June 2020

Transportation and Energy Policy in Louisiana

Cody Nehiba*
Assistant Professor
Center for Energy Studies
Louisiana State University

LSU | Center for Energy Studies

*E-mail: cnehiba@lsu.edu. Address: Center for Energy Studies, Louisiana State University, Energy, Coast, and Environment Building, S. Quad Dr., Baton Rouge, LA 70808.

Transportation and Energy Policy in Louisiana

Table of Contents

List of Figures

List of Tables

Design by Steve Radcliffe

Executive Summary

This document will examine the status of Louisiana's transportation system and transportation energy policies. Important issues in transportation (congestion, air pollution, accidents, and road damage) and their standing within Louisiana will be detailed in depth. The importance of energy policy (gasoline and diesel taxes, electric vehicle subsidies, etc.) in addressing these issues to improve societal welfare will also be discussed.

Louisiana's current ground transportation system is found to rank poorly across many dimensions. Congestion costs are high in many areas—particularly given their populations. Louisiana experiences above average traffic fatalities per vehicle mile traveled. Almost 800 lives were lost in collisions in the state in 2018. The pavement quality within the state is among the worst in the nation. Air pollution—while improving—is still a cause for concern. Economic and transportation literatures are examined, and some simple policy changes are suggested to improve these issues: (1) increasing the state's gasoline tax would reduce congestion, pollution, and accidents; (2) changing diesel taxes to taxes that charge freight trucks on both the weight of their vehicle and miles driven would reduce the number of fatal collisions and preserve the state's roads; (3) electric vehicle subsidies and efforts to reduce emissions from electricity generation must go hand in hand if the state is to experience improved air quality.


EXIT 155A
TO LSU
Nicholson Dr
Highland Rd
1 MILE

1 | Introduction

Transportation is central to economic activity. The transportation network is used to move people to work, inputs to factories, final goods to markets, tourists to their destinations, professionals to meetings, deliver goods purchased through internet vendors, and countless other tasks. Indeed, it is difficult to find an economic transaction that cannot be traced back to transportation, at least to some extent.

Transportation can therefore be considered a key component to a region's economic well- being. A well-functioning, efficient transportation system can be an impetus of economic activity while systems plagued by congestion, poor maintenance, and other issues can impede growth. The transportation system is vital for Louisiana's economy.

This document will examine Louisiana's surface transportation network in detail. The current state of Louisiana's network will be catalogued, key issues will be highlighted, and policy solutions and their potential issues will be discussed. Importantly, these policy solutions largely revolve around energy use in transportation.

This paper will focus on four key issues in the transportation realm—congestion, traffic accidents, road damage and infrastructure, and air pollution. Energy policies that have been traditionally set at the local or state level will be examined. Their relative advantages and disadvantages in addressing these issues will be investigated.

2 | Key Issues

Many of the major issues in transportation can be classified as "externalities." Externalities are costs or benefits that accrue to a party that did not choose to incur those costs or benefits. In other words, situations in which one individual's actions impose some costs or benefits on another individual(s) who does not have a say in the costs or benefits he or she accrues. Canonical examples of externalities include a firm that releases pollution into a town's water source as part of its production process or a neighbor who improves his or her property and increases in the market value of all homes in the neighborhood.

Externalities that impose costs are labelled "negative externalities" while those that generate benefits for other individuals are labelled "positive externalities." In transportation, we generally see negative externalities. Because each individual's decision to drive imposes additional congestion, accident risk, road damage, and air pollution on other drivers, these are considered externalities. But to understand why these externalities exist, and how we can correct them, we must understand why these issues arise.

When externalities occur, it is because individuals do not face the full social costs of their actions. For example, when an individual chooses to drive to the grocery store, they consider all relevant costs that they may incur. These private costs can include fuel costs, vehicle maintenance costs, and time costs (i.e. the opportunity cost of the time spent traveling); however, individuals do not consider that by driving they also generate congestion and increase the travel times of all other individuals on the road. The increase in congestion from any individual vehicle is small, but the increased time costs are spread across many individuals. Adding together the individuals' private costs and the small increases in time costs for all other road users gives the full social cost (when only considering congestion).

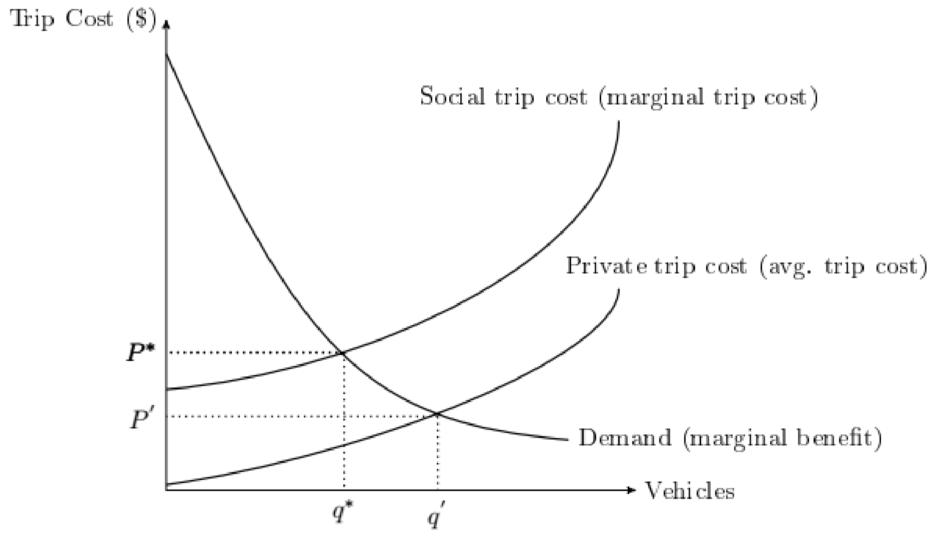
Because the individual's private costs of driving are less than the full social cost of driving, individuals tend to drive more than is socially optimal. This line of thought also applies to the other transportation externalities mentioned. Individuals also tend to ignore the fact that they create air pollution, damage roads, and increase accident risks that affect other road users and even individuals who do not use the roadway (e.g. carbon emissions contribute to climate change—affecting both drivers and non-drivers).

This excess driving, fuel consumption, etc. imposes significant costs on society. Indeed, these externalities are examples of market failures—situations where the allocation of goods or services by a free market is inefficient. These market failures lead to a net loss in societal welfare relative to the socially optimal outcome.

These external costs can be illustrated using a simple graphical example. Consider the situation depicted in Figure 1, where private trip costs (e.g. personal fuel costs and time costs) and social trip costs (e.g. cumulative fuel costs and time costs) are both increasing in the number of vehicles on the road (because congestion causes vehicles to slow down and idle more—increasing trip time and fuel usage). The demand for vehicle trips declines as trip costs increase, because if costs rise, individuals may choose to forgo less important trips.

In the absence of regulation, individuals will ignore the external costs they impose on society. This will result in individuals considering only their private costs. If this occurs, then the equilibrium will occur at the point where demand equals private costs and the quantity of vehicles on the road will be q' and trip costs will be P'. This equilibrium results in too many vehicles on the road.

Figure 1: Automobile externalities



Notes: Figure depicts the trip costs on the y-axis and number of vehicles on the x-axis. Lines for the social trip cost, private trip cost, and demand for trips are displayed. P' and q' denote the equilibrium vehicle trips and trip costs in an unregulated market. P* and q* denote the socially optimal equilibrium that can arise if regulatory measures are undertaken (e.g. a Pigouvian tax, tax = P*− P' (1), is levied).

The socially optimal equilibrium occurs at the point where social trip cost equals demand. This equilibrium results in q* vehicles on the road and trip costs of P*. This suggests that the socially optimal number of vehicles on the road can be achieved by increasing the price of trips from P' to P*. One way to reach this outcome is to levy a tax on the market equal to the difference between P' and P* (i.e. tax = $P^* - P'$ (1)).

Here, the socially optimal outcome can arise by aligning the social and private costs of driving. Economic theory has provided several pathways that can guide us to this equilibrium, including Pigouvian taxation (charging individuals a tax equal to the difference between social and private costs) or subsidies (paying individuals to reduce their consumption of the externality producing good) and cap-and-trade programs that set a limit on the amount of miles that can be driven and allows individuals to trade permits to drive.

Though theoretically appealing, these policies are generally believed to be politically or technologically infeasible. This means we must consider other policies to control these transportation externalities in practice. This burden often falls on energy policies in the United States. This includes gasoline and diesel taxes, fuel economy standards, and electric vehicle subsidies. These and similar policy options will be examined in detail in the coming sections, including discussions of the relative strengths and weaknesses of each policy.

2.1 Congestion

Congestion plagues cities across the United States and the world, and its costs have been recognized by economists for decades (Vickrey, 1969). Some estimates of time lost due to sitting idly in traffic for the average American were as high as 97 hours in 2018 (Reed and Kidd, 2019). Congestion is a spatially and temporally isolated issue. Large costs accrue during peak travel periods—morning and evening rush hour commutes—but outside of these hours, congestion costs are usually negligible. Within these peak hours, congestion costs generally increase with the urbanization level of the metropolitan area, with some exceptions (Nehiba, 2019). Some of these exceptions exist in the state of Louisiana.

Based on the methodology of Schrank et al. (2019), Louisiana was not home to any "large" cities, but its two largest population centers—New Orleans and Baton Rouge—ranked as having the second and third worst congestion, respectively, among "midsize" cities within the United States in 2018. These cities have particularly bad congestion when compared to other metropolitan areas of similar size. For example, New Orleans was estimated to have average costs of congestion per capita of $1,208 in 2017. The average per capita costs for medium-sized metropolitan areas was only approximately $810 (Schrank et al., 2019). This enormous gap between New Orleans' costs and comparable cities is largely representative of Louisiana as a whole. In fact, many cities within the state have congestion costs that rank similarly to major metropolitan areas that are perceived to have some of the worst congestion in the nation. New Orleans' costs were within $100 per capita of Dallas (TX), Philadelphia (PA), Detroit (MI), Riverside-San Bernardino (CA), and Denver (CO) (Schrank et al., 2019).

Congestion is generally a local issue predominantly occurring in urban areas. To illustrate the areas where congestion may be of greatest concern, Figure 2 illustrates annual vehicle miles traveled (VMT) for each parish in Louisiana. The estimates of annual VMT are for 2018. VMT is measured in millions of miles.

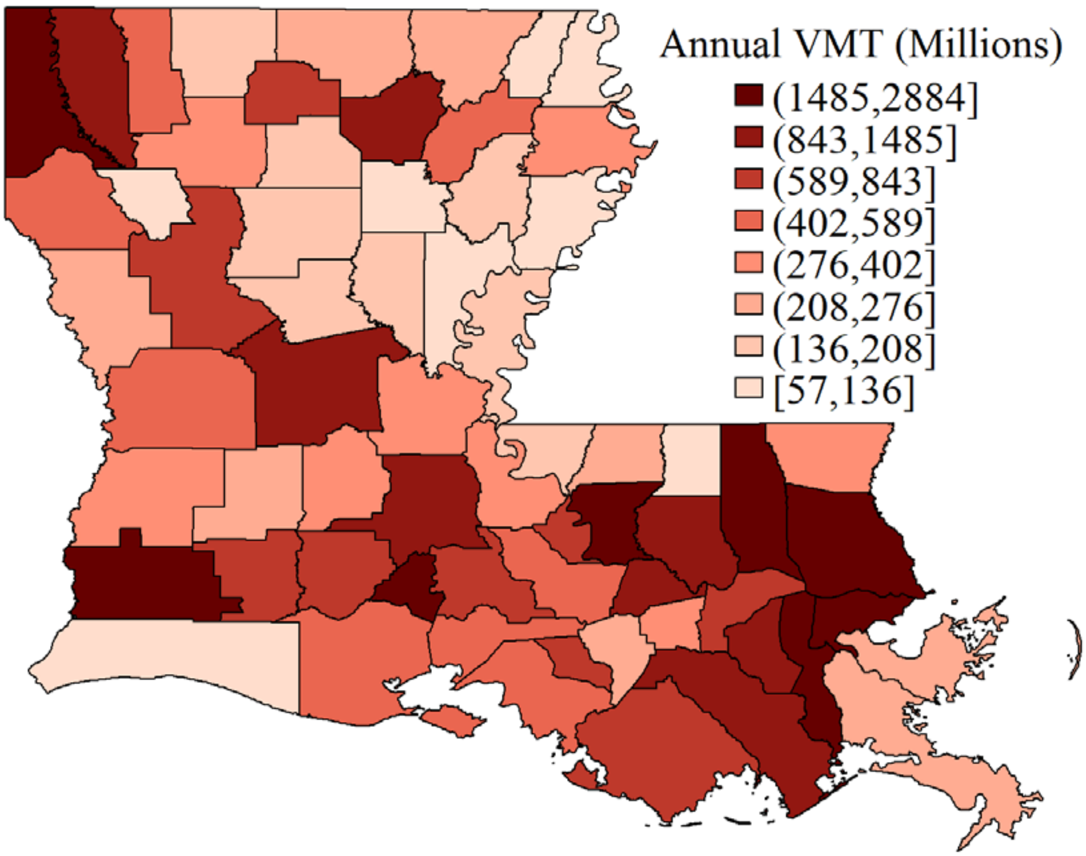
As expected, parishes with large urban centers exhibit the highest VMT. Among the highest VMT parishes are Caddo, Calcasieu, East Baton Rouge, Orleans, and St. Tammany Parishes. These five parishes—which encompass and border major cities including Shreveport, Lake Charles, Baton Rouge, and New Orleans—cumulatively contribute over 27% of Louisiana's total VMT.

Smaller metro and rural areas are not immune to high congestion costs in Louisiana though. Smaller cities like Mandeville-Covington ($728 in congestion costs annually per capita), Lake Charles ($733 in congestion costs annually per capita), and Lafayette ($691 in congestion costs annually per capita) also experience high levels of congestion (Schrank et al., 2019). These examples illustrate that congestion is a widespread issue throughout the area.

The question then arises: What is the root cause of all this congestion? While there are many contributing factors, there are several key differences between Louisiana and other states that may be the source of the issues.

Figure 3 depicts annual vehicle miles traveled for Louisiana and the entire U.S. VMT is measured in millions of miles traveled with Louisiana miles on the left axis and U.S. miles on the right axis. The figure presents historical data from 2007 to 2018. When compared to the United States at large, Louisiana has experienced a slightly more rapid increase in vehicle miles traveled in recent years. Louisiana's VMT seems to have rebounded from the 2007-2008 financial crisis before many other states in the country.

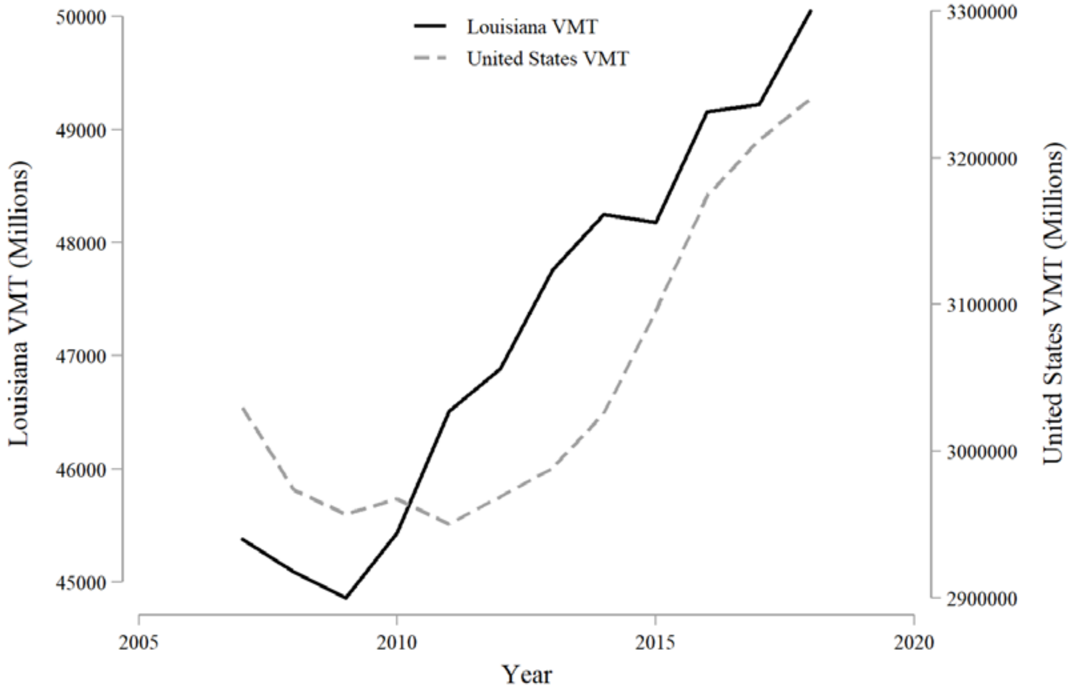
Figure 2: Annual VMT by Parish



Notes: Figure depicts the annual vehicle miles traveled in each parish in Louisiana in 2018. VMT is measured in millions of miles.

Source: Louisiana Department of Transportation and Development.
http://wwwsp.dotd.la.gov/Inside_LaDOTD/Divisions/Multimodal/Data_Collection/Inventory%20Reports/Daily%20Vehicle%20Miles%20Traveled%20(2018).pdf

Figure 3: Evolution of LA and US VMT



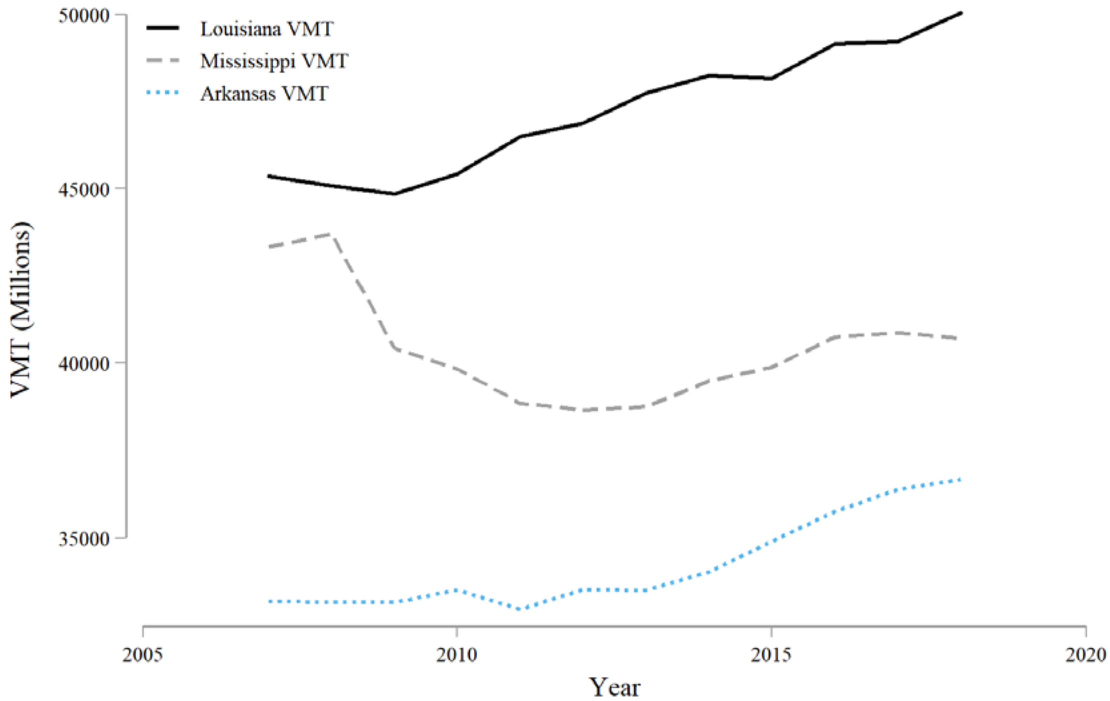
Notes: Figure depicts the evolution of annual vehicle miles traveled in both Louisiana and the United States as a whole. VMT is measured in millions of miles traveled. Data spans from 2007 to 2018.

Source: U.S. Federal Highway Administration. https://www.fhwa.dot.gov/policyinformation/statistics.cfm

We can also examine how Louisiana's VMT has changed relative to neighboring states to provide a deeper understanding of where Louisiana fits within the region. Figure 4 illustrates the evolution of annual VMT in Louisiana, Mississippi, and Arkansas (neighboring states with similar VMT) between 2007 and 2018. VMT is measured in millions of miles.

Figure 4 provides evidence that VMT in Louisiana has increased more rapidly than in comparable neighboring states. This suggests that Louisiana had above average growth in VMT both across the nation and within its geographical region.

Figure 4: Evolution of LA and neighboring states' VMT



Notes: Figure depicts the evolution of annual vehicle miles traveled in Louisiana, Mississippi, and Arkansas. VMT is measured in millions of miles traveled. Data spans from 2007 to 2018.

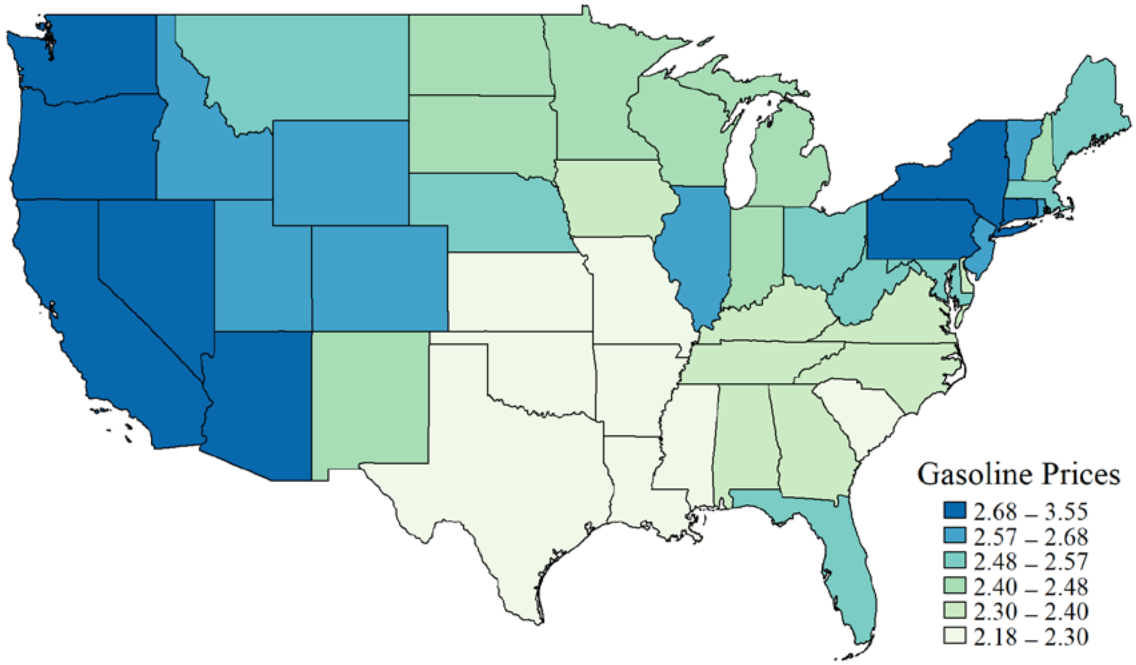
Source: U.S. Federal Highway Administration. https://www.fhwa.dot.gov/policyinformation/statistics.cfm

This above average growth in VMT may be responsible for many of the transportation issues—especially congestion—in Louisiana today. This point may be especially true if, as will be discussed in more detail in the following sections, transportation funding and infrastructure investments have not kept pace with VMT growth. Combining above-average VMT growth and below-average funding could strain Louisiana's transportation system and expose underlying issues.

One potential reason that VMT in Louisiana has outpaced many other parts of the country is the extremely low price of gasoline within the state. As will be discussed in the coming sections, Louisiana's gasoline tax is among the lowest in the country. The state is also one of the largest oil producers within the country and is home to approximately 18% of the country's petroleum refinery capacity (EIA, 2019). These low taxes and close proximity to oil and gas infrastructure drive prices in Louisiana far lower than most other states. The low usage costs in turn leads consumers to drive more.

This can be seen clearly in Figure 5. This figure depicts the average per gallon gasoline price in each state for the month of January in 2020. Louisiana (and its neighboring states) enjoy some of the lowest per gallon gasoline prices in the country. Louisiana's average January 2020 retail price (including taxes) was $2.25 per gallon—the fifth lowest in the nation.

Figure 5: Gasoline Prices in the United States



Notes: Figure depicts the average per gallon gasoline price in each state for January of 2020.

Source: GasBuddy.com and author's calculations.

2.2 Accidents

When an individual chooses to drive, they increase their own probability of being in a vehicular collision and the risks for all other drivers on the road—as well as for more vulnerable populations like pedestrians or cyclists. Each year these traffic collisions impose enormous costs on society. Traffic accidents are a leading cause of death in the United States—fitting the definition of a public health crisis (CDC, 2019; Sharma, 2008; WHO, 2016). Traffic accidents were the 13th leading cause of death in 2015 and ranked even higher for certain age groups (NHTSA, 2018).[1] Moreover, these collisions ranked 7th overall in terms of life-years lost (NHTSA, 2018).

Beyond the enormous toll of these collisions in terms of human life, they also impose financial costs. Medical bills, insurance premiums, automobile repairs, and work missed due to injury are just a few ways motor-vehicle collisions impede the economy. Given these large costs, the country and Louisiana should have great interest in reducing collisions.

Figure 6 depicts the evolution of fatal collisions and total fatalities in traffic accidents in Louisiana between 2004 and 2018. The X's denote the total number of collisions which had at least one fatality while the level of the bars denote the total number of fatalities in each year. The distance between the symbols and the bars indicate the difference in the number of accidents with at least one fatality and the total quantity of fatalities.

There was a downward trend in fatal collisions and total fatalities in Louisiana between 2007 and 2012. Unfortunately, this trend has reversed in more recent years with modest increases in totals every year until a slight decrease in 2018. The gap between total fatalities and collisions with at least one fatality appears to have shrunk throughout most of the period. This suggests that, conditional

[1] Traffic accidents ranked as the number one cause of death for individuals aged 8-24 (NHTSA, 2018).

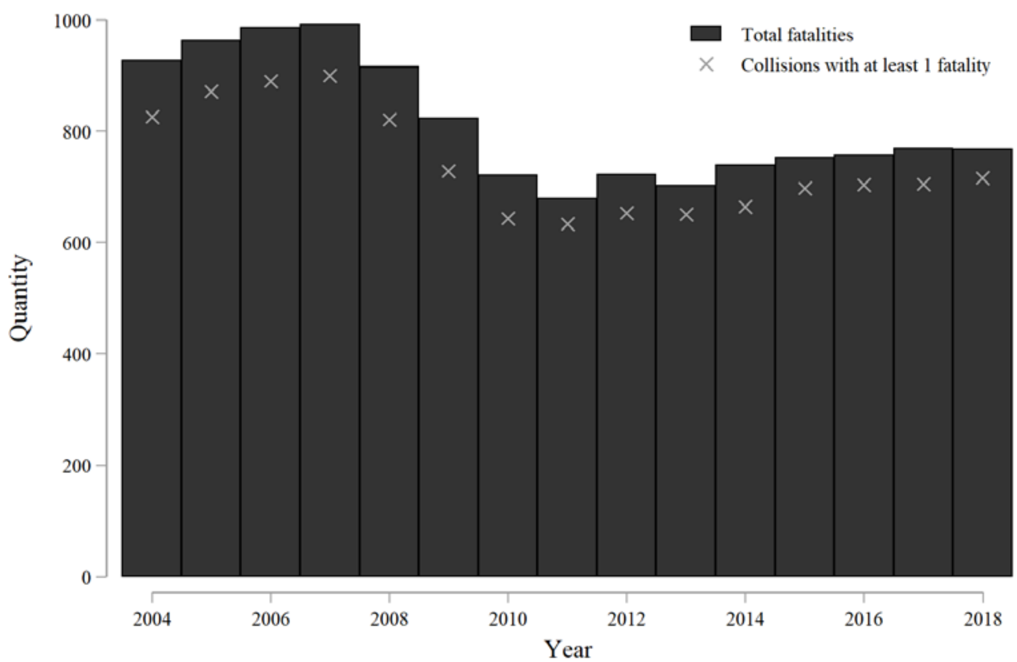
on a fatal collision occurring, the probability that the collision has only one fatality has increased. The decrease in fatalities from 2000's levels and the decrease in multiple fatality collisions are both bright spots for Louisiana.

However, Louisiana still experiences more fatal collisions than comparable states. Figure 7 depicts the total number of fatalities from traffic collisions in various states against their annual vehicle miles traveled in 2018. VMT is measured in millions of miles on the x-axis and fatalities are reported on the y-axis. The dashed line estimates the linear relationship between fatalities and vehicle miles traveled. States above the line have an above average number of fatalities for each mile driven, while states below the line experience a below average number of fatalities per mile driven.

Louisiana is near the middle of the states shown in terms of vehicle miles traveled, but above average in the number of fatal road collisions. Louisiana is very comparable to Mississippi and Oklahoma in terms of VMT and fatalities. In general, southern states appear to have more fatalities per vehicle mile traveled than northern states. A similar break between south/north is seen in gasoline and diesel taxes, with northern states having much higher gas taxes.[2] Louisiana, Mississippi, and Oklahoma also have very similar gasoline taxes.

These differences in fuel taxes—as will be discussed in more depth in the coming sections— may be important for several reasons. First, higher fuel taxes increase the costs of driving. These high costs reduce driving, and therefore reduce accidents. Second, the revenues from fuel taxes can be used to fund road infrastructure. Improvements in roads can decrease the number of fatal collisions (Arhin et al., 2015)

Figure 6: Fatal Collisions in Louisiana

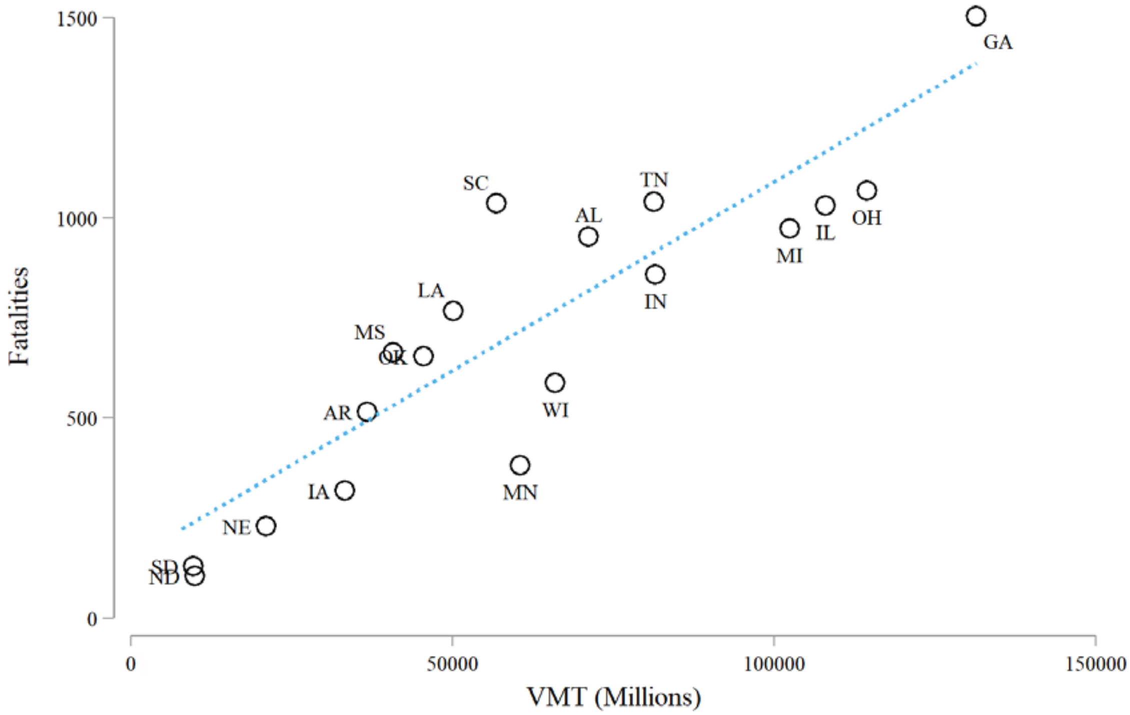


Notes: Figure depicts the number of collisions with at least one fatality and the total number of fatalities from traffic collisions in Louisiana in each year. Data span from 2004 to 2018.

Source: Fatality Analysis Reporting System. https://www.nhtsa.gov/research-data/fatality-analysis-reporting-system-fars

[2] This will be discussed in more detail in the coming sections. State level gasoline taxes are depicted in Figure 13.

Figure 7: Fatal Collisions in the United States



Notes: Figure depicts the total number of fatalities from traffic collisions in various states against their annual vehicle miles traveled in 2018. The dashed line represents a linear fit. States above the line have an above-average number of fatalities relative to the VMT. States below the line have a below-average number of fatalities relative to VMT. States plotted include: AL, AR, GA, IA, IL, IN, LA, MI, MN, MS, ND, NE, OH, OK, SC, SD, TN, WI.

Sources: Fatality Analysis Reporting System. https://www.nhtsa.gov/research-data/ fatality-analysis-reporting-system-fars, U.S. Federal Highway Administration https:/ www.fhwa.dot.gov/policyinformation/motorfuelhwy_trustfund.cfm, and author's calculations.

2.3 Road Damage and Infrastructure

Roads play a critical role in the development and organization of our cities and industries. Beginning with the Federal Aid Highway Act of 1944, the federal government has invested an enormous amount of capital into developing a nationwide network of highways (Baum-Snow, 2007). Individual states and localities also invest resources into ensuring that their transportation networks meet demands. The United States Department of Transportation utilized $98.1 billion in funds for the 2017 fiscal year to improve the nation's transportation network, and the Louisiana Department of Transportation and Development's total budget for 2017 was $870 million (ranked 50th in the nation) (DOT, 2018; DOTD, 2018).

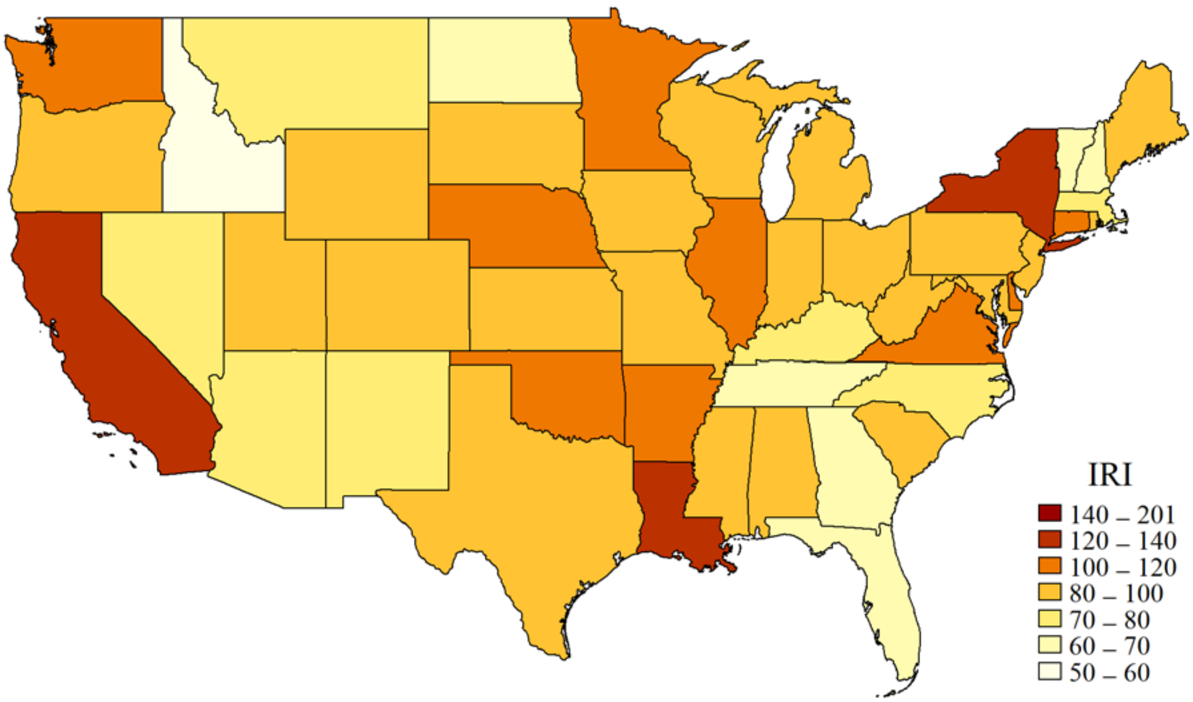
Road quality and provision impact all other aspects of the transportation network. Inadequate roads can lead to accidents, more fuel usage (and pollution), and increased congestion (Hu et al., 2017; Louhghalam et al., 2015; Nyberg et al., 1996; Winston and Langer, 2006). Maintaining and improving the road stock is therefore crucial to Louisiana's economy.

Figure 8 displays the average pavement roughness for all urban roads in each state. Pavement roughness data is from 2011. Roughness is measured by the International Roughness Index (IRI). This index is a widely used measure of road quality that states are required to report to the Federal

Highway Administration (Arhin et al., 2015; Sayers, 1995). Lower IRI values indicate smoother (higher quality) roads. The U.S. standard for a road in "good" condition is an IRI value less than 95, and the standard for a road in "acceptable" condition is an IRI value less than 170 (Arhin et al., 2015). A complete breakdown of IRI quality categories can be seen in Appendix Table A1.

Figure 8 shows that urban road pavement in Louisiana is far below the average state quality. Louisiana ranks among the bottom three states depicted (New York, California, and Louisiana) in terms of average urban pavement roughness.[3] Louisiana's urban IRI average is 124 in/mi.

Figure 8: Average Urban Pavement Roughness (in/mi)



Notes: Figure depicts the average pavement roughness for urban areas in each state. Roughness is measured by the International Roughness Index. For individual sections, a value of less than 95 is considered "good." A value of less than 170 is considered "acceptable." Data is for 2011.

Source: Federal Highway Administration. https://www.fhwa.dot.gov/interstatebrief2011/

Figure 9 displays the average pavement roughness for all rural roads in each state. Rural road pavement in Louisiana tends to be slightly less rough than urban pavement, relative to other states; however, Louisiana still ranks in the bottom five states depicted (Colorado, New York, Washington, and California have higher average rural pavement roughness).[4] Louisiana's rural IRI average 93 in/mi.

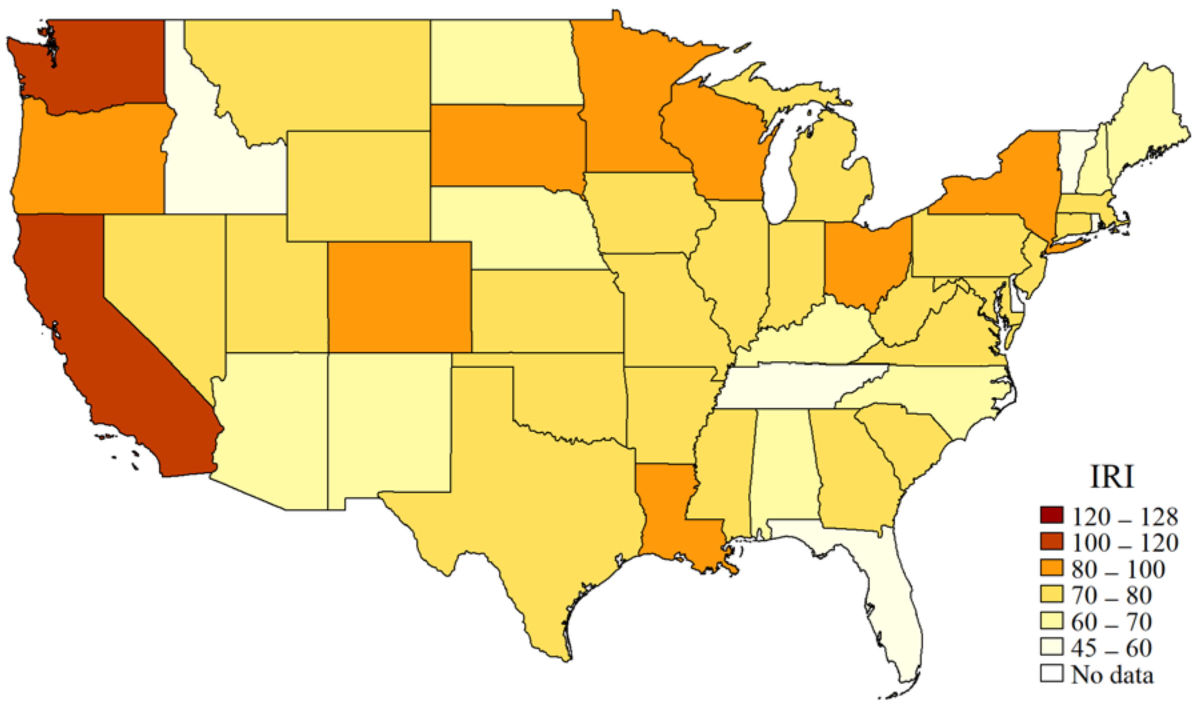
Based on IRI values, average road quality in Louisiana is among the worst in the country. These low-quality roads are likely caused by numerous factors. High per-capita VMT, numerous major ports carrying freight, and low levels of infrastructure investment all likely contribute to this issue.

[3] Washington D.C. and Hawaii (not depicted) have higher IRI urban averages (201 and 147, respectively) than NY, CA, and LA.

[4] Alaska and Hawaii (not depicted) also have higher average rural pavement roughness than Louisiana.

In particular, the large number of major ports within the state and associated freight trucking may be a significant contributor to the poor road quality. Table 1 lists the top 20 ports in the U.S. by tonnage in 2018. Five of the top 20 ports by tonnage are in Louisiana. This includes the Port of South Louisiana, which leads the nation in tonnage at 275.5 million tons moved in 2018. Further, the Louisiana ports tend to land higher on the list—the 13th ranked Port of Plaquemines is the lowest of the Louisiana ports. Moreover, states neighboring Louisiana (that could feasibly ship freight by truck through the state) including Texas and Alabama, are also featured on the list.

Figure 9: Average Rural Pavement Roughness (in/mi)



Notes: Figure depicts the average pavement roughness for rural areas in each state. Roughness is measured by the International Roughness Index. For individual sections, a value of less than 95 is considered "good." A value of less than 170 is considered "acceptable." Data is for 2011. No data is available for Delaware.

Source: Federal Highway Administration. https://www.fhwa.dot.gov/interstatebrief2011/

This freight shipping has major implications for Louisiana's roads because, a significant share of the goods travel to or from these ports in heavy-duty trucks. Not only does this create pollution, congestion, and accidents, but heavy-duty trucking also causes most of the damage incurred by pavements (Sathaye et al., 2010). Moreover, pavement damage increases exponentially with the weight of a truck's axle (Sathaye et al., 2010). This leads to a complex relationship between road damage, pollution, congestion, and accidents caused by trucking. Heavy trucks can damage roads and cause severe accidents, but reducing truck weight and sending more shipments causes congestion and pollution to rise (Cohen and Roth, 2017; Franzese, 2011; Kamakat´e and Schipper, 2009; Nehiba, 2020). These relationships and what they mean for Louisiana will be discussed more in the coming sections.

Table 1: Top 20 Ports in U.S. by Tonnage in 2018

Ports	Rank	Total tons (Millions)
South Louisiana, LA, Port of	1	275.5
Houston, TX	2	268.9
New York, NY and NJ	3	140.3
Beaumont, TX	4	100.2
Corpus Christi, TX	5	93.5
New Orleans, LA	6	93.3
Long Beach, CA	7	86.5
Baton Rouge, LA	8	82.2
Virginia, VA, Port of	9	71.8
Los Angeles, CA	10	67.8
Mobile, AL	11	58.6
Lake Charles, LA	12	56.9
Plaquemines, LA, Port of	13	56.9
Baltimore, MD	14	44.8
Texas City, TX	15	42.7
Savannah, GA	16	41.3
Port Arthur, TX	17	39.9
Cincinnati-Northern KY, Ports of	18	38.5
St. Louis, MO and IL	19	37.4
Duluth-Superior, MN and WI	20	35.1

Source: Bureau of Transportation Statistics. https://www.bts.dot.gov/content/ tonnage-top-50-us-water-ports-ranked-total-tons

2.4 Air Pollution

Air pollution is a major concern in the United States and globally. Various forms of air pollution are linked to numerous ailments and concerns, including climate change, respiratory health, cognitive ability, worker productivity, and fetal development. Carbon emissions are a driving factor behind climate change (AMS, 2019; Lindsey, 2020). Worker productivity can be affected by ozone, particulate matter (both fine (PM2.5) and coarse (PM10)), NO2, and SO2 (Chang et al., 2016, 2019; Graff Zivin and Neidell, 2012; He et al., 2019). Lead pollution's negative effects on cognitive ability and behavioral issues are well studied (Aizer and Currie, 2019; Billings and Schnepel, 2018). And many of the above pollutants cause respiratory illnesses (e.g. asthma), which burden individuals with medical bills and, in extreme cases, lead to death (Deryugina et al., 2019; Sheldon and Sankaran, 2017).

The transportation sector produces (or in the case of lead, produced) large shares of each of these (and other) pollutants, and many of these emission shares have been increasing over time. For example, the transportation sector is the largest contributor of greenhouse gas emissions and accounts for over 55% of total NO2 emissions inventory in the United States (EPA, 2019a,b). Given their large role in producing these emissions, targeting pollution from automobiles has the potential to drastically improve the quality of life for Louisianans.

Figure 10 depicts ozone emissions across numerous parishes in Louisiana. Shaded parishes are "Core-Based Statistical Areas" that the EPA provides data for. Unshaded areas do not have pollution monitors that track ozone or too few observations to create a reliable estimate. Ozone is measured in parts-per-million (number of units of mass of ozone per one million units of total mass). Readings are the fourth daily maximum eight-hour concentration of ozone (applicable National Ambient Air Quality Standard is 0.070 ppm).

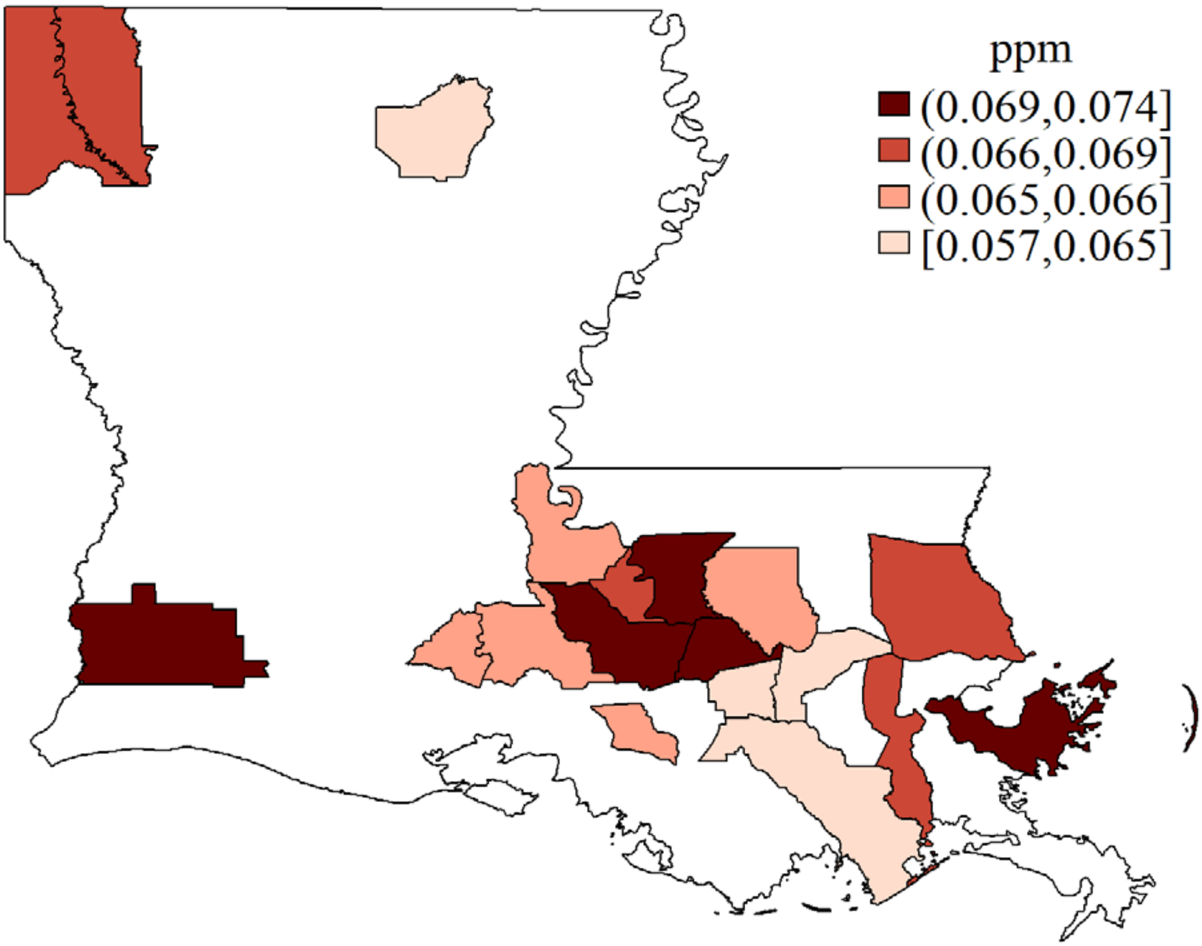
Ozone levels vary significantly across parishes in the state. More metropolitan areas have higher ozone concentrations. For example, areas around Baton Rouge and New Orleans have some of the highest concentrations within the state. As was seen in Figure 2, these parishes also tend to have higher VMT.

Figure 11 presents the progression of ozone pollution in seven metro areas around Louisiana (Baton Rouge, Hammond, Houma-Thibodaux, Lake Charles, Monroe, New Orleans-Metairie, and Shreveport-Bossier City) between 2000 and 2018. Ozone is measured in parts-per-million. An overall downward trend in ozone pollution can be seen throughout the period. For the most part, metro areas are relatively similar in their ozone concentration levels. One notable exception is Monroe. Ozone levels in Monroe begin to deviate from the other areas around 2006-2007 and remain significantly lower for the remainder of the period.

Figure 12 presents similar emissions trends for PM2.5 for the same areas between 2000 and 2018. Emissions are measured in terms of micrograms per cubic meter of ambient air. Again, there is a marked decrease in emissions over this period in all counties. Baton Rouge begins the period with higher emission levels, and this difference remains throughout the period. Monroe, which exhibited much lower ozone emissions than the other areas, is near the middle of the seven areas in terms of PM2.5 pollution throughout the years.

These figures show that, overall, emissions of many pollutants have fallen in Louisiana in recent years; however, there is heterogeneity in which pollutants have decreased and in what areas these gains have occurred.

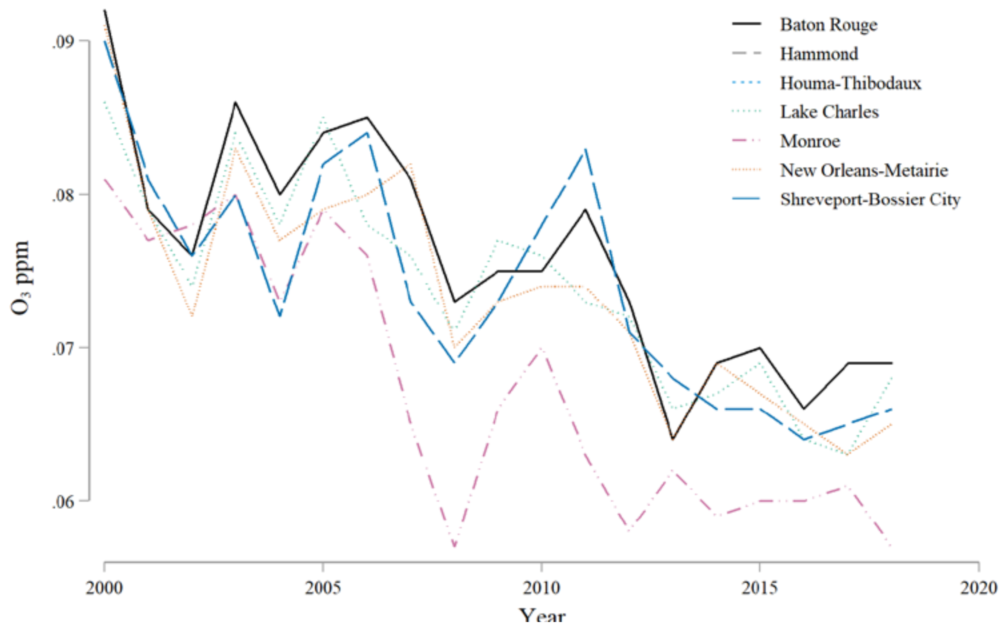
Figure 10: O_3 8-Hr Pollution in Louisiana



Notes: Map depicts fourth daily maximum eight-hour concentration of O3 in ppm. The applicable NAAQS is 0.07 ppm.

Source: United States Environmental Protection Agency. https://www.epa.gov/air-trends/air-quality-cities-and-counties

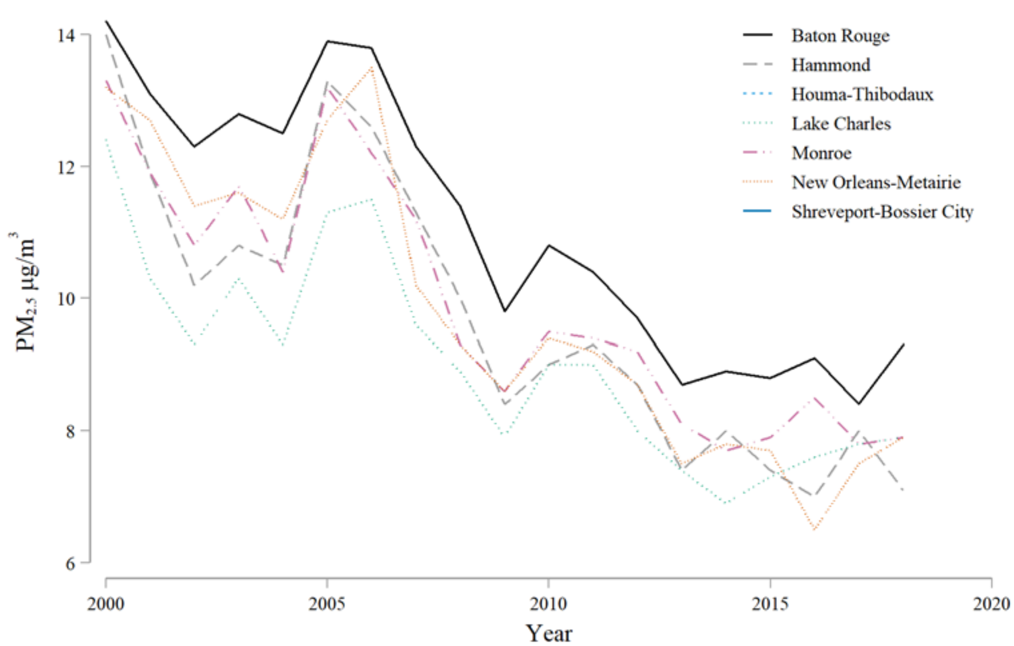
Figure 11: O_3 Pollution Trends in Louisiana



Notes: Figure depicts fourth-highest daily maximum eight-hour concentration of ozone across numerous urban areas in Louisiana from 2000 to 2018. Ozone is measured in ppm.

Source: United States Environmental Protection Agency. https://www.epa.gov/air-trends/air-quality-cities-and-counties

Figure 12: $PM_{2.5}$ Pollution Trends in Louisiana



Notes: Figure depicts weighted annual mean concentration of PM2.5 across numerous urban areas in Louisiana from 2000 to 2018. Concentrations are measured in micrograms per cubic meter.

Source: United States Environmental Protection Agency. https://www.epa.gov/air-trends/air-quality-cities-and-counties

3 | Energy Policy

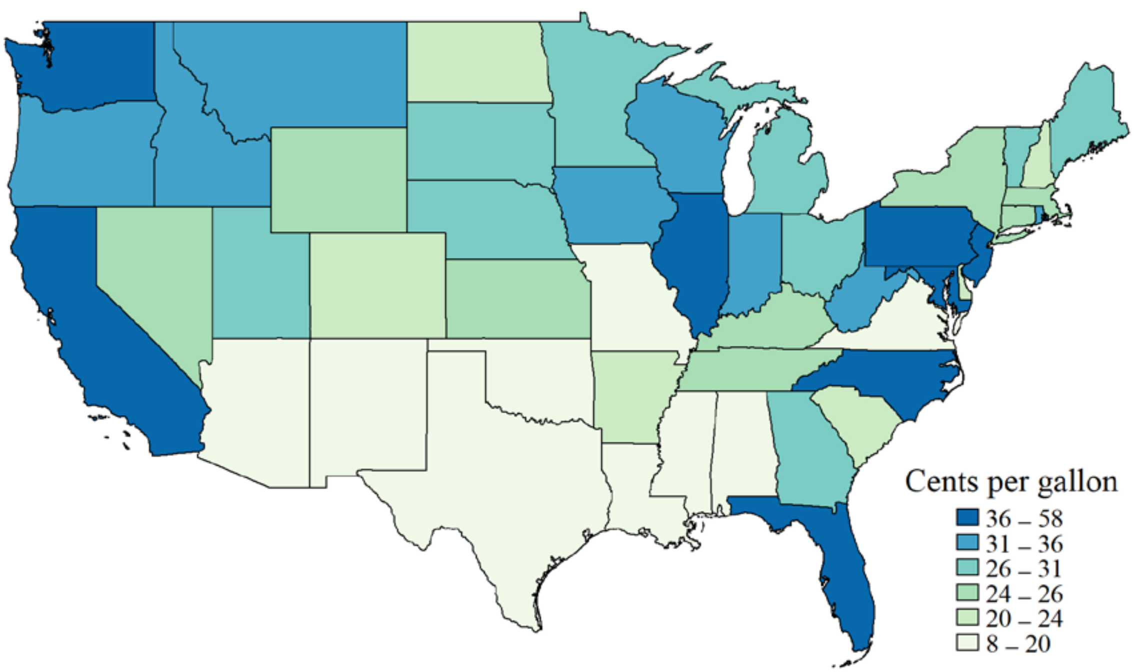
3.1 Gasoline Taxes

Gasoline taxes are ubiquitous in the United States. In 1919, Oregon, recognizing that the addition of motor vehicles to roads increased maintenance costs, levied the first gasoline tax in the U.S. in an effort to fund transportation infrastructure.[5] Gasoline taxes quickly proliferated across the country, and the federal government levied its own fuel tax in 1932. Today, each state and the federal government levy a tax on gasoline.

Most fuel taxes were and continue to be levied to fund road infrastructure and repair. A notable exception to this is the federal gasoline tax, which was initially levied as an emergency tax to control budget deficits in during the Great Depression, but has since largely been used to fund infrastructure (Lowry, 2015). The federal gasoline tax is currently 18.4 cent per gallon and has not been changed since 1993.

Louisiana currently has the 43rd lowest gasoline tax in the U.S. at only $0.20 per gallon. Figure 13 illustrates each state's gasoline tax as of March of 2020. States exhibit large differences in their gasoline taxes with rates ranging from 8 to 58 cents per gallon. Southern states generally have lower gasoline taxes, but there are exceptions to this (e.g. Florida).

Figure 13: Gasoline Taxes by State



Notes: Figure depicts gasoline taxes in cents per gallon across the U.S. Gasoline taxes depicted are current as of March 2020.

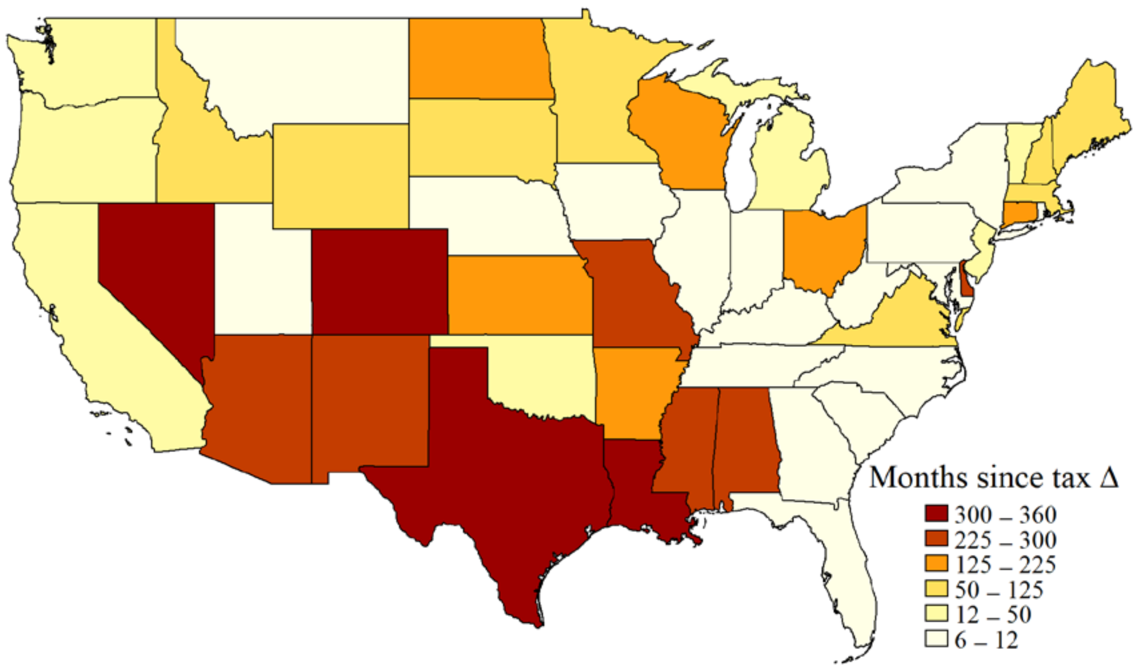
Source: U.S. Federal Highway Administration. https://www.fhwa.dot.gov/policyinformation/motorfuelhwy_trustfund.cfm

[5] See https://time.com/4803516/gas-tax-history/ for a thorough review of the history of gasoline taxes.

Gasoline taxes are often thought of as a partisan issue with Democratic-leaning states imposing higher gasoline taxes than Republican-leaning states. Figure 13 suggests that this may not be the case. For example, many states that voted for Donald J. Trump in the 2016 presidential election have relatively high gasoline taxes. This includes states like North Carolina, Florida, and Pennsylvania that are in the highest gasoline tax bracket ($0.36–$0.58 per gallon of gasoline). Other states like Idaho, Montana, Wisconsin, Iowa, and West Virginia also voted Republican in the 2016 presidential election and fall in the second-highest tier of gasoline taxes ($0.31-$0.36 per gallon of gasoline).

Figure 14 depicts the number of months since each state has changed their gasoline tax. Changes may be either increases or decreases, but with few exceptions the changes are increases in the gasoline tax. Months since tax change are calculated relative to March 2020.

Figure 14: Months since gasoline tax change



Notes: Figure depicts how many months it has been since the state last updated its gasoline tax, regardless of whether this change was an increase or decrease. Months since is measured from March 2020.

Source: U.S. Federal Highway Administration. https://www.fhwa.dot.gov/policyinformation/motorfuelhwy_trustfund.cfm

Louisiana is among the states with the longest-standing gasoline tax rates. Other states comparable to Louisiana along this dimension are Texas, Nevada, and Colorado. Each of these four states has not changed their gasoline tax in at least the previous 300 months (equivalent to 25 years). Low gas taxes are strongly correlated with time since last gasoline tax change. Interestingly, many states that voted Republican in the 2016 presidential election have changed their gasoline tax since the election. For example, Florida, Georgia, South Carolina, North Carolina, Tennessee, Kentucky, West Virginia, Pennsylvania, Indiana, Iowa, Nebraska, Utah, and Montana all voted Republican in the 2016 presidential election and changed their gasoline taxes between March and October of 2019. These tax changes further suggest that gasoline taxes need not be the partisan issue they are often viewed as.

To illustrate how a gasoline tax may be able to remedy some of Louisiana's transportation issues, we can examine potential outcomes for Louisiana if the gas tax were increased to $0.30 per gallon. It is worth noting that this $0.10 increase is still far lower than the optimal gas tax supported by many economic studies (Nehiba, 2019; Parry and Small, 2005; West and Williams, 2007).

The most significant outcome of an increase in the gasoline tax would be a reduction in travel demand. Drivers now facing gasoline prices that are closer to the socially optimal price would begin to change their behavior. Many drivers would have multiple channels to change their behavior in the short run, including switching to public transit for some trips, walking (or other active transportation modes), using a more fuel efficient vehicle (if multiple vehicles are owned), reducing leisure trips (in either quantity or length), and others (Bento et al., 2009; Gallo, 2011; Li et al., 2014; Storchmann, 2001; West and Williams, 2004). There will also be longer-run adaptations that could provide significant changes in the vehicle fleet (e.g. through individuals buying more fuel efficient vehicles) (Klier and Linn, 2010; Leard et al., 2017).

Regardless of how these reductions in travel demand manifest, they will have consequences for societal welfare. Individuals will reduce the number of trips they are taking/miles driven. Because drivers received utility from these trips, society will lose out on these benefits. Assuming a short-run VMT elasticity of -0.358, Louisiana's 2018 VMT, and utilizing the model in Nehiba (2019), the reduction in VMT will reduce welfare in Louisiana by $8 million annually. It is worth noting that this number will fall in the future as longer-run adjustments are made.

However, the short-run adjustments in VMT will provide significant benefits to the state. Again using the model and parameters from Nehiba (2019) and 2018 estimates of Louisiana's VMT, the reductions in congestion, pollution, and accidents can be valued at $12 million, $176 million, and $27 million annually. This suggests that there is the potential for a net welfare gain of $207 million annually within the state from an increase in the per gallon gasoline tax of $0.10.

Outside of this welfare calculation is the cash transfer from drivers to the government in the form of $170 million in additional gasoline tax revenue. These funds can be used in any number of ways to generate even more benefits/economic growth. Obvious uses could include infrastructure improvements. However, economists have long lobbied for the revenues generated by environmental taxes (like a gasoline tax) to reduce taxes on "good" behaviors (Fullerton and Metcalf, 1997). For example, the revenue from the increased gasoline tax could be used to lower labor taxes. This would disincentivize driving—which generates negative externalities—and remove disincentives for working—which may provide significant economic benefits.

The tax revenues could also be used to combat a common critique that gasoline taxes may be regressive (i.e. having a disproportionate impact on low income individuals). Some possibilities include a full revenue recycling scheme where the revenues from gasoline taxes are fully given back to drivers in proportion to the harm the tax imposed on them. This recycling is unlikely to be politically feasible as gasoline tax revenue is generally thought of as funding for infrastructure (Bento et al., 2009); however, partial revenue recycling, which allocates some of the revenue to very low income households, may make the tax progressive and politically feasible (Spiller et al., 2017).

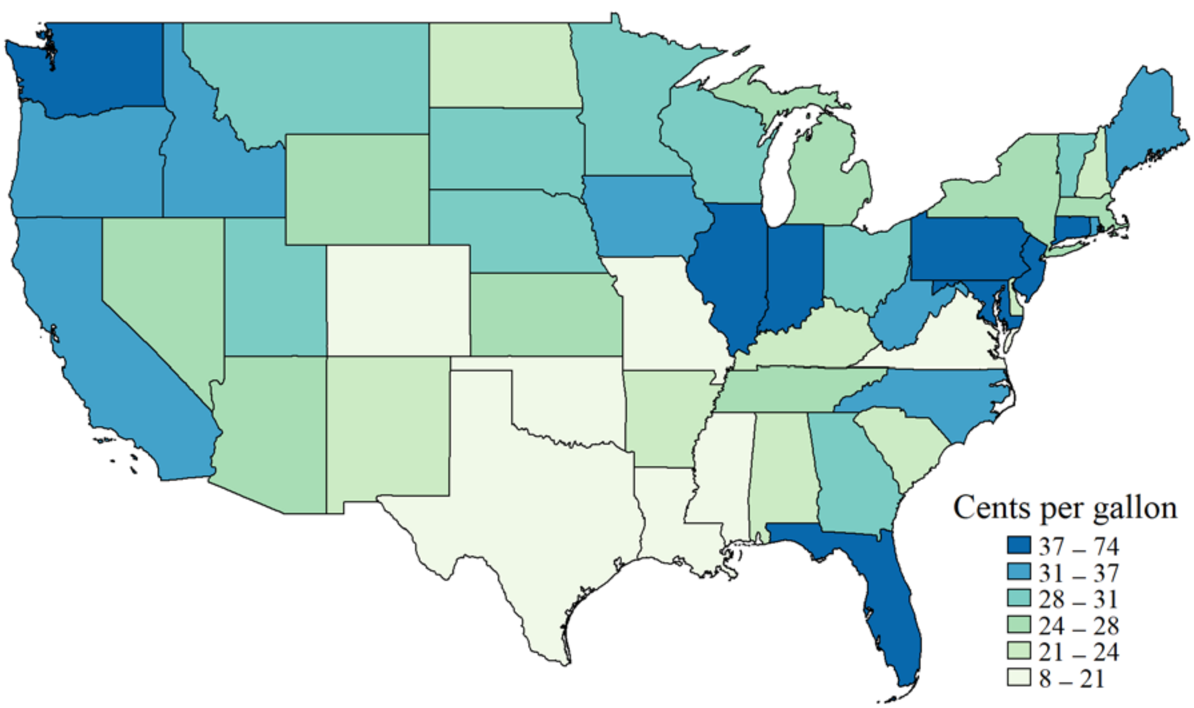
3.2 Diesel Taxes and Other Freight Policies

Diesel taxes have followed a similar trajectory as gasoline taxes in the state of Louisiana. Louisiana's state diesel fuel tax is identical to the gasoline tax at 20 cents per gallon. At 24.4 cents per gallon the federal diesel tax in the U.S. is slightly higher than the 18.4 cents per gallon gasoline tax. This means Louisianans (or long-haul truckers passing through the state) pay a cumulative 38.4 cents per gallon in taxes for on-road diesel fuel.

The state diesel tax rate was also last updated in 1990. This means that diesel taxes suffer from the same woes as the gasoline tax. Over time, increasing fuel efficiency of vehicles and inflation have eroded both the amount of revenue received for each mile driven on Louisiana roads and the value of that revenue. Since these fuel taxes are one of the primary sources of road infrastructure funding, this means Louisiana's real available funds per mile driven have decreased over time.

Figure 15 depicts state level diesel taxes in cents per gallon across the United States. Diesel taxes are current as of March 2020. Louisiana and its immediate neighbors are all in or near the lowest diesel tax bracket ($0.08-$0.21 per gallon of diesel fuel). In general, more northern states tend to have higher diesel taxes (though there are notable exceptions, (e.g. Florida). The variation in these taxes is very similar to the variation in gasoline taxes across states depicted in Figure 13.

Figure 15: Diesel Taxes by State



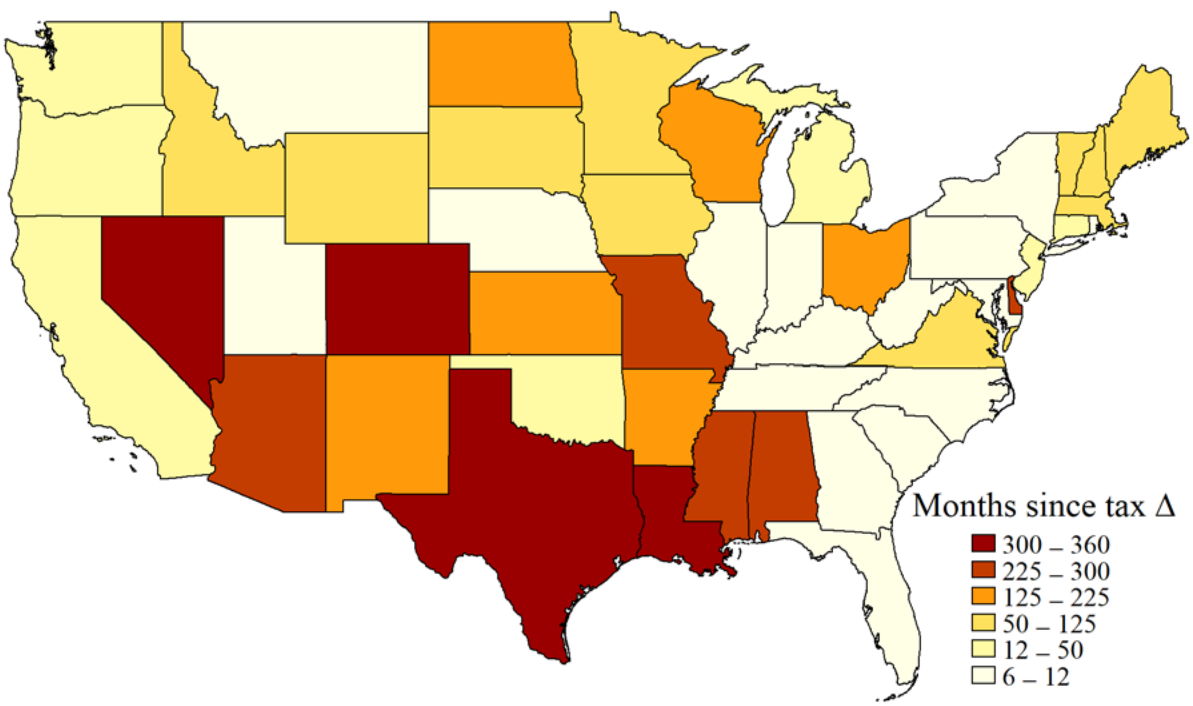
Notes: Figure depicts Diesel taxes in cents per gallon across the U.S. Diesel taxes depicted are current as of March 2020.

Source: U.S. Federal Highway Administration. https://www.fhwa.dot.gov/policyinformation/motorfuelhwy_trustfund.cfm

Like gasoline taxes, diesel taxes are often thought of as a partisan issue with Democratic leaning states imposing higher gasoline taxes than Republican leaning states. Figure 15 again suggests that this may not be the case as many traditionally conservative states exhibit relatively high diesel fuel taxes.

Figure 16 depicts the number of months since each state has changed their diesel tax. Changes may be either increases or decreases, but with few exceptions the changes are increases in the diesel tax. Months since tax change are calculated relative to March 2020. Again, the variation is very similar to that seen in Figure 14. This is because states generally review fuel taxes in tandem—fuel taxes are increased jointly in most cases. Louisiana is among the states with the longest standing diesel tax rates. Other states comparable to Louisiana along this dimension are Texas, Nevada, and Colorado. None of these states has changed its diesel tax in at least the previous 300 months (equivalent to 25 years). Low taxes are again strongly correlated with time since last tax change. Interestingly, many states that voted Republican in the 2016 presidential election have changed their diesel tax since the election. For example, Florida, Georgia, South Carolina, North Carolina, Tennessee, Kentucky, West Virginia, Pennsylvania, Indiana, Nebraska, Utah, and Montana all voted Republican in the 2016 presidential election and changed their diesel taxes between March and October of 2019. These tax changes further suggest that fuel taxes need not be the partisan issue they are often viewed as.

Figure 16: Months since diesel tax change



Notes: Figure depicts how many months it has been since the state last updated its diesel tax, regardless of whether this change was an increase or decrease. Months since is measured from March 2020.

Source: U.S. Federal Highway Administration. https://www.fhwa.dot.gov/policyinformation/motorfuelhwy_trustfund.cfm

Unlike gasoline, a significant portion of diesel fuel use in the state is used by freight shippers transporting goods across the country. Freight trucks hauling these goods have an increased ability to respond to fuel price changes (caused by either market forces or fuel tax changes) which may have significant implications for Louisiana.

When fuel prices increase, freight shippers can alter their shipments to decrease fuel costs. These shippers have been shown to decrease the total number of shipments they make, but increase the cargo on each shipment when diesel fuel prices increase (Cohen and Roth, 2017). Though the increased cargo weight reduces the fuel efficiency of the freight trucks, the fuel cost savings of the reduction in total trips leads to a net reduction in fuel spending (Franzese, 2011); however, shippers are theorized to only reduce shipments when fuel prices increase because it lowers the quality of their services offered (forcing firms to store additional stock) (Cohen and Roth, 2017).

Higher fuel prices then reduce the number of trucks on the road and fuel usage which generates reductions in air pollution and congestion (just like the gasoline tax does for passenger vehicles); however, the increased weight of the remaining trucks on the road creates new problems related to road damage and safety.

These heavier trucks increase the amount of damage done to roadways because road damage increases exponentially as a function of a truck's axle weight (FHWA, 1995). Therefore small increases in truck weight can have drastic consequences for the road network's lifetime. Heavy trucks are also more likely to be involved in serious collisions involving either a hospitalization or fatality of an involved party. In other words, heavier trucks skew the distribution of truck-involved collisions towards fatal outcomes (Nehiba, 2020).

Recent economic analyses in Cohen and Roth (2017) and Nehiba (2020) have shown that increasing diesel fuel taxes does not improve economic efficiency. Though the taxes reduce pollution and congestion, these benefits are more than offset by the increases in road damage and fatal collision costs. Further, because fuel taxes are generally viewed as a source of funding for infrastructure, much of the revenue generated by a diesel tax is offset by funds that must be used to repair roads damaged because of the diesel tax (Cohen and Roth, 2017).

If diesel taxes do more harm than good, what can be done to reign in the external costs of freight trucking and raise funding for road infrastructure? One option is to explicitly tax trucks for the damage they do to roads. This would take the form of an axle-weight-mileage tax. In other words, a per mile tax that varies by the axle weight of a truck, and therefore varies by the amount of road damage done and potential for serious collisions.

Though implementing a new tax structure can often be difficult both politically and technologically, an axle-weight-mileage tax may be feasible in the state of Louisiana for several reasons. First, it is important to note that much of the infrastructure required for such a tax is already in place. Freight truckers that pass through multiple states are taxed on a per mile basis in each state. For example, a truck that travels in Louisiana for 100 miles before passing into Texas is only charged Louisiana's diesel tax for the 100 miles they were within the state. Shippers keep track of how many miles they drive in each state and where they purchase their fuel (and therefore how much tax they have already paid). Next, they report these metrics to the International Fuel Tax Association (IFTA), along with states with which they have credits/liabilities in diesel tax revenues. IFTA then acts as a clearing house between states. They facilitate revenue transfers between the states based on the miles driven and gallons purchased in each state. Drivers are then either owed money back on their taxes or must pay IFTA.

The next piece of information required for an axle-weight-mileage tax is an accurate record of each truck's weight. This is also readily available to regulators. Truck weights are already regulated in the

U.S. (usually with a maximum allowable weight of 80,000 lbs.) and are regularly weighed to ensure that they are within the allowable weight range.

By combining these two existing regulatory systems, an axle-weight-mileage tax could easily be implemented in Louisiana. Because we already know the weights or every truck and the miles driven within the state, the only adjustments required would be clerical. Admittedly, this system would be slightly more complex, and some of this burden would fall on drivers. But the system is not prohibitively complex. Evidence of this can be found in several European countries that already use a similar tax structure, or even as close as Oregon, which has eliminated its per gallon diesel fuel tax in favor of weight-mileage taxes.

3.3 Electric Vehicle Policies

Electric vehicles (EVs) are a small but growing segment of the vehicle fleet across the United States. Over the past several years EV and plug-in hybrid vehicle sales have exploded across the country. Much of this transition has occurred in just a handful of states though— Louisiana not being one of them.

In Louisiana, electric vehicle sales have shown steady increases, but at a much slower rate than the national average. Battery electric vehicles and plug-in hybrid electric vehicles composed only 0.28% of the vehicle sales in the state in 2018.[6] To put this into context, only 613 EVs were sold in Louisiana in 2018. There were only three states that had lower market shares for EV sales—Mississippi, North Dakota, and West Virginia.

Though the sales have not been particularly large in Louisiana, there are several policies that encourage EV adoption. This includes a federal tax credit that EV purchasers can take advantage of regardless of state. This tax credit can range from $1,875 to $7,500, depending on the vehicle purchased.[7] Many of the policies incentivizing adoption are levied at a more local level though. For example, Louisiana provides a state tax credit up to $3,000 for EV purchases.[8] Beyond these governmental incentives, some energy providers have also begun to offer programs that encourage EV purchase. These policies include Entergy's $250 tax credit for installing an EV charging station in your home.[9]

These incentives are designed to boost EV and plug-in hybrid adoption throughout the nation and the state; however, in Louisiana and many other parts of the U.S., electric vehicles are not currently delivering pollution benefits (Holland et al., 2016). The environmental benefits from electric vehicles are well known to vary across regions, depending on the underlying electricity emissions, with local environmental damages often being exported to other areas or states. This means tail-pipe emissions in one area can be "swapped" for electricity emissions in other areas—allowing for local subsidies to be rationalized even though they provide negative environmental benefits to society as a whole (Holland et al., 2016).

In 2016, the optimal average subsidy on electric vehicles in the U.S. to fully internalize the change in pollution damages was -$1,095 (Holland et al., 2016). That means, on average, EVs were worse

[6] For a breakdown of EV sales and market shares by state see https://evadoption.com/ ev-market-share/ev-market-share-state/

[7] See https://www.fueleconomy.gov/feg/taxevb.shtml for a complete list of federal tax credits currently available for each electric vehicle and plug-in hybrid currently available purchase in the U.S.

[8] See the Louisiana Department of Revenue Alternative Fuel Credit Rule for more details on the tax credit. http://revenue.louisiana.gov/LawsPolicies/2012_12RevenueRule.pdf.

[9] See the Department of Energy's Alternative Fuels Data Center website https://afdc.energy.gov/laws/12260 or the Entergy eTech website https://entergyetech.com/ for details on this credit.

for the environment than gasoline powered vehicles. This optimal subsidy exhibited significant heterogeneity though with subsidies ranging from $2,785 in California to -$4,964 in North Dakota (Holland et al., 2016). Much of this variation is due to the underlying electricity generation portfolio across regions. Eastern states have historically relied on “dirtier” forms of generation (like coal) than western states.

Holland et al. (2016) demonstrated that the eastern half of the U.S. (including Louisiana) did not receive environmental benefits from EV adoption; however, this is rapidly changing as electricity generation becomes cleaner. Newer estimates have shown that a massive decline in air pollution from electricity generation in the U.S. has been centered in the east (Holland et al., 2020). This reduction—driven by a reduction in coal-fired generation and an increase in gas plants—has pushed EVs to have on average positive environmental benefits in the U.S. (Holland et al., 2020). Though some areas of the U.S. still incur negative environmental benefits from EV adoption, this illustrates how quickly the landscape is changing for EVs.

The heterogeneity in emissions from electric vehicles also leads to different groups being more (or less) affected by EV adoption. Holland et al. (2019) find that adoption of electric vehicles by individuals living in census block groups with median income greater than $65,000 receive positive environmental benefits and those with median incomes below $65,000 receive negative environmental benefits. Likewise, individuals of different ethnicities are differentially affected. This regressivity raises concerns that fostering adoption of EVs in the short run may be regressive; however, this is likely to change as emissions from electricity generation continue to decrease.

Beyond pollution issues, there are several other concerns that have been raised regarding EV adoption. Many of these concerns revolve around the loss of gasoline tax revenue if EVs are widely adopted. Some estimates suggest that gasoline taxes have already been reduced by $250 million annually in the U.S. because of electric vehicle adoption (Davis and Sallee, 2019). This issue can be easily averted by charging EVs a mileage tax in lieu of a gasoline tax. A mileage tax would not only recoup “lost” gasoline tax revenue, but also function as a corrective tax that can target pollution, congestion, and accident externalities. Implementing a type of mileage tax for EVs may be particularly useful in Louisiana, which has the lowest electricity prices in the nation ($0.071 per kWh) (EIA, 2020). These low prices suggest that EV drivers face low marginal costs for each mile driven, potentially leading to additional driving (generating congestion, accidents, and pollution). This mileage tax could help increase the costs of driving for these individuals, bringing them closer to the true social costs. However, little research has been conducted on how EV mileage responds to prices.

An alternative to a mileage tax proposed in Louisiana (and in use in other states) is the use of increased registration fees for plug-in hybrid and electric vehicles.[10] While these fees may increase revenue, their uniform nature likely means they are economically inefficient. Because all EV drivers pay the same registration fees, those with high mileage (and high external damages) are charged the same as low mileage (and low external damage) drivers. This creates a situation where low mileage EV drivers may “subsidize” the high mileage drivers.

[10] See https://www.ncsl.org/research/energy/new-fees-on-hybrid-and-electric-vehicles.aspx for a list of fees for hybrid and electric vehicles.

4 | Conclusion

Louisiana's road transportation system has numerous areas that require attention. Congestion, accidents, pollution, and damaged roads all weaken the state's economy. Energy policy can be used strategically to both alleviate some of these growing concerns and generate revenue that can be used to reinvest in the transportation system.

These ideas seem to be gaining traction within the state as residents and policy makers come to grasp with the condition of the state's infrastructure. This can be seen in recent attempts to increase the gasoline tax—and even calls to implement a spatially differentiated gasoline tax. This shows not only a desire to implement policy, but sound policy that has strong economic support.

Other areas will continue to require attention and further push from policy makers. The development of an alternative freight tax would be a step in the right direction in terms of improving road safety, preserving current infrastructure, and generating revenue for repairs and reinvestment. EV subsidies and usage fees will also play a growing role in these activities in the future.

References

Aizer, A. and J. Currie. “Lead and juvenile delinquency: New evidence from linked birth, school, and juvenile detention records.” *The Review of Economics and Statistics* 101, no. 4 (2019): 575–587.

AMS . “State of the climate in 2018.” *Bulletin of the American Meteorological Society* 100, 9 (2019).

Arhin, S. A., E. C. Noel, and A. Ribbiso. “Acceptable international roughness index thresholds based on present serviceability rating.” *Journal of Civil Engineering Research* 5, no. 4 (2015): 90–96.

Baum-Snow, N. “Did Highways Cause Suburbanization? *The Quarterly Journal of Economics* 122, no. 2 (2007): 775–805.

Bento, A. M., L. H. Goulder, M.R. Jacobsen, and R. H. von Haefen. “Distributional and efficiency impacts of increased us gasoline taxes.” *American Economic Review* 99, no. 3 (2009): 667–99.

Billings, S. B., and K. T. Schnepel. “Life after lead: Effects of early interventions for children exposed to lead.” *American Economic Journal: Applied Economics* 10, no. 3 (2018): 315–44.

CDC. “Road traffic injuries and deaths—a global problem.” Technical report, Center for Disease Control and Prevention (2019).

Chang, T., J. Graff Zivin, T. Gross, and M. Neidell. “Particulate pollution and the productivity of pear packers.” *American Economic Journal: Economic Policy* 8, no. 3 (2016): 141–69.

—. ‘The effect of pollution on worker productivity: Evidence from call center workers in china.” *American Economic Journal: Applied Economics* 11, no. 1 (2019): 151–72.

Cohen, L. R., and K. D. Roth. “A second-best dilemma: Freight trucks, externalities, and the dispatch effect.” Working Paper (2017).

Davis, L. W., and J. M. Sallee. “Should electric vehicle drivers pay a mileage tax?” Working Paper 26072, National Bureau of Economic Research (2019).

Deryugina, T., G. Heutel, N. H. Miller, D. Molitor, and J. Reif. “The mortality and medical costs of air pollution: Evidence from changes in wind direction.” *American Economic Review* 109, no. 12 (2019): 4178–4219.

DOT. “DOT fiscal year 2017 budget fact sheet.” Technical report, Department of Transportation (2018).

DOTD “Transportation infrastructure investment plan.” Technical report, State of Louisiana (2018).

EIA. “Number and capacity of petroleum refineries.” Technical report. (2019).

—. “State electricity profiles.” Technical report (2020).

EPA. “Fast facts on transportation greenhouse gas emissions.” Technical report, Environmental Protection Agency (2019a).

—. “Smog, soot, and other air pollution from transportation.” Technical report, Environmental Protection Agency (2019b).

FHWA. “Comprehensive truck size and weight study phase 1-synthesis.” Technical report, Federal Highway Administration (1995).

Franzese, O. “Effect of weight and roadway grade on the fuel economy of class-8 freight trucks.” Technical report, Oak Ridge National Laboratory (2011).

Fullerton, D., and G. E. Metcalf. “Environmental taxes and the double-dividend hypothesis: Did you really expect something for nothing?” Working Paper 6199, National Bureau of Economic Research (1997).

Gallo, M. “A fuel surcharge policy for reducing road traffic greenhouse gas emissions.” *Transport Policy* 18, no. 2 (2011): 413–424.

Graff Zivin, J. and M. Neidell. “The impact of pollution on worker productivity. *American Economic Review* 102, no. 7 (2012): 3652–73.

He, J., H. Liu, and A. Salvo. “Severe air pollution and labor productivity: Evidence from industrial towns in china.” *American Economic Journal: Applied Economics* 11, no. 1 (2019): 173–201.

Holland, S. P., E. T. Mansur, N. Z. Muller, and A. J. Yates. “Are there environmental benefits from driving electric vehicles? The importance of local factors.” *American Economic Review* 106, no. 12 (2016): 3700–3729.

—. “Distributional effects of air pollution from electric vehicle adoption.” *Journal of the Association of Environmental and Resource Economists* 6, no. S1 (2019): S65–S94.

—. “Decompositions and policy consequences of an extraordinary decline in air pollution from electricity generation.” *American Economic Journal: Economic Policy* Forthcoming: 3700–3729.

Hu, J., X. Gao, R. Wang, and S. Sun. “Research on comfort and safety threshold of pavement roughness.” *Transportation Research Record* 2641, no. 1 (2017): 149–155.

Kamakat́e, F., and L. Schipper. “Trends in truck freight energy use and carbon emissions in selected OECD countries from 1973 to 2005." *Energy Policy* 37, no. 10 (2009): 3743 – 3751. Carbon in Motion: Fuel Economy, Vehicle Use, and Other Factors affecting CO2 Emissions from Transport.

Klier, T., and J. Linn. "The price of gasoline and new vehicle fuel economy: Evidence from monthly sales data." *American Economic Journal: Economic Policy* 2, no. 3 (2010): 134–53.

Leard, B., J. Linn, and V. McConnell. "Fuel prices, new vehicle fuel economy, and implications for attribute-based standards." *Journal of the Association of Environmental and Resource Economists* 4, no. 3 (2017): 659–700.

Li, S., J. Linn, and E. Muehlegger. "Gasoline taxes and consumer behavior." *American Economic Journal: Economic Policy* 6, no. 4 (2014): 302–342.

Lindsey, R. "Climate change: Atmospheric carbon dioxide." Technical report, National Oceanic and Atmospheric Administration (2020).

Louhghalam, A., M. Akbarian, M., and F.-J. Ulm. "Roughness-induced pavement–vehicle interactions: Key parameters and impact on vehicle fuel consumption." *Transportation Research Record* 2525, no. 1 (2015): 62–70.

Lowry, S. "The federal excise tax on motor fuels and the highway trust fund: Current law and legislative history." Technical report, Congressional Research Service (2015).

Nehiba, C. "Correcting heterogeneous externalities: Evidence from local fuel taxes. Working paper. (2019).

–. "Taxed to death? Freight truck collision externalities and diesel taxes." Working paper. (2020).

NHTSA. "Traffic safety facts–motor vehicle traffic crashes as a leading cause of death in the United States, 2015." Technical report, National Highway Traffic Safety Administration (2018).

Nyberg, P., U. Bj¨ornstig, and L.-O. Bygren. "Road characteristics and bicycle accidents." *Scandinavian Journal of Social Medicine*, 24, no. 4 (1996): 293–301.

Parry, I. W. H. and K. A. Small. "Does Britain or the United States have the right gasoline tax?" *American Economic Review* 95, no. 4 (2005): 1276–1289.

Reed, T. and J. Kidd. "Inrix 2018 global traffic scorecard." Technical report. INRIX (2019).

Sathaye, N., A. Horvath, A., and S. Madanat. "Unintended impacts of increased truck loads on pavement supply-chain emissions." *Transportation Research Part A: Policy and Practice* 44, no. 1 (2010): 1 – 15.

Sayers, M. W. "On the calculation of international roughness index from longitudinal road profile." *Transportation Research Record* 1501 (1995).

Schrank, D., B. Eisele, and T. Lomax. "2019 urban mobility report." Report. Texas A & M Transportation Institute (2019).

Sharma, B. "Road traffic injuries: A major global public health crisis." *Public Health*, 122, no. 12 (2008): 1399–1406.

Sheldon, T. L. and C. Sankaran. "The impact of Indonesian forest fires on Singaporean pollution and health." *American Economic Review* 107, no. 5 (2017): 526–29.

Spiller, E., H. M. Stephens, and Y. Chen. "Understanding the heterogeneous effects of gasoline taxes across income and location." *Resource and Energy Economics* 50 (2017): 74– 90.

Storchmann, K.-H. "The impact of fuel taxes on public transport—an empirical assessment for Germany." *Transport Policy* 8, no. 1 (2001): 19–28.

Vickrey, W. S. "Congestion theory and transport investment." *The American Economic Review* 59, no. 2 (1969): 251–260.

West, S. E. and R. C. Williams. "Estimates from a consumer demand system: implications for the incidence of environmental taxes." *Journal of Environmental Economics and Management* 47(3):535 – 558. Including Special Symposium Section from the National Bureau of Economic Research Conference on Advances in Empirical Environmental Policy Research.

—. "Optimal taxation and cross-price effects on labor supply: Estimates of the optimal gas tax." *Journal of Public Economics* 91, no. 3 (2007): 593 – 617.

WHO. "Scale of traffic deaths and injuries constitutes 'a public health crisis' – safe roads contribute to sustainable development." Technical report, World Health Organization (2016).

Winston, C. and A. Langer. "The effect of government highway spending on road users' congestion costs." *Journal of Urban Economics* 60, no. 3 (2006): 463 – 483.

A | Appendix

A.1 Additional maps of pollutants in Louisiana

This section provides several additional figures that illustrate pollution in Louisiana. Several different pollutants and measures of pollutants are depicted. The counties included in each map vary depending on the data the EPA provides. Generally, counties are excluded if they do not have any or adequate monitors that track each pollutant.

Figure A1 depicts NO2 pollution in Louisiana. The pollutant is measured as the arithmetic mean concentration in ppb. NAAQS for this pollutant measure is 53 ppb.

Figure A2 depicts another measure of NO2 pollution in Louisiana. The pollutant is measured as the 98th percentile daily maximum 1-hour concentration of NO2 in ppb. The applicable NAAQS is 100 ppb.

Figure A3 depicts a measure of PM2.5 pollution in Louisiana. The pollutant is measured as the 98th percentile 24-hour concentration of PM2.5 in micrograms per cubic meter. The applicable NAAQS is micrograms per cubic meter.

Figure A4 depicts a measure of PM2.5 pollution in Louisiana. The pollutant is the annual mean concentration of PM2.5 in micrograms per cubic meter. The applicable NAAQS is 12 micrograms per cubic meter.

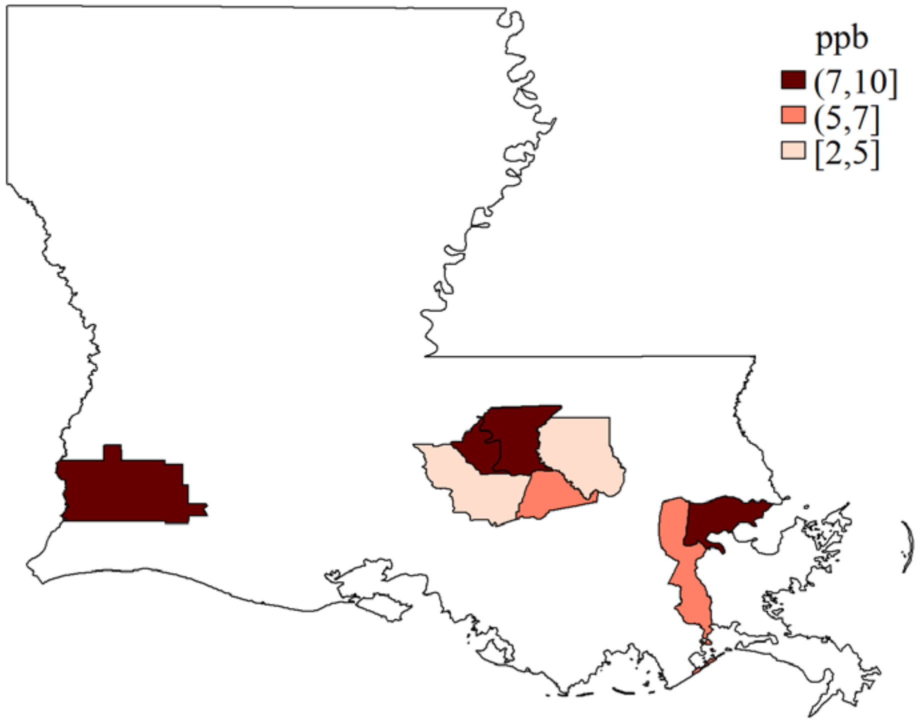
Figure A5 depicts a measure of PM10 pollution in Louisiana. The pollutant is measured as the second maximum 24-hour concentration of PM10 in micrograms per cubic meter. The applicable NAAQS is 150 micrograms per cubic meter.

Figure A6 depicts a measure of SO2 pollution in Louisiana. The pollutant is measured as the 99th percentile daily maximum 1-hour concentration of SO2 in ppb. The applicable NAAQS is 75 ppb.

A.2 IRI Quality Thresholds

Table A1 provides IRI quality thresholds for roads in good, acceptable, and poor condition in in/mi.

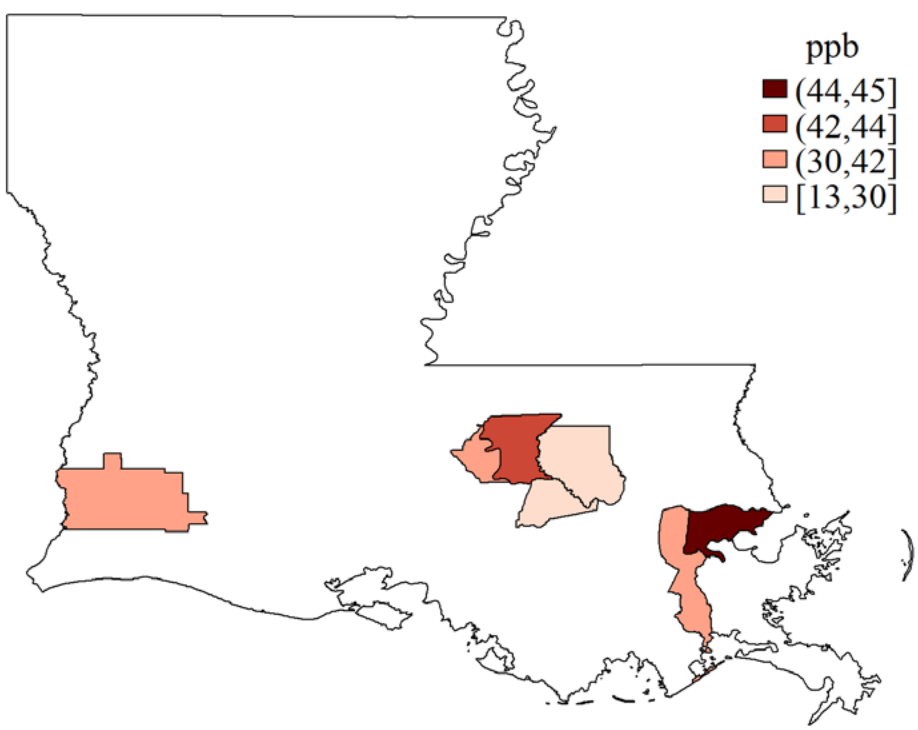
Figure A1: NO_2 AM Pollution in Louisiana



Notes: Map depicts the arithmetic mean concentration of NO2 in ppb. The applicable NAAQS is 53 ppb.

Source: United States Environmental Protection Agency. https://www.epa.gov/air-trends/ air-quality-cities-and-counties

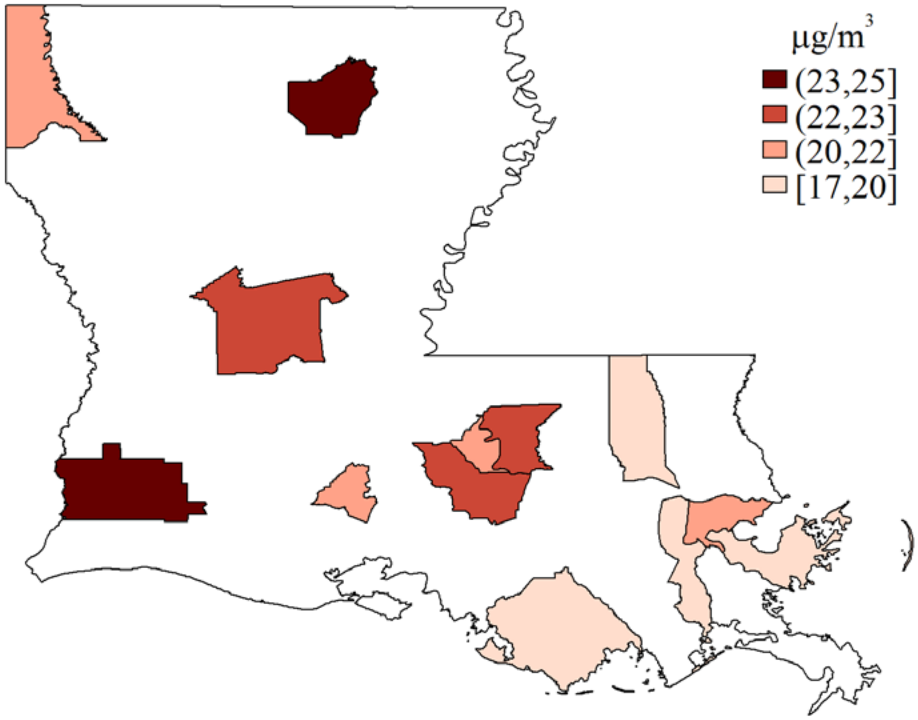
Figure A2: NO_2 1-Hr Pollution in Louisiana



Notes: Map depicts 98th percentile daily maximum 1-hour concentration of NO2 in ppb. The applicable NAAQS is 100 ppb.

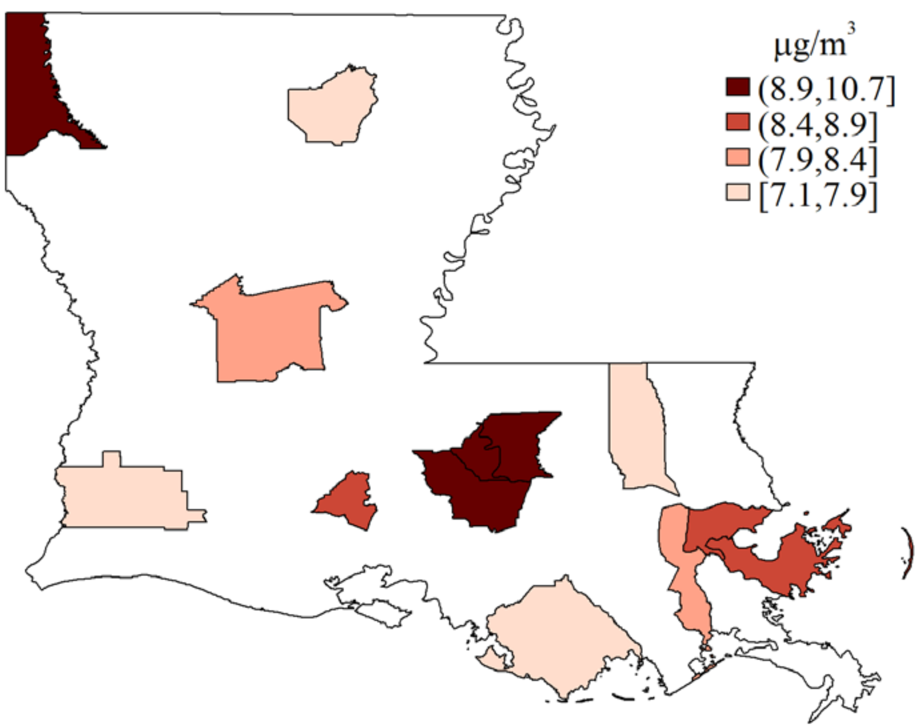
Source: United States Environmental Protection Agency. https://www.epa.gov/air-trends/air-quality-cities-and-counties

Figure A3: $PM_{2.5}$ 24-Hr Pollution in Louisiana



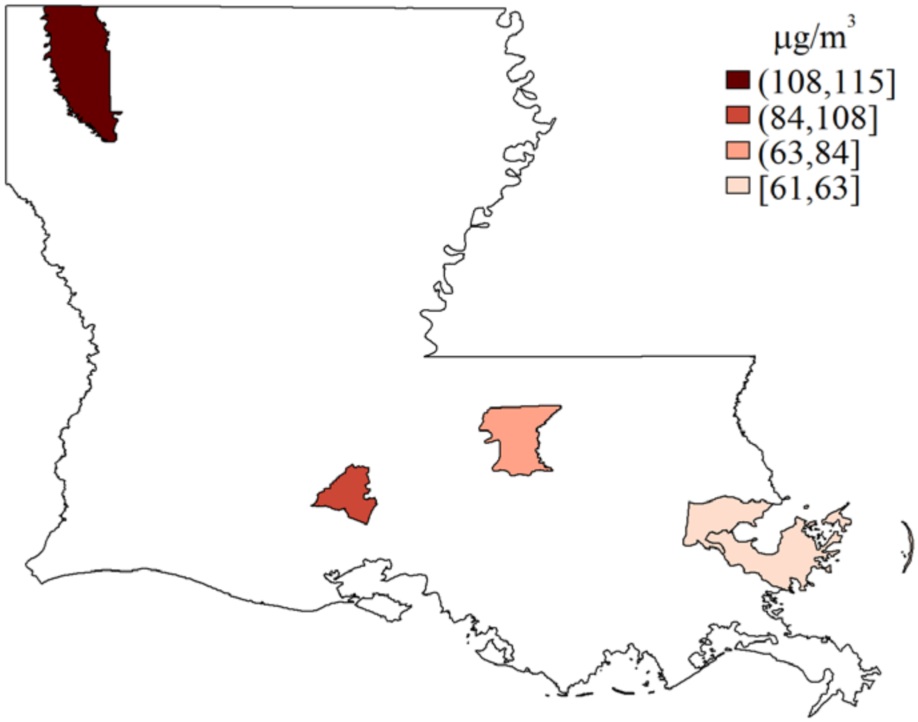
Notes: Map depicts 98th percentile 24-hour concentration of PM2.5 in micrograms per cubic meter. The applicable NAAQS is 35 micrograms per cubic meter.
Source: United States Environmental Protection Agency. https://www.epa.gov/air-trends/air-quality-cities-and-counties

Figure A4: $PM_{2.5}$ Weighted Annual Mean Pollution in Louisiana



Notes: Map depicts weighted annual mean concentration of PM2.5 (applicable NAAQS is 12 micrograms per cubic meter).
Source: United States Environmental Protection Agency. https://www.epa.gov/air-trends/ air-quality-cities-and-counties

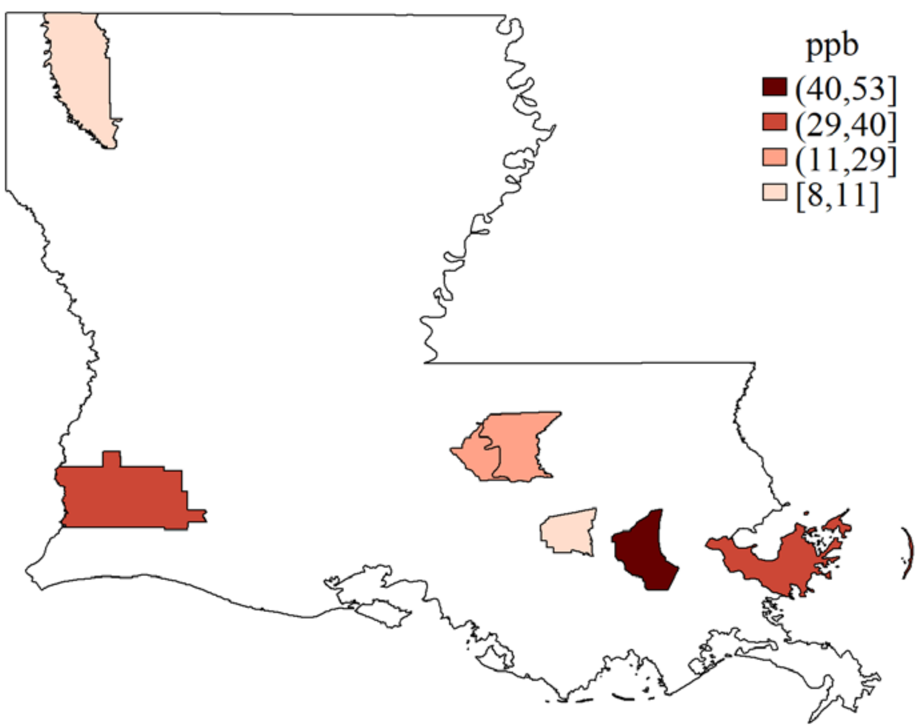
Figure A5: PM_{10} Pollution in Louisiana



Notes: Map depicts second maximum 24-hour concentration of PM10 in micrograms per cubic meter. The applicable NAAQS is 150 micrograms per cubic meter.

Source: United States Environmental Protection Agency. https://www.epa.gov/air-trends/air-quality-cities-and-counties

Figure A6: SO_2 1-Hr Pollution in Louisiana



Notes: Map depicts 99th percentile daily maximum 1-hour concentration of SO2 in ppb. The applicable NAAQS is 75 ppb.

Source: United States Environmental Protection Agency. https://www.epa.gov/air-trends/air-quality-cities-and-counties

Table A1: IRI Quality Thresholds

Quality	IRI Threshold (in/mi)
Good	< 95
Acceptable	≥ 95 and ≤ 170
Poor	>170

Source: Federal Highway Administration. https://www.fhwa.dot.gov/policyinformation/ presentations/hisconf/thu01_hpms_and_tpm-part_1_overview_of_performance_measures-pavement_condition_max_grogg.pdf

LSU