)			0.032	0.034
			(0.072)	(0.073)
Average Annual Temperature (Fahrenheit)			0.031	0.031
			(0.02)	(0.02)
Average Annual Precipitation (Inches)			-0.016	-0.016
			(0.014)	(0.014)
Unemployment			0.079	0.079
			(0.094)	(0.098)
VMT Per Capita (Miles)			1.895***	1.828***
			(0.489)	(0.489)
Density (Population per square mile)			8.026	7.720
			(5.659)	(5.283)
Year FE	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
N	539	539	539	539
R^2				
Within	0.205	0.204	0.269	0.266
Bewteen	0.090	0.129	0.060	0.057
Overall	0.044	0.040	0.071	0.068

***, **, * Significant at the 1%, 5%, and 10% confidence level respectively

Sources: http://www.fhwa.dot.gov/policyinformation/statistics, https://www.eia.gov/, http://www.bls.gov/, http://www.census.gov/, and http://www.noaa.gov/

References

Ahmed, Anwaar, Qiang Bai, Steven Lavrenz, and Samuel Labi. "Estimating the Marginal Cost of Pavement Damage by Highway Users on the Basis of Practical Schedules for Pavement Maintenance, Rehabilitation and Reconstruction." *Structure and Infrastructure Engineering* (2014): 1-14. *ResearchGate*. Web. 11 Nov. 2015.

Alesina, Alberto, Reza Baqir, and William Easterly. "Public Goods and Ethnic Divisions." *The Quarterly Journal of Economics* 114.4 (1999): 1243-284. *JSTOR [JSTOR]*. Web. 13 Oct. 2015.

Anbarci, Nejat, Monica Escaleras, and Charles A. Register. "Traffic Fatalities: Does Income Inequality Create an Externality?" JSTOR. The Canadian Journal of Economics / Revue Canadienne D'Economique, Feb. 2009. Web. Oct. 2015.

Cohen, Alma, and Liran Einav. "The Effects of Mandatory Seat Belt Laws on Driving Behavior and Traffic Fatalities." JSTOR. The Review of Economics and Statistics, Nov. 2003. Web. Oct. 206.

Current Results. "Average Annual Temperature for Each US State." Current Results Weather and Science Facts. Current Results Nexus, 2015. Web. 2 Nov. 2015.

Freeborn, Beth A., and Brian McManus. "Substance Abuse Treatment and Motor Vehicle Fatalities." JSTOR. Southern Economic Journal, Apr. 2010. Web. Nov. 2015.

Grabowski, David C., and Michael A. Morrisey. "The Effect of State Regulations on Motor Vehicle Fatalities for Younger and Older Drivers: A Review and Analysis." JSTOR. The Milbank Quarterly, 2001. Web. Oct. 2015.

Grabowski, David C., and Michael A. Morrisey. "Gasoline Prices and Motor Vehicle

Fatalities." JSTOR. Journal of Policy Analysis and Management, 2004. Web. 11 Nov. 2015.

Ingraham, Christopher. "Where America's Worst Roads Are — and How Much They're Costing Us." *The Washington Post*. N.p., 25 June 2015. Web. 20 Oct. 2015.

National Economic Council and the President's Council of Economic Advisers. "An Economic Analysis of Transportation Infrastructure Investment." N.p., July 2014. Web. 4 Oct. 2015. <https://www.whitehouse.gov/sites/default/files/docs/economic_analysis_of_transportation_investments.pdf>.

Powers, Martine. "Fuel Savings Bring Worry About Gas Tax Revenue." 2015 Boston Globe Media Partners, LLC. Globe Staff, 26 May 2014. Web. 9 Nov. 2015.

TRIP. "Bumpy Roads Ahead : America's Roughest Rides and Strategies to Make Our Roads Smoother." *TRIP a National Transportation Research Group*. N.p., July 2015. Web. 1 Nov. 2015. <http://tripnet.org/docs/Urban_Roads_TRIP_Report_July_2015.pdf>.

United States Census Bureau. "Median Annual Household Income." Income. United States Census Bureau, 2015. Web. 14 Nov. 2015. <http://www.census.gov/hhes/www/income/data/statemedian/index.html>.

United States Census 2010. "Population Density." Resident Population Data. United States Census 2010, 2010. Web. 20 Nov. 2015. <http://www.census.gov/2010census/data/apportionment-dens-text.php>.