Three Essays on Highways and U.S. Non-profits

by
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To All that Love and Inspire Me, Especially Xinyuan Zhang

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he who learns must suffer.
Even in our sleep, pain which cannot forget
falls drop by drop upon the heart,
until, in our own despair, against our will,
comes wisdom through the awful grace of God.
—Aeschylus, in *Agamemnon*

Getting this PhD is much more strenuous than expected. It is fitting and proper to acknowledge the many travel companions that I came to know along this odyssey, without whom "fulfilling all the requirements for the doctorate degree" would not be possible.

First and foremost, my deepest gratitude goes to members of my dissertation committee for their invaluable advice and patience. Paul Rhode was instrumental in guiding my interest and landing on the research topic of highways in early twentieth century America. I benefited immensely from his encyclopedic knowledge on American history, and his many comments from the big picture to exposition. Jim Hines is a great adviser, coauthor, and friend. Our conversations over the last eight years are inspiring and intellectually nourishing. Looking forward, I imagine aI would ask myself many times "What would Jim do?" when doing research and handling relationships. Josh Hausman, Martha Bailey, and Ugo Troiano are relatively late additions to my committee. Josh is extremely generous with his time. His detailed comments on my work reminded me of *Mr. Fujino* by Lu Xun. I also received laser-focused methodological advice from Martha and Ugo.

I am very grateful for helpful comments and inspirations I got for from many professors and fellow graduate students. I am particularly grateful for suggestions from Hoyt Bleakley, John Bound, Charlie Brown, Gaurav Khanna, Carl Kitchens, and Benjamin Thompson. Parts of this dissertation benefited tremendously from comments and suggestions of seminar participants at the Michigan Public Finance Free Lunch Seminar, the Michigan Economic History Workshop, and the National Tax Association 2014 Annual Conference, the Economic History Association 2015 Annual Meeting, and the Economic and Business History Society 2016 Annual Conference.

On a more practical level, I am grateful for financial support obtained from the Center for Local, State, and Urban Policy, the Office of Tax Policy Research, and the Department of Economics at the University of Michigan, as well as the Economic History Association for various projects included in this dissertation. Also, I thank the wonderful people from the Buhr Shelving Facility and the Spatial and Numeric Data Services at the University of Michigan Library. Special thanks go to Glen Vargo and Linfeng Li for exceptional research assistance.

When I was young, I thought happiness and sense of achievement are a monotonically increasing function of age, and there is a positive correlation between happiness and knowledge or wisdom. In the last few years, I learned from research, literature, and my own experiences that happiness is a U-shape function over age, and if anything, happiness and knowledge or wisdom seems to have a negative correlation. Maintaining morale has been a constant challenge throughout my PhD life. I feel indebted to the friendship, inspiration, and support from the following individuals at various stages of my PhD life: Lloyd Chia, Max Kapustin, James Kim, Changkeun Lee, Vu Thien Nguyen, Taejun Oh, Edith Ostapik, Ryoko Sato, Benjamin Thompson, Evan Wright, Lin Ma and many friends in Michigan's Sociology Department and Anthropology Department that I met through him, and many fellow economics PhD students coming from China in the entering classes of 2010, 2013 and 2014. I am sure I will miss Ann Arbor—my second hometown in many ways, and all these lovely people that I met there.

Finally, my wife, Xinyuan Zhang, to whom this dissertation is dedicated to, deserves a special recognition. My PhD journey spanned a long-distance relationship, a wedding, her master's study, and the birth of our son Paul. Through all these, she showed quiet resolve, endless patience, admirable fortitude, and provided support in many shapes and forms. For all these, I am eternally grateful.

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ABSTRACT

This dissertation studies highway construction in the United States in the interwar years and payments in lieu of taxes (PILOTs) that charitable nonprofit organizations pay to local governments.

The first chapter studies the impacts of Federal-Aid Highways on the evolution of retail trade in the 1920s. In the Roaring Twenties, the U.S. federal government strongly encouraged state highway construction with its Federal-Aid Highway program, as a result of which state highway spending increased dramatically. The same decade saw a 36 percent decline in general stores. I offer causal evidence that these two developments were related: that increasing highway spending by 10 percent would reduce the number of general stores by 30 percent. General stores in rural communities and more sparsely populated counties exhibited greater sensitivity to highway spending. These results speak to the decline of rural trade center during the early twentieth century and show one of the many ways that highway construction in the interwar years literally and figuratively altered the landscape of the American economy.

The second chapter studies the impact of Federal-Aid Highways on improvements in education in the U.S. South. During the 1920s and early 1930s, public school enrollment and per student spending both increased substantially, and education disparities between whites and African Americans widened in the South. I find that spending on the Federal-Aid Highway program might play a role in explaining these significant changes in education: more spending on Federal Highways is associated higher per student spending, especially in white schools, longer school year in black schools, and modest increase in enrollment; highway spending is also associated with a widening per student spending gap. The spatial distribution of highway spending matches well with that of the Rosenwald schoolprogram, a massive philanthropic program in the

early twentieth century to improve African American education. The evidence is consistent with the hypothesis that highway expenditure attracted external investments (in this case philanthropic investment in education), which improved educational outcomes.

The third chapter, coauthored with James Hines and Jill Horwtiz, studies the determinants and the effects of payments in lieu of taxes (PILOTs). Nonprofit charitable organizations are exempt from most taxes, including local property taxes, but U.S. cities and towns increasingly request that nonprofits make payments in lieu of taxes (known as PILOTs). Strictly speaking, PILOTs are voluntary, though nonprofits may feel pressure to make them, particularly in high-tax communities. Evidence from Massachusetts indicates that PILOT rates, measured as ratios of payments to the value of local tax-exempt property, are higher in towns with higher property tax rates: a one percentage point higher property tax rate is associated with a 0.2 percentage point higher PILOT rate. PILOTs appear to discourage nonprofit activity: a one percentage point higher PILOT rate is associated with 0.8 percent lower real property ownership by local nonprofits, 0.2 percent lower total assets, and 0.2 percent lower revenues of local nonprofits. These patterns are consistent with voluntary PILOTs acting in a manner similar to low-rate, compulsory real estate taxes.

Of the two broad topics explored in this dissertation, one (Federal-Aid Highways constructed in the interwar years) fundamentally changed the way Americans traveled and was claimed to have pivotal impacts on in long-term economic growth and economic integration nationwide, the other sees ever-increasing popularity in policy discussions in an economy of a growing non-profit sector and cash-strapped local governments. But neither has been extensively studied before. I hope readers will find this dissertation to be a useful contribution to our understanding of both topics, and I hope this will be the first of many dissertations written on these topics.

Chapter 1: Interwar Highways and the Demise of the General Store

1.1 Introduction

The retail sector in the United States has undergone many transformations during the last one hundred years. Small, independent retailers gave way to national chains of discount general merchandise stores such as Kmart and Wal-Mart and specialty chains such as Home Depot and Best Buy, which are now being challenged by online shopping firms like Amazon.com. The massive restructuring and reallocation in the 1990s was largely attributed to the adoption of information technologies. However, one primary cause of the decline of general stores and rural trade centers in the 1920s and the 1930s was massive improvement in roads.[1] In this chapter I attempt to closely examine the impact roads have on retail trade.

From the 1910s to 1940, the United States witnessed the birth of modern retailing: small, independent retailers were displaced by chain stores and department stores. Retail trade shifted away from small stores at crossroads to outlets located at bigger trading centers. In this study, I focus on one particular type of retail outlet—the general store. The reason to focus on general stores is that they used to dominate the retail landscape, but experienced a dramatic decline in the 1920s. In a sample of eight states, the total number of general stores fell by 36 percent from 1922 to 1930. I define general stores as small, independent retailers that carried both food products and general merchandise. In this chapter, "country general stores"—which were "stores located in places of less than 10,000 population and handled both foods and a general line of other merchandise like dry goods, clothing and shoes"—are called rural general stores. "General merchandise

[1] Foster et al. (2006) documented the massive changes and restructuring of U.S. retail trade in the 1990s. *Recent Economic Changes*, pages 331 to 336 and *Selected Articles on Trends in Retail Distribution*, pages 295 to 301 discussed the role that roads and the automobile played in changes in retail trade in the 1920s.

stores"—which were small, "non-departmentalized general stores in places of more than 10,000 population, with annual sales less than $100,000"— are called urban general stores.[2]

At the same time, America experienced a transportation revolution during the interwar period. As a response to the exponential growth of automobile ownership and an ever-increasing demand for road transportation, Congress passed the Federal-Aid Highway Act of 1921 to build a national network of Federal-Aid Highways, commonly known today as "U.S. Routes". In the 1920s, governments collectively spent an average of $199.8 million dollars per year, or approximately 0.22 percent of GDP, on roads. Over 90,000 miles of roads were worked on, and solid progress was made toward the completion of this national highway network.[3] Before the Eisenhower Interstate Highway System, highway construction in the 1920s and 1930s signified the first of two massive highway building episodes in U.S. history. It contributed significantly to the total factor productivity (TFP) growth in the 1920s and 30s and played a pivotal role in making the United States the most highway-dependent nation in the developed world.[4][5] Yet highway construction during the interwar years has been under-studied because of data challenges. To my knowledge, this study is the first that uses micro data to evaluate its impact.

To estimate the effect of highway construction on general stores, I collected county-level retail establishment data from contemporary commercial magazines, and county-level highway data from state highway department reports. My sample consists of eight states from the South and the Midwest. I worked hard to ensure that the categorization of retail outlets was consistent across different sources. Because the word

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[2] "Country general stores" and "general merchandise stores" are two categories in the 1929 Census of Distribution. Those quotes are definitions given on pages 104 and 107 of the summary the Census.

[3] National aggregate data cited in this study come from *Historical Statistics of the United States, Millennium Edition* unless otherwise noted. The mileage number adds up "mileage completed" during each year. Because the figure is likely to contain sections that were improved more than once—for instance, from improved dirt to macadam, and then to concrete—one should not interpret the figure to mean that the Federal Highway system was extended by 90,000 miles throughout the decade.

[4] For highway's contribution to TFP, see calculations in Field (2012).

[5] On America's reliance on highways: According to one OECD report published in 2013, the U.S. only ranked behind Estonia and Portugal in volume of traffic per unit of GDP in 2011. See http://www.oecd-ilibrary.org/environment/environment-at-a-glance-2013/road-traffic-vehicles-and-networks_9789264185715-20-en

"highway" could refer to any intercity road in the early twentieth century, and because there was significant heterogeneity among state highways within and across states, I focus on Federal-Aid Highways, and use total spending on the construction of Federal-Aid Highways from 1921 to 1930 to measure highway activity in the 1920s.

Reduced form results suggest that more highway spending is strongly correlated with sharper decline of general stores. To address the concern of endogenous placement of highway spending, I use a county's relative location to a virtual highway network as well as the presence of bodies of water as instrument variables for highway spending. The preferred point estimate from instrumental variable regressions suggests that a one-standard-deviation increase in total spending on Federal-Aid Highway construction from 1921 to 1930 increased the decline in the total number of general stores by 4.44 more percentage points between 1922 and 1930. The impact is even larger for general stores in places with less than 2,500 people: a one standard deviation increase in total highway spending in the 1920s reduced the number of stores by 15 to 26 percent. The effect on rural general stores is larger than for all general stores, suggesting that improvement in road conditions might have enabled more consumers to shop at county seats, which fits into contemporary observations at that time about the impact of highways on the decline of rural trade centers.

My study complements existing studies on the impact of transportation infrastructure in the following ways. First, while historians generally agree on the crucial importance of highway construction during the interwar years, this chapter is the first to quantitatively evaluate the impacts of this massive but under-studied infrastructure program. Moreover, many studies have shown that highways or railroads stimulated the economy and promote long-term economic growth. However, the main results of my study suggest that the changes in retail landscape brought about by new highways did not benefit all communities or business entities.

The welfare consequences of the decline of the general store were ambiguous. On the one hand, the demise of general stores speaks to the decline of rural trade centers during the early twentieth century. Less retail trade in rural areas meant fewer social interactions that came with it, which then might adversely affect social networks and social capital in rural communities. With closures of the general store, some Southern tenant farmers and sharecroppers lost their only access to credit. But on the other hand, these farm hands were liberated from the perpetual debt cycle under the crop-lien system. The chain specialty stores, supermarkets, and department stores that replaced general stores exhibited economies of scale. While consumers might have to drive farther to shop, they were offered lower prices and more varieties. The demise of the general store was likely to be a creative destruction process. The impact on general stores is only one of the many channels through which the construction of highways in the 1920s literally and figuratively altered the landscape of the American economy.

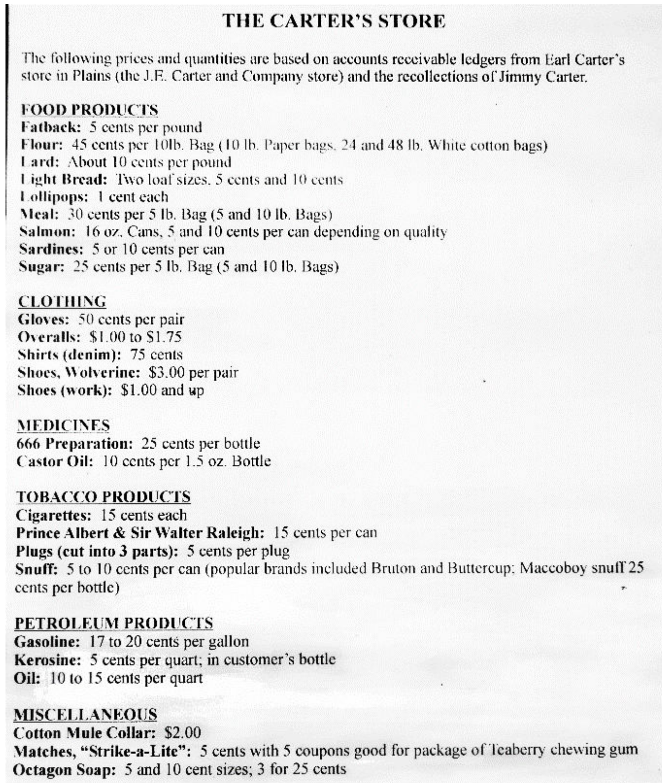
1.2 General Stores and Highway Construction in the 1920s

1.2.1 The Historical Significance of General Stores

At the beginning of the twentieth century, except in a few big metropolises, small, independent retailers dominated the retail landscape. Among them, the general store occupied a significant position. Table 1.1 shows that, in 1909, general stores were 10.6 percent of the U.S. retail sector, and that in 1919, general stores still represented 9.3 percent of retail sales. Statistics by types of goods in Table 1.2 show that 14 percent of manufactured food products (salt, sugar, dry meat, and others), 19 percent of tobacco products, and 16 percent of textiles were sold at general stores in 1919. Most of these stores were in rural communities or small towns with less than 10,000 people, and were often referred to as "country general stores". But some were found on the outskirts of large cities. For my purpose, characteristics other than location determine whether a store is classified as a general store. In this chapter, I consider every small, independent store that sold both foods and other merchandise to be a "general store".[6] Figure 1.1 provides a list of products carried by the general store that Earl Carter, President Jimmy Carter's father, operated in the early 1930s.

[6] Classifications of retail establishments will be discussed more extensively in the Data section.

Figure 1.1: A list of Goods and Prices at Earl Carter's General Store.



THE CARTER'S STORE

The following prices and quantities are based on accounts receivable ledgers from Earl Carter's store in Plains (the J.E. Carter and Company store) and the recollections of Jimmy Carter.

FOOD PRODUCTS
Fatback: 5 cents per pound
Flour: 45 cents per 10lb. Bag (10 lb. Paper bags. 24 and 48 lb. White cotton bags)
Lard: About 10 cents per pound
Light Bread: Two loaf sizes. 5 cents and 10 cents
Lollipops: 1 cent each
Meal: 30 cents per 5 lb. Bag (5 and 10 lb. Bags)
Salmon: 16 oz. Cans, 5 and 10 cents per can depending on quality
Sardines: 5 or 10 cents per can
Sugar: 25 cents per 5 lb. Bag (5 and 10 lb. Bags)

CLOTHING
Gloves: 50 cents per pair
Overalls: $1.00 to $1.75
Shirts (denim): 75 cents
Shoes, Wolverine: $3.00 per pair
Shoes (work): $1.00 and up

MEDICINES
666 Preparation: 25 cents per bottle
Castor Oil: 10 cents per 1.5 oz. Bottle

TOBACCO PRODUCTS
Cigarettes: 15 cents each
Prince Albert & Sir Walter Raleigh: 15 cents per can
Plugs (cut into 3 parts): 5 cents per plug
Snuff: 5 to 10 cents per can (popular brands included Bruton and Buttercup; Maccoboy snuff 25 cents per bottle)

PETROLEUM PRODUCTS
Gasoline: 17 to 20 cents per gallon
Kerosine: 5 cents per quart; in customer's bottle
Oil: 10 to 15 cents per quart

MISCELLANEOUS
Cotton Mule Collar: $2.00
Matches, "Strike-a-Lite": 5 cents with 5 coupons good for package of Teaberry chewing gum
Octagon Soap: 5 and 10 cent sizes; 3 for 25 cents

Source: On display at the Jimmy Carter National Historic Site in Plains, GA. Ledgers were from the early 1930s. Photo credit: Author, August 2015

Earl Carter's store turned out to be a representative case: Table 1.2 listed categories of products of which a significant portion were eventually sold at general stores. These include manufactured foods, dry goods and notions, tobacco, shoes, and farming equipment.[7] Vance and Scott (1994)'s general stores' popular items list also looks strikingly similar:

> Food products: salt, sugar, coffee, tea spices, and dry meat, among others
> Tobacco and cigars
> Lanterns and kerosene
> Dry goods: linens, piece goods, and notions
> Farm equipment: ropes, harnesses, and yokes, among others
> Household essentials: pins, needles, toiletries, and soaps, among others.[8]

[7] Dry goods and notions are materials for homemade clothing. This and farming equipment reflects that most general stores were in small towns and rural communities where the economy was largely agricultural and self-sufficient during this period.
[8] Vance and Scott (1994), page 17.

Figure 1.2 depicts a typical country general store from this era.

Figure 1.2: The Exterior of a Country General store in South Carolina.

Source: Rural Commerce in Context: South Carolina Country Stores: 1850-1950, New South Associates (2013), page 6.

“The store was usually a two-story frame building, painted white, and fronted by a raised porch for convenient loading and unloading. When visitors entered the store, they were met with dim light, long counters, rounded glass show cases, and side walls lined with shelves, drawers, and bins. Other items such as buggy whips, horse harnesses, lanterns, pails, ropes and more hanged from the ceiling. Produce, nuts, beans, and nails were stored in bins, usually on the floor or against a wall. Shelves not only contained food stuffs, but, also fabric and sewing notions, household items, soaps, medicines, spices, crockery and dishes, cartridges and shells, and small farm implements. Generally, there were no side windows, contributing to the dark interior.

“Sitting on the counter tops, shoppers might find merchandise that included stacks of overalls, denim and khaki pants, candy jars, tobacco, and all manner of other products. Also sitting on the counter, one would usually see the cash register, a coffee mill, scales for weighing grocery items, and a wrapping paper unit with string attachment. Virtually, the counter tops would be filled with merchandise, leaving only enough room for purchases, and wrapping of the items. Between floor to ceiling shelves that lined the walls, and the multitude of items sitting atop and below the counters, visitors would find a pot-bellied stove surrounded by a couple of chairs, a coal bucket, the ever present spittoon, and yes, a checkerboard sitting atop an empty nail keg. Elsewhere, in the narrow passage way that was the middle of the store, could be found barrels that might contain any number of items -- from pickles, to crackers, potatoes, mincemeat, and more candies." [9]

The business practices of these general stores were very different from any modern retailer. First, it was not uncommon for shoppers not to pay in full when the transaction took place. Sometimes a storekeeper took the shoppers' produce in exchange for cash payment and then shipped the produce to an urban market. In the South, tenant farmers typically used next year's cotton crop as credit to purchase needed goods during the year.[10] Second, prices were often not transparent. Transactions involved haggling with the storekeeper; favored customers were offered discounted prices. Third, there was no self-service. A counter divided the customer and the shopkeeper with his merchandise. Table 1.2 also shows that general stores got almost all their merchandise (98 percent) from a wholesaler, not directly from producers.

General stores served important social functions. In many rural communities and small towns, people not only went to a general store to shop, but to also exchange information, see notices, and discuss politics. Moreover, it was not uncommon for the general store building to house the local post office, making it a social center of the community. General stores in the postbellum South were pillars in the financial system. They provided many sharecroppers and tenant farmers their only access to credit, albeit at high rates of interest.

1.2.2 The Decline of the General Store

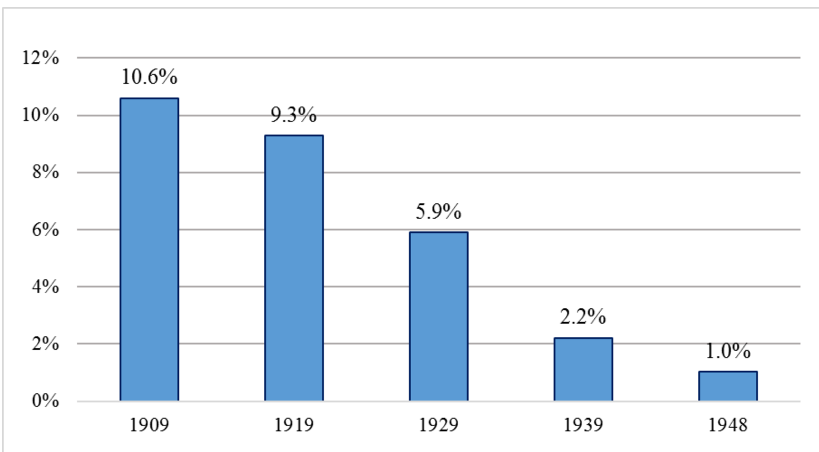
The general store experienced a significant decline in the interwar years. As seen in Figure 1.3, the share of total retail sales that went through general stores declined from 9.3 percent to 5.9 percent during the 1920s, a remarkable 36 percent decline. The demise of general stores continued during the Great Depression. By the end of World War II, general stores had become a much diminished institution in the retail sector, carrying

[9] This vivid webpage description of the ambience in a country general store in the early twentieth century is from the webpage http://www.legendsofamerica.com/ah-countrystores.html.
[10] This crop-lien credit system is discussed extensively in Chapter 7 of the classic by Ransom and Sutch (2001) *One Kind of Freedom, 2nd Edition.*

only 1 percent of total retail sales. Table 1.2 shows that the general stores' importance in the distribution of its main merchandise also diminished significantly. For example, its share in shoe sales fell from 15 percent to 11.1 percent, and its share in manufacturing food sales dropped from 14 percent to 10.3 percent. In the eight states that I study, the total number of general stores decreased by 44 percent, and the total number of general stores in places with less than 10,000 people decreased by 30 percent.[11]

Since the late nineteenth century, general stores had been on a steady decline for decades because of competition from specialty stores and the mail-order business. The rising standard of living called for specialty stores that offered more variety and often more fashionable items. After rural free delivery (RFD) was adopted nationwide in 1902, mail-order houses took advantage and began to deliver goods advertised through magazines. But such competitions could not explain why the decline of the general store was "markedly accelerated since 1920."[12] Contemporary researchers attributed the

Figure 1.3: The Share of Retail Sales Through General Stores, 1909-1948.



Source: Barger (1955), pp. 121-124.

significant decline of the general store in the 1920s mainly to the adoption of automobiles and good roads. For example, Melvin Copeland of Harvard, a contributing author to *Recent Economic Changes* (1929), observed that

[11] More discussions about retail establishment data that I use and sample in the Data section.
[12] *Recent Economic Changes*, page 331.

> "The chief feature of this change (in buying habits of consumers) was a major shift in retail trading areas away from crossroads stores, village stores, to stores located at county seats and other trading centers.… The primary causes for the change in trading areas that has occurred have been the increased use of automobiles and the construction of good roads."[13]

Berger (1979) cited this observation from a 1925 publication

> "When the automobile and good roads brought us into competition with the outside world, the town was dazed. Then stores modernized and prices were reduced. A few of the inefficient places gave up. There was consolidation."[14]

Vance and Scott (1994) seemed to agree with this narrative as well:

> "The greater mobility of rural shoppers due to the increasing use of the automobile and the expansion of improved roads shaped major changes (in retail trade) in the 1920s."[15]

1.2.3 Federal-Aid Highways in the Interwar Years

"The construction of good roads" mentioned in these studies refers to the nationwide construction of highways in the 1920s. In the early twentieth century, the word "highway" meant something very different than it does today. At the turn of the twentieth century, any intercity road could be referred to as a "highway," even those that were narrow unimproved dirt roads. It is helpful therefore to clarify that in this dissertation, I only study Federal-Aid Highways.[16] Both the route selection and the completion of all Federal-Aid Highway projects were subject to federal supervision. This makes Federal-Aid Highways more comparable than state highways in different states, in terms of both engineering standards and their relative economic importance.

The construction of Federal-Aid Highways in the 1920s was a response to ever-increasing demand for road transportation. First and foremost, the exponential growth

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[13] *Recent Economic Changes*, page 331 and 336.
[14] Berger (1979), page 112. Berger cited a 1925 study published by the Houghton Mifflin Company in Boston named *A Study of Rural Society: Its Organization and Changes*. The quote was attributed to an unnamed small-town editor.
[15] Vance and Scott (1994), page 21.
[16] My study is therefore different from a recent unpublished paper by Hoa Nguyen (2015) of the University of Arizona. She uses all state highways and investigates the interaction between automobile ownership and road building.

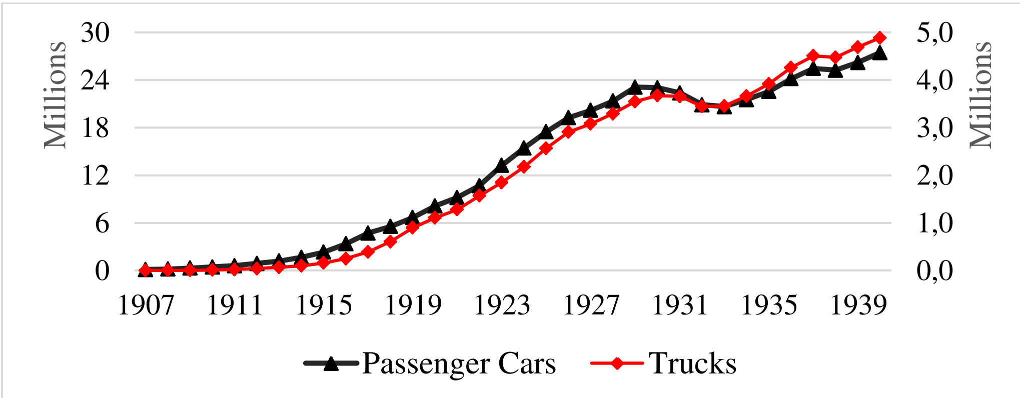
in passenger cars as well as the emerging trucking industry in the 1910s called for more long-haul intercity transportation and better roads. (See Figure 1.4.) Portland cement, which had a much shorter curing time and was excellent for road building, became increasingly available. This development made the large-scale construction of all-weather, hard-surfaced roads more feasible. During World War I, Congress realized that the railroad system was not sufficient for the rapid movement of goods and personnel. Congress passed the Federal-Aid Highway Act of 1916, which pledged a total of $75 million over five years for the construction of rural post roads. Starting in 1920, Congress authorized the U.S. army to transfer about 22,000 idle World War I trucks and over 20,000 tons of left-over explosives to state governments. The trucks were used to haul gravel and stones, and explosives to blast rocks. This large capital injection from the federal government boosted the states' highway building effort. Then Congress passed the Federal-Aid Act of 1921, which appropriated $75 million of federal funds for highway construction per year for the next ten years. Moreover, the Act required that states established highway departments to administer federal aids, and limited the usage of federal money to 7 percent of existing state mileage. These clauses ensured that highways would be connected and form a national highway network.

This landmark legislation kick-started the highway boom in the 1920s. From 1922 to 1930, average annual federal spending on highways was $85.56 million. The average federal and state government spending on highways was $197.38 million per year, which amounted to 0.22 percent of U.S. GDP and 13.6 percent of non-defense federal spending over this period.[17] To provide some metrics to interpret the magnitude, from 1917 to 1921, total government spending on highways was $222 million, which accounted for 0.058 percent of GDP over that period. In other words, total highway spending as a share of GDP went up by 368 percent after the Federal-Aid Highway Act of 1921. Figure 1.5 compares the relative magnitude of highway spending from 1921 to 1970. During the peak of

[17] Highway expenditure statistics come from the U.S. Federal Highway Administration's *Highway Statistics (1967)* and annual issues thereafter. Numbers include both federal and state funds. Numbers include both construction and maintenance costs. Non-defense federal spending data come from the U.S. Department of Treasury's *Statistical Appendix to Annual Report of the Secretary of the Treasury (1970)*. I exclude defense spending, interest payments, and veterans' compensations and pensions from the total federal expenditure. GDP figures come from https://www.census.gov/statab/hist/HS-32.pdf. All figures are in current dollars.

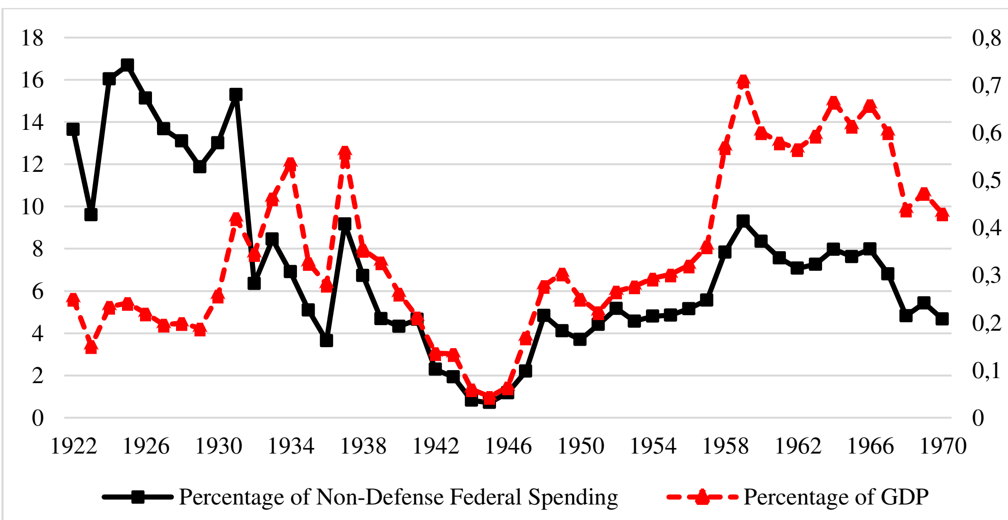
Interstate Highways construction (1957—70), total highway spending was on average 0.56 percent of GDP and 7.02 percent of non-defense federal spending. In 2014, government spending on highway construction amounted to about 0.35 percent of GDP.[18]

Figure 1.4: U.S. Motor Vehicle Registrations, 1907 to 1940.



Source: U.S. Federal Highway Administration, Highway Statistics (1997), Table MV-200. Notes: The scale for passenger cars is on the left. The scale for trucks is on the right. Data represent the national stock of motor vehicles.

Figure 1.5: Relative Magnitude of Highway Spending, 1921 to 1970



Sources: U.S. Federal Highway Administration's Highway Statistics, U.S. Department of Treasury's Statistical Appendix to Annual Report of the Secretary of the Treasury (1970)., U.S. Census Bureau. See footnote #17 for details. The scale for the percentage of non-defense spending series is on the left. The scale for the percentage of GDP series is on the right.

[18] The highway spending figure for 2014 comes from the Congressional Budget Office (CBO). See Exhibit 17 of https://www.cbo.gov/sites/default/files/114th-congress-2015-2016/reports/49910-Infrastructure_FigureData_0.xlsx. GDP and GDP deflator data are from BEA: http://www.bea.gov/iTable/ (Table 1.1.5 and Table 1.1.9)

Compared to modern superhighways like the Eisenhower Interstate Highway System, Federal-Aid Highways built in the 1920s were subject to much lower design standards. For example, the Interstate is controlled-access, while Federal-Aid Highways in the 1920s were typically open-access. Most Interstates have two lanes in each direction, twelve-foot-wide lanes, and wide shoulders. Federal-Aid Highways outside big cities almost always had only two lanes eight to ten feet wide, almost non-existent shoulders and medians, and sometimes steep grades. But compared to what they replaced, these hard-surfaced, all-weather roads represented a huge improvement.[19] A telling testimony of this improvement is how much faster transcontinental road travel became in a span of ten years. In the summer of 1919, a group of army men spent 62 days and six broken trucks driving across America from Washington D.C. to Oakland, California.[20] In 1930, a trip from Los Angeles to New York on a Greyhound bus took about seven days. The Greyhound Lines rose to national prominence in the 1920s, and buses accounted for a quarter of intercity passenger miles.[21] These developments in the busing industry would not be possible without the huge improvement in roads.

The Interstate routes are few and far between, whereas the system of Federal-Aid Highways had more routes and penetrated more areas. In my sample, only 230 out of 947 counties are passed through by an Interstate, but 846 counties had at least one federal-aid highway project by 1930.[22] Figure 1.6 below provides visual evidence of the difference in route density between these two highway systems in Kansas. Clearly, Federal-Aid Highways brought improvement in road conditions to a lot more areas. It was very plausible, therefore, that highways changed the market access of many areas and thus had a widespread impact on local economies, especially on the retail landscape.

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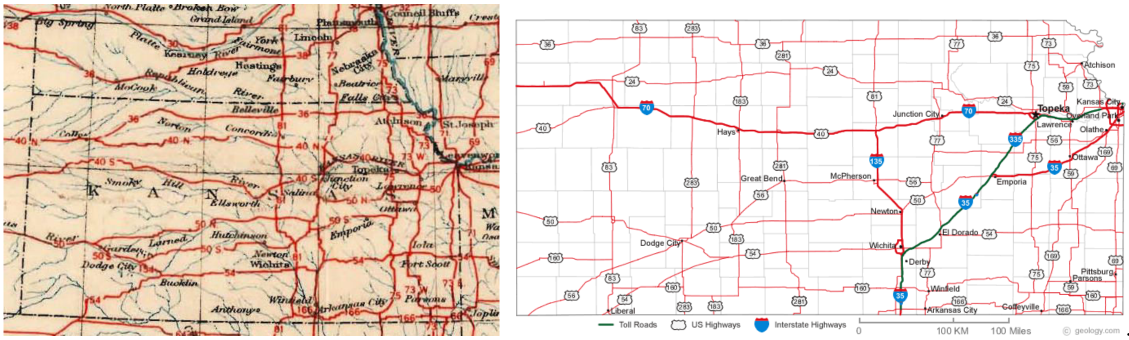
[19] Not all Federal-Aid Highways built in the 1920s were paved. This is because the network of Federal-Aid Highways was more far-reaching than the Interstates. These highways reached most county seats. For many counties, there was not enough demand for more expensive paved roads.

[20] Dwight Eisenhower participated this first Army transcontinental motor convoy. The experience from this trip and his witness of the *Reichsautobahn* inspired him to champion the Interstate Highway System. For more information about this trip, see http://www.eisenhower.archives.gov/research/online_documents/1919_convoy.html.

[21] See on http://greyhoundhistory.com/ and in Walsh (2000), page 27.

[22] The count of number of counties having Interstate(s) uses data used in Michaels (2008). The count of number of counties having federal-aid projects in the 1920s comes from my own data.

Figure 1.6: Comparison of Highway Density: Federal-Aid Highways vs the Interstates



Source: (left) the 1926 Map of Designated U.S. Highways, Bureau of Public Roads, (right) present-day highway map from geology.com. The thick red routes with the blue-red shield signs as well as the routes in green are Interstates.

1.3 Highway and Retail Data

1.3.1 Highway Data and Measure

Highway construction during the interwar years was as economically significant as the railroad revolution in the latter half of the nineteenth century, and the Eisenhower Interstate Highway System built in the third quarter of the twentieth century. Interwar highway construction played a pivotal role in making roads to replace railroads as the dominant mode of transportation on land. Despite its significance, it has been under-studied by economists. To the best of my knowledge, mine is the first study to use micro data to evaluate the impact of interwar highway construction.

This attention deficit has been caused primarily by data availability. Historical records on the Interstate Highway System were synchronized and many of them digitized by the Federal Highway Administration. During the interwar years, the federal government did not keep record of highway activities. Information was scattered in state highway department reports to the state legislatures.[23] This is primarily because states bore the bulk of the fiscal burden of in building and maintaining these highways. Besides their different formats, frequencies, and levels of details, the biggest challenge of processing these reports lie in the lack of uniformity and comparability of concepts mentioned in these documents.

[23] As requested by the Federal-Aid Highway Act of 1921, states established highway departments to administer the usage of federal aid money. State highway departments or commissions reported to state legislature annually or biennially.

(Snapshots of state highway reports can be seen in the Appendix A-1.) Judging by total mileage, type of surface, and cost of construction per mile, “state highways” and “state trunk-line systems” in Michigan represented totally different types of roads than “state highways” in Georgia and Kansas. To make my subject of analysis more comparable across states, I focus only on Federal-Aid Highways. Admittedly, the Federal-Aid Highways were not subject to a set of clear engineering standards as were the Interstate Highways. But because their routes constituted the network of U.S. Routes and they were subject to federal supervision upon completion, they should be therefore considered the best-built intercity roads, and are more comparable across states.

The data collection process involved sorting through more than 11,000 pages of state highway authority reports covering highway construction from 1921 to 1930. I constructed a panel dataset of Federal-Aid highway construction from 1921 to 1930 for eight states: Indiana, Michigan, Wisconsin, Missouri, and Kansas represent the Midwest, and Georgia, Texas, and Alabama represent the South. The dataset contains county-level information on total expenditure on highway construction, construction expenditure by type of surface, completed highway mileage, and mileage by type of surface on annual or biennial basis.[24]

I recorded only variables on construction because maintenance included expenses on regular patrol, beautification, snow removal, and the like, which did not represent real improvement in road conditions. To avoid double counting, I only included accounts of “completed projects” from each report. To ensure that only Federal-Aid Highway projects were included, I either only used “Completed Federal-Aid Projects” or “Federal-Aid Expenditure” tables, or only included projects that reported positive federal aid, or that had an “FA” or “F” label. In some years, Michigan and Wisconsin did not distinguish “federal-aid” projects from “state trunk system” projects. I settled for “state trunk system” projects as a proxy.[25]

[24] Of the eight states, Indiana, Georgia, and Alabama had highway reports annually; Texas and Michigan issued reports biennially but annual data were available; only biennial data were available for Missouri, Wisconsin, and Kansas for this period. States had (and still have) different start and end dates of fiscal year.

[25] These should be fine because the resulting summary statistics—highway expenditure per capita, expenditure per mile for a given type of surface, and mileage per square mile—are all comparable with

For regression analysis, I use total expenditure on highway construction from 1921 to 1930 as my measure of highway activities. I aggregate highway expenditures to ten-year totals primarily because the outcome variables were only available in two years (1920 and 1930). Also, the year-to-year fluctuation in highway spending might reflect politics in governments and budgetary constraints and did not help to explain structural changes in the economy. I prefer expenditure to mileage because mileage variables may have been double-counted. Suppose three miles of roadway were improved from dirt to gravel in 1924 and then turned into a section of concrete-surfaced highway in 1928. Then the mileage recorded for 1921-30 would be six miles whereas only 3 miles were actually improved. Using the same example, one could also see that only using the hard-surfacing expenditure variable would underestimate the actual spending level: it would only capture costs incurred in the surfacing step of the project, and it would only include those hard-surfaced projects.

Table 1.3 gives an overview of Federal-Aid Highway construction in the 1920s in the eight states that I study. Echoing Figure 1.6, the data show that the coverage of Federal-Aid Highway construction was broad: 89 percent of counties (846 out of 946) reported having a Federal-Aid project in the 1920s, whereas only 24 percent of them (230 out of 946) were on one or more primary Interstate route(s).[26] 53 percent of counties reported having at least one hard-surfaced highway project (i.e. highways paved with concrete or asphalt). The difference between this statistic and the 89 percent statistic reflects that there was not enough demand for a paved highway in many counties, especially some rural counties in the South. Another factor to consider is that there was ongoing construction in 1930—many roads were paved shortly after 1930. The percentage of counties having paved highways and the percentage spent on paved highways shows a sharp contrast between the South and the Midwest. The discrepancy between the number of counties reportedly having Federal-Aid projects and the number of counties shown to have a U.S. Route was likely due to that state governments did not allocate all the federal funding in building thoroughfares. Some Federal-Aid projects

summary statistics from other states. And the sum is on the same order of magnitude as the reported state total in U.S. Statistical Abstract.

[26] Primary Interstate Highways are those that have one- or two-digit designations. These are thoroughfares, to be distinguished from those auxiliary three-digit Interstates in and around urban areas.

were earmarked to serve only local interests. Hence, most but not all Federal-Aid projects were designated as U.S. Routes.

Figure 1.7 below shows the geographical variation of highway spending during the 1920s. The data reported in this figure are not weighted by, and do not control for, any variable. Counties in Wisconsin and Michigan, two of the most industrialized and prosperous states in my sample, tend to have very high levels of highway spending. The eastern part of Texas and counties along the I-70 corridor in Missouri also showed a high level of highway construction. Underdeveloped and sparsely populated regions, such as western Texas, western Kansas, and some Ozark Highland counties in Missouri, had little or no highway activity.

1.3.2 General Store Data and Measure

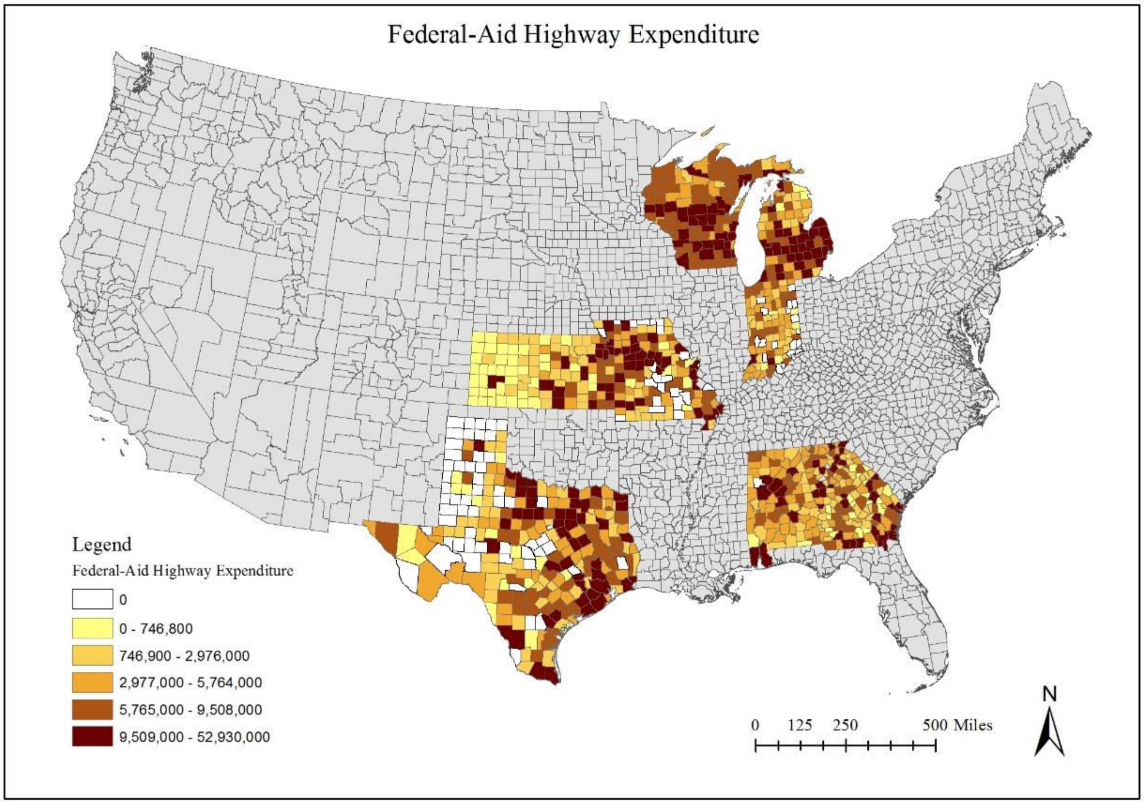
For information on general stores, I used newly collected data tabulated in contemporary commercial magazines to supplement the first Census of Distribution in 1929. In the 1920s, major publishing companies published statistical summaries of the economy. Along with other statistics, this information on retail trade was meant to help manufacturers, advertising agents, and salesmen to "secure the most efficient and economical distribution of merchandise."[27] [28] Publishers certainly believed that such data were informative about "buying centers" (i.e. retail trade areas), which suits my purpose of understanding changes in retail landscape through general stores.

Specifically, I collected information on numbers of retail establishments from the following three sources. *National Markets and National Advertising* published by the Crowell Publishing Company in 1923 (hereafter Crowell), *Women's World County Handbook of national Distribution*, published by Women's World Magazine in 1923 (WW), and *Markets and Quotas, A Study of Counties and of Cities with Population of 10,000 and Over* by the Curtis Publishing Company in 1932 (Curtis). Crowell and WW

[27] Other economic statistics include value of agricultural products, wage in manufacturing, automobile ownership and sales, consumers of electricity and gas, bank deposits, number of income tax returns, and circulations of various magazines.
[28] The quote is on the dedication page of the *Women's World's County Hand Book of National Distribution* published in July, 1923.

used different data sources but both recorded counts of retail outlets in 1922.[29] The 1929 Census of Distribution was not taken until the spring of 1930.[30] Both the Census and Curtis recorded number of retail establishments and sales by category (of retailers) in 1930. There are no data on general stores between 1922 and 1930.[31]

Figure 1.7: Geographical Distribution of Spending on Highway Construction, 1921-30



Source: Author's Calculations. Except for those with no highway expenditure, the remaining counties are equally divided into five bins based on highway spending level. They are then represented by five colors, with the darkest color representing counties with the highest level of highway spending.

One challenge in merging these data was to match these different sources which categorized retail outlets differently. To make matters worse, three out of four sources—except for the Census—did not clearly explain criteria of their categorizations.

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[29] WW's source for retail outlets was actual counts of retail outlets on R. G. Dun & Co.'s September, 1922 list. Crowell used R. L. Pol's Census of Retail Outlets of 1922. 1922 seems to be the earliest year for which such nationally-representative enumeration data were available. Information about the retail sector in earlier years were on small store surveys (N < 200) in few big cities.

[30] Barger (1955), pp. 105.

[31] The Curtis Publishing Company's publications in 1925 and 1927 only had information on department stores with annual sales of more than $100,000 (in current dollars), grocery and drug stores with annual sales of more than $50,000.

So I started with the definitions in the Census of Distribution documentation and found reasonable matches in the other sources. My definition of a *general store* is a small, independent retailer that carried both food products and general merchandise. The 1929 Census of Distribution defined "country general stores" as "general stores in places of less than 10,000 population". Further, the documentation specified that country general stores carried both food and "other merchandise" such as clothing, a limited line of shoes, dry goods, and notions. Separately, "general merchandise stores" were defined as "non-departmentalized general stores in places of more than 10,000 people, or departmentalized general stores having annual sales of less than $100,000". "General merchandise stores" also carried both food and other merchandise. The sum of these two types of outlets in the Census fits my definition of the general store well. Furthermore, it is useful to define the stores in the "country general store" category as general stores in rural areas, or *rural general stores*, and those under the "general merchandise" umbrella as general stores in urban places, or *urban general stores*.

Table 1.4 compares the total number of outlets of selected categories in different publications. It is obvious from Table 1.4 that retailers that were labeled as "general merchandise" in Crowell were the same as the "country general stores" in the Census, which are general stores in places with population less than 10,000, and that those were labeled as "departmentalized stores" in Crowell were in fact those "general merchandise stores" in the Census, which are as the general merchandise stores in places with more than 10,000 people but with annual sales of less than $100,000. Throughout this chapter, I call the former "rural general stores" and the latter "urban general stores". For store counts in 1922, I chose Crowell over WW because overall, the categories Crowell used more closely resembled those of the Census. For store counts in 1930, I chose the Census over Curtis because it was obvious from Table 1.4 that the Curtis counts seemed to be a subset of the Census figures, leading to concerns that the Curtis compilation might be incomplete. Results shown in this chapter are not sensitive to these choices.

Figure 1.8 offers a scatterplot of the total number of general stores (rural and urban combined) in 1922 versus the total number of general stores in 1930. The imposed red line is the 45-degree line if the figure is drawn to scale; it is not the fitted line of a linear regression. Most dots are above the line, reflecting the fact that the number of general stores declined, often quite remarkably, in most counties over the eight-year period. More importantly, one can see a clear upward trend—meaning places that had more general stores in 1922 still had more general stores in 1929. This rank-preserving phenomenon lends support to my interpretation that these selected variables in two different years measure the same type of retailers.

My primary outcome variables are growth rates of the number of general stores between 1922 and 1930.[32] These include the growth rate of general stores overall, as well as growth rates of rural general stores and urban general stores separately.

Figure 1.8: A Scatterplot of the Total Number of General Stores, 1922 vs 1930.

Source: Author's Calculations. The red line is the 45-degree line, not the linear fit.

1.4 Empirical Strategy

The baseline estimation is a specification of the form:

$$g_{i,1922-30} = \beta_0 + \beta_1 \cdot \sum Hwy_i + \beta_2 \cdot N_{i,1922} + \gamma X_{1920} + d_s + \varepsilon_i \qquad (1)$$

where $g_{i,1922-30}$ measures the growth rate of the number of general stores, $\sum Hwy_i$ represents the (natural) logarithm of total highway spending from 1921 to 1930, $N_{i,1921}$ is the log of number of general stores in 1922. X_{1920} is a vector of control variables

32 The growth rate is the change in the number of retail establishments (1930 level – 1922 level) normalized by the 1922 level.

either measured in 1920 or time-invariant. d_s represents the set of state dummies, and ε_i is the error term.

A primary reason for including controls is to alleviate the omitted variable bias. For example, the log of the initial stock of general stores, $N_{i,1921}$, controls for "regression to the mean", the common statistical artifact that predicts counties that started with very few stores tended to grow faster. The coefficient on highway spending would have been bigger in absolute value without this control. Land area and population density controls are added because they were determinants of highway funding per Highway Act of 1921. Demographic variables, such as the share of black, foreign-born, and illiterate populations, are customarily included.

A group of geographical and climate variables are also included as controls: monthly average precipitation, monthly average temperature, access to major rivers—rivers that pass through 11 to 20, 21 to 50, and 50-plus counties, the range in elevation within the county, coastal access dummy, the number of lakes and swamps in the county.[33] Along with state dummies, these variables are meant to partially control for locational fundamentals that may affect the number of general stores. Separately, state dummies can capture unobserved state level variations such as anti-chain legislations that would affect the fate of general stores.

Moreover, I control for pre-trend and pre-existing economic conditions by adding population growth rate from 1910 to 1920, value of farmland per acre in 1920, as well as log of manufacturing output in 1920. Population growth rate from the previous decade is an effort to control for county-wide pre-trend that may affect changes in general stores in the 1920s. Land value and the amount of manufacturing activity measure prosperity of the local economy, which in turn might affect buying habits or change in shoppers' access to other retail outlets.

Counties are small geographical units, so the error term ε_i can be spatially correlated. To address this, the standard errors reported in all regression are clustered using economic regions defined by economic development agencies or organizations as

[33] A coastal access dummy is equal to one if the county is on the coast of the Atlantic Ocean, the Pacific Ocean, the Gulf of Mexico, or the Great Lakes.

of November, 2015. The idea of an economic region is that the state agency thinks the counties within the region are more inter-connected. I use these well-defined regions as clusters under the reasonable assumptions that (1) the spatial correlation of counties in different economic regions is negligible, and (2) patterns of spatial correlation between counties have not changed radically in the last 90 years. Altogether there are 84 economic region clusters.[34]

1.4.1 Instrumental Variables

Ideally, the specification (equation (1)) should be a difference-in-difference specification where *change* in highway spending is regressed on *change* in the number of general stores. In treating highway spending in the 1920s as the *change* in highway spending, I essentially assume highway spending before 1920 was zero. In most of the country, there was no Federal Highways built before 1920, but still, failing to include pre-1920 spending theoretically could be a concern.

A real threat to identification may be that highway spending was not randomly distributed, but distributed in response to economic conditions. If the government prioritized connecting booming places—which also attracted a lot of chain stores and other retail outlets and led to a more rapid decline of general stores—OLS regressions might overestimate the impact of highway spending. If instead the government treated the highway program as a stimulus package and allocated more funds to economically backward regions, or to places experiencing economic hardship, OLS regressions might underestimate the impact of highway spending.

I adopt an instrumental variable strategy to address these concerns. The instrumental variable strategy rests on a virtual highway network that predicts the highway spending

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[34] Texas: 13 regions. Source: http://txsdc.utsa.edu/Reference/GeoCountyCER.aspx
Alabama: 12 regions. Source:
http://ceds.alabama.gov/wp-content/uploads/2011/05/Statewide-Strategic-Plan-2-19-07.pdf
Georgia: 12 regions. Source: http://garc.ga.gov/latest-news-information/
Michigan: 10 regions. Source:
http://www.michiganbusiness.org/cm/Files/Collaborative_Development_Council/EDC-Map.pdf
Wisconsin: 9 regions. Source: http://www.forwardwi.com/map.php
Indiana: 11 regions. http://www.stats.indiana.edu/maptools/maps/boundary/economic_growth_regions.pdf
Kansas: no economic regions defined. 8 road districts defined at: https://www.ksdot.org/district_areas.asp
Missouri: 9 regions. Source: https://www.missourieconomy.org/regional/index.stm.
All the webpages were accessible as of February 2016.

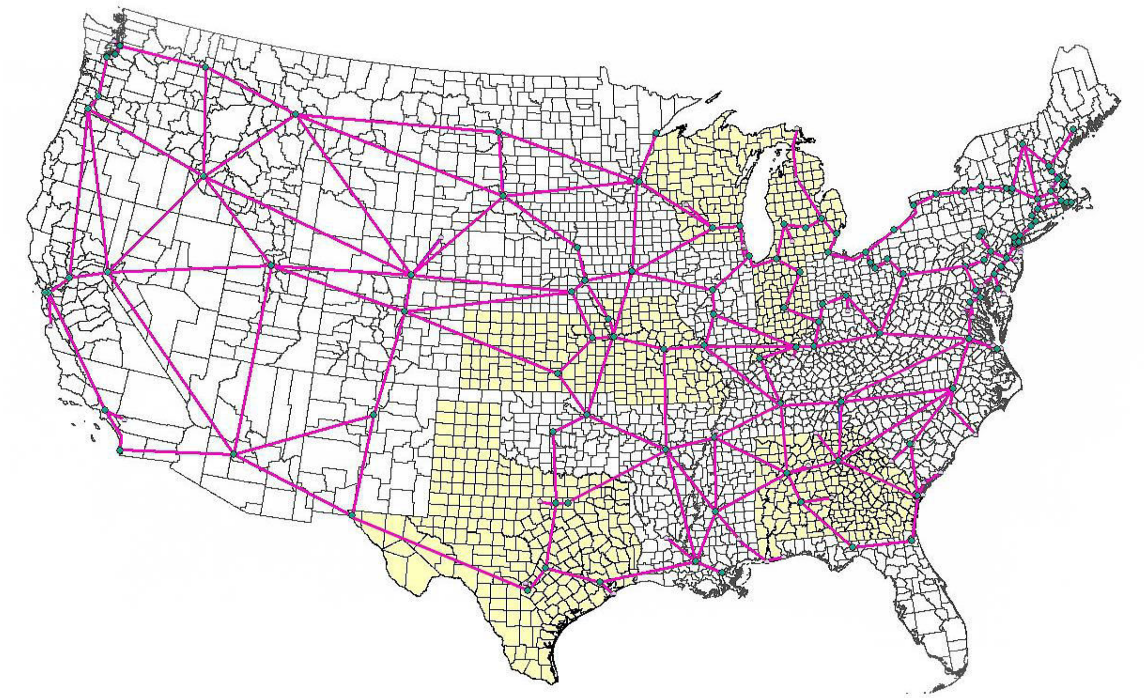
level by predicting the actual placement of highways. This design would satisfy the exclusion restriction intuitively, in that the impact of a county's relative location on general stores had to be through actual highway spending.[35]

The virtual highway network concept starts from the reasonable assumption that a national highway network that best promotes interstate commerce must connect the most populous places and the most politically important cities. Moreover, I exploit the fact that the United States experienced a massive military build-up for World War I shortly before 1921. Some military facilities built for the War—such as Fort Benning and Fort Sam Houston—eventually became huge permanent bases that still exist today. For logistical purposes, the federal government had to build quality highways to connect those forts to the nearest big cities. Therefore, to represent "nodes" of the virtual network, I chose (a) the top 100 most populous cities in 1920, (b) state capitals (if they were not on the top-100 list), and (c) permanent military forts established during 1914-1918.[36] To construct the virtual network, I first connected all the city nodes using Kruskal's minimum spanning tree algorithm. Then, permanent military bases were connected to the nearest city. To compensate for the loss of route precision caused by having too few lines, I added routes to ensure that (1) at least one line connects every city node with its nearest neighbor within the state; and (2) each state is connected with all its neighboring states on land. The resulting straight line network can be seen in Figure 1.10 below.

[35] Recent studies adopting this identification strategy include Atack et al (2009), Banerjee et al. (2012), Ghani et al (2012), Gutberlet (2013), and Faber (2014). All these studies use the virtual network to predict the placement of highways, rather than highway spending.

[36] By "permanent military bases" I meant military bases that were continuously occupied and operated at least until the military downsizing after WWII. I exclude mobilization camps and temporary training facilities that were only used during 1917-19 and/or 1939-45.

Figure 1.10: A virtual Straight-line Highway Network.



Note: On this map, big turquoise dots represent locations of city nodes. Smaller purple dots represent locations of military forts, which only are connected with the closest city. Pink lines composite a complete and economical virtual network of highways. The distance from each county seat to the nearest segment of this network then captures the exposure of counties to actual highways. Highlighted in yellow are states in my sample.

Two distance measures that help predict the likelihood of a county getting highways are used as instruments. The first is the natural logarithm of the distance from each county seat to the nearest segment of the straight line network. The second instrument is the first distance interacted with the log distance from each county seat to the nearest top-100 city. This interaction term is necessary because the effect of county location has on its likelihood of getting a highway may depend on its location relative to a big city. Note that the distance to city may strongly predict the size and the structure of a county's economy, thus it may affect general stores directly. Using the distance to city separately as an instrument intuitively would violate the exclusion restriction, but the interaction term does not have this problem.

Regression presented in the main text use the two instruments discussed in the above. However, I also consider other instruments. For example, natural features such as elevation range (the difference between highest and lowest point) and the presence of bodies of water (rivers, lakes, and swamps) may predict level of highway spending: bumpy land requires more grading effort, and the presence of water requires building bridges, which are expensive. I use the following three criteria in choosing natural-feature-based instruments. First, the chosen instruments had to have the expected signs in the first stage. Second, they had to provide meaningful explanatory power to the first stage regression. Third, they had to pass the statistical test for the over-identifying restriction. The number of lakes and the number of swamps satisfy these criteria. I combine these two variables so that they are not seen as proxies for Michigan, Wisconsin, and the South respectively.[37]

To alleviate the concern that the level of highway spending picks up the "proximity-to-city" effect, I excluded counties with city nodes. I also excluded "suburban' counties, which was defined those neighboring counties of cities with a population of more than 150,000 that had a larger-than-median density themselves. The list of excluded counties can be seen in the Appendix A-4.

1.5 The Impact of Highway Spending on General Stores

Table 1.5 presents descriptive statistics for the sample of counties in eight states, distinguished by their locations on the virtual network. Columns 1 and 2 of Table 1.5 present descriptive statistics for the 35 counties excluded from the regression analysis. These consist of counties where top-100 biggest cities and state capitals reside, and also some suburban counties. Compared to the rest of the sample, the much more populous, urban, and industrialized nodal and suburban counties had more general stores, witnessed a sharper decline of general stores in the 1920s, but were still left with more general stores by 1930. Nodal and suburban counties also spent more in highway construction. Columns 3 and 4 present descriptive statistics for the remaining 911 counties and the last two columns present descriptive statistics for the entire sample of 946 counties. Counties in the rest of the sample were mostly rural by 1920, but experienced significant

[37] I acknowledge that my instruments are all time-invariant and potential shortcomings as a result. I will explore the possibility of interacting my instruments with meaningful 1920s-specific variables. I will also look for 1920s-specific instruments.

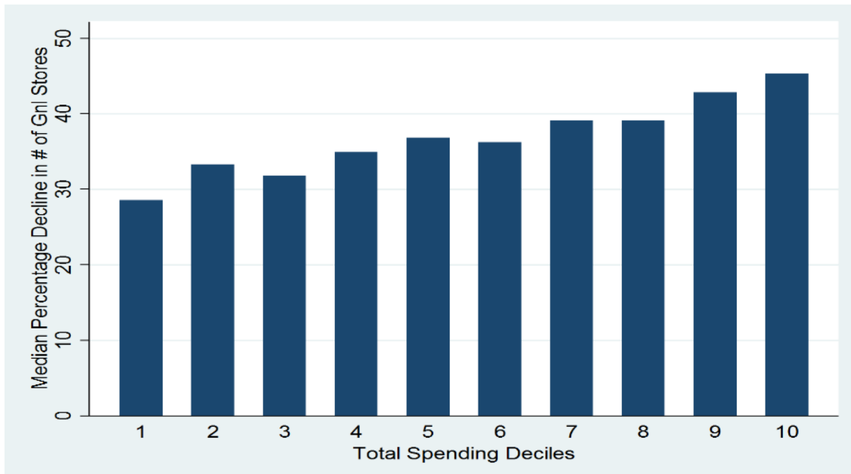
urbanization in the 1920s. About 31 percent of general stores in those "remaining counties" disappeared in the 1920s. The decline of general stores in places with more 10,000 people was much more pronounced: almost two thirds of them went out of business or were changed to another type of retailer.

1.5.1 Descriptive Evidence

Figures 1.11, 1.12, and 1.13 provide descriptive evidence that more highway spending is associated with a sharper decline in the number of general stores. In each of these bar charts, counties are divided into ten groups of equal sizes, distinguished by their total spending on highway construction from 1921 to 1930. The leftmost decile represents the approximately 90 counties with the least spending on highway construction in the ten-year period; the rightmost decile represents counties with the most spending on highway construction. Figure 1.11 depicts the median percentage decline in the number of total general stores of each group. It exhibits a gentle upward slope, and indicates that counties with more highway spending also had a shaper decline of general stores. Figure 1.12 depicts the median percentage decline in the number of rural general stores. Its slope suggests that highway spending is correlated with a shaper decline of general stores in rural areas. This negative relationship between highway spending and the number of general stores does not weight the observations or control for other variables, but is nonetheless suggestive. On the other hand, Figure 1.13, which depicts the median percentage decline in the number of urban general stores, shows that the number of general stores fell by more than 60 percent in urban areas. However, the largely flat slope suggests the decline did not seem to be correlated with the level of highway spending. Taken together, Figure 1.11 to 1.13 indicate that many general stores in urban areas were wiped out because of some other factors, and highways might play a role in explaining the more modest decline of general stores in rural areas. For the remainder of this chapter, I focus on all generals stores and rural general stores, not on urban general stores.

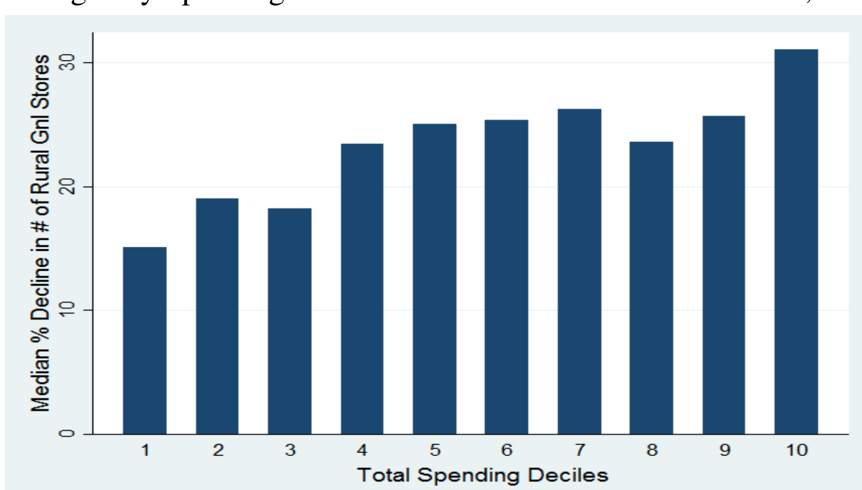
Table 1.6 presents OLS results for the impact of highway spending on the percentage change of the number of general stores. Panel A examines the percentage change in the total number of general stores. Panel B focuses on rural general stores. All specifications reported in Table 1.6 include state fixed effects. The regressions reported in column 2 add in the number of stores in 1922, population density in 1920, and county land mass. Column 3 adds demographic and geographical control variables. Column 4 further controls for pre-trend and economic conditions in 1920 by adding population

Figure 1.11: Highway Spending and the Decline of General Stores, 1922-30



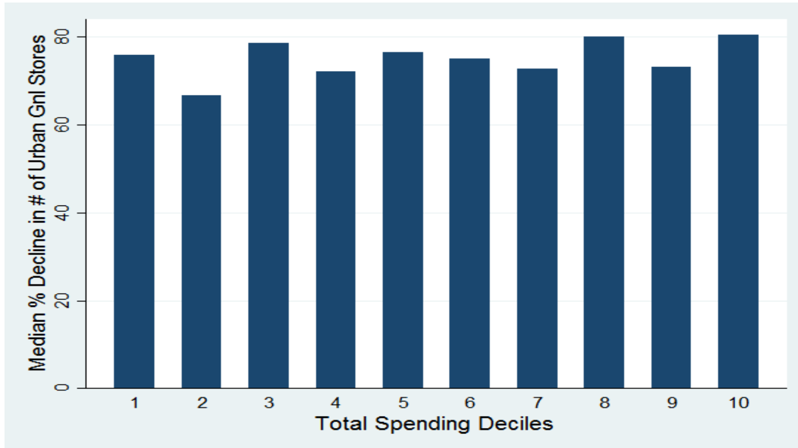
Source: Author's Calculations. The figure presents median rate of decline for 10 groups of counties, grouped by their total highway spending throughout the 1920s. Counties in the first highway spending decile from the left spent the least on highways, whereas those in the tenth highway spending decile had the most spending on highways. The heights of the bars depict percentage change in the number of general stores from 1922 to 1930.

Figure 1.12: Highway Spending and the Decline of Rural General Stores, 1922-30



Source: Author's Calculations. The only difference between Figure 1.12 and 1.11 is that now the heights of the bars depict percentage change in the number of rural general stores from 1922 to 1930.

Figure 1.13: Highway Spending and the Decline of Urban General Stores, 1922-30.



Source: Author's Calculations. The only difference between Figure 1.13 and 1.11 is that now the heights of the bars depict percentage change in the number of urban general stores from 1922 to 1930.

growth from 1910 to 1920, the average value of an acre of farmland and log of manufacturing output measured in the 1920 Census. All regressions are weighted by county population in 1920, and have the standard errors clustered at the regional level. I also reported in Appendix Table B-1 the same set of regressions with the standard errors clustered at the county level.

Results from Table 1.6 show that the construction of Federal-Aid Highways led to an economically and statistically significant decline in the number of general stores, in particular for those general stores in rural communities. The -1.232 coefficient in column 1 of Panel A indicates that a 1 percent increase in highway spending in the 1920s is associated with 1.232 percentage points fewer general stores in 1930. As more controls are added, the effect falls in magnitude but is still statistically significant. The -0.387 coefficient in column 4, the most flexible specification, suggests that doubling highway spending would result in 5.22 percentage points fewer general stores, which amounts to a 17 percent decrease in the number of general stores relative to the sample mean.

Highway spending had a bigger negative impact on rural general stores. Results from panel B of Table 1.6 suggest that, depending on the specification, a one percent increase of Federal-Aid Highways expenditure in the 1920s decreased the number of rural general stores by 0.54 to 1.27 percentage points. Using the coefficient from column 4 of Panel B, doubling highway spending would result in a 26 percent decrease in the number or rural general stores relative to the sample mean. Omitted results show that Federal-Aid Highways could not predict the decline in the number of general stores in communities of more than 10,000 people with precision. The construction of highways having a larger impact in rural communities is sensible: highways connected villages and farms with towns and cities. The decline of rural general stores signified the decline of rural trade centers.

The specification used in Table 1.6 assume that highway spending does not affect counties differentially. But one may reasonably hypothesize that highways might have had differential effects on counties of different sizes. Table 1.7 explores heterogeneous effects of highway spending among different counties, distinguished by their 1920 population density. As with Table 1.6, Panel A shows results for all general stores, and Panel B presents results for rural general stores.

In both panels of Table 1.7, the coefficients of population density are all negative and significant, meaning there was a sharper decline in counties with higher population densities. This could be explained by asserting that general stores in densely populated counties faced more competition from other retailers, especially chain stores. The population density coefficient is smaller in rural general store regressions, which fits the competition-with-chain-store hypothesis, as fewer chain stores would locate in small communities.

The positive coefficients on the interaction term in Table 1.7 suggest that the effect of highway spending on the decline of general stores decrease as population density increases. In other words, highway spending was associated with a sharper decline in the number of general stores in more sparsely populated counties. The difference is not huge, but nevertheless significant: the effect of highway spending on all general stores in a county with one standard deviation (32.2) higher population density would be 0.198 percentage point smaller, which is about 32 percent (0.198/0.616) of the main effect coefficient. For rural general stores, the impact of the interaction term as a result of a one standard deviation change in population density is about half the size (17.3%, or 100%*0.00358*32.2/0.665). Highway construction lowered transportation costs, which might lead to the entry of a national chain, or the expansion of a local grocer. Any of these events would have a bigger impact on smaller markets because the market could only support a handful of retailers. The smaller effect on rural general stores could be because that chain stores were less likely to be in rural communities.

1.5.1 Instrumental Variables Regressions

One may worry about the non-random placement of highways and the resulting (statistical) inconsistency of the OLS estimates. I used the virtual highway network discussed in Section 4.1 to identify the casual impact of highway construction on general stores. Tables 1.8 and 1.9 present the instrumental variable regression results. Table 1.8 reports the results from the first stage of the 2SLS estimation. Recall that the virtual highway network is intended to predict a county's likelihood of getting actual highway projects and thus its level of spending on highway construction. My priors are that the log distance to the virtual highway network and its interaction with the log distance to the nearest city are both negatively correlated with highway expenditure e. My first prediction holds but not the second. The negative sign of the interaction term suggests that for two counties equally distant from a virtual highway line, the one closer to a city is less likely to get the highway. This paradoxical result may be explained by observing that as connecting the county seat close to one terminus of a straight line (the city) may require a sharper detour, which makes it more unlikely. Most coefficients are highly significant and sizable. The first-stage F-statistics are not huge but acceptable, considering the sample size. This is not very surprising as these instruments strongly predict the placement of highways but the level of highway spending may be affected by other factors.

Table 1.9 presents the 2SLS estimates of the effect of highway spending on the decline of general stores. Consistent with OLS results, highway spending caused significant declines in general stores overall, particularly in rural areas. The most flexible econometric model in column 4 suggests that a one-percentage increase of Federal-Aid Highways expenditure would cause the number of general stores to decline by 0.92 percentage points and the number of rural general stores to decline by 1.15 percentage points. To interpret the magnitudes of these coefficients, recall from Table 1.5 that the mean of the log of highway construction spending is 13.49, and the average rate of decline of general stores is 30.8 percent (27.5 percent for rural general stores) in the regression sample. The highway spending coefficients then suggest that doubling highway spending in the 1920s would result in a 29 to 52 percent more decline in the number of general stores relative to the average rate of decline.[38] The point estimate and the standard error in Panel B implies that doubling the highway spending during the 1920s led to a 41 to 72 percent greater decline in the number of general stores relative to the sample mean.

Here is another way to interpret the magnitude of these results. Assume that the decline of general stores is a linear time trend, then the highway spending coefficients reported in Table 1.9 mean that doubling highway spending in the 1920s would further accelerate the demise of general stores by about 9 years. It would accelerate the demise of rural general stores by about 13 years. In reality, the level of highway spending in the 1930s was several times higher, which would further accelerate the downfall of general stores. Hence, the impact of interwar highway building on general stores is huge.

Comparing Table 1.9 with Table 1.7, it is obvious that that the IV estimates are bigger in absolute value than the OLS estimates. I offer two explanations for the discrepancy between IV and OLS estimates. The first is that the OLS estimates might underestimate the true impact because I do not observe highway spending from the 1910s. In the standard omitted variable bias formula $\widehat{\beta_{OLS}} = \beta + \delta\alpha$, β represents the true coefficient, $\widehat{\beta_{OLS}}$ is the OLS estimate, α is the effect of the omitted variable(s) on the outcome variable, and δ is the probability limit of the OLS estimator of the omitted variable(s) on the included regressor(s). Here, the omitted variable is government spending on highway construction in the 1910s. A negative δ is conceivable because—except for cases where a project started in the 1910s continued into the 1920s —more completed highways in the 1910s meant less new construction in the 1920s. The sign of α—the impact of spending on highway construction in the 1910s on the decline of general stores in the 1920s—is more complicated. More spending in the 1910s could have caused so many general store closures in the 1910s that few were left by 1920, which would suggest a positive α because highway spending in the 1910s led to a

[38] The lower bound is calculated as [100%*(0.921-0.261)*13.49]/30.79; the upper bound is calculated as [100%*(0.921+0.261)*13.49]/30.79.

smaller decline in the general stores during the 1920s. However, anecdotal evidence, such as the statistics in Tables 1.1 and 1.2, suggests that in the early 1920s there were still many general stores in most places. Therefore, it is more reasonable to assume that α is negative because prior highway spending would contribute to the decline of general stores in the 1920s, just as highway spending in the 1920s would do. If α and δ were both negative, β will be bigger in absolute value than $\widehat{\beta_{OLS}}$.

The second explanation concerns the endogenous placement of highways. Table 1.10 offers suggestive evidence of the relationship between economic prosperity in the 1920s and its impact on highway spending, as well as the change in the number of general stores. I used growth of manufacturing output and change in land value as alternative measures of local economic conditions and ran two separate sets of regressions. Column 1 suggests that more funds were appropriated to counties that had slower growth in manufacturing or lower appreciation in land value. More importantly, this is consistent with the hypothesis that the government treated the highway program as a stimulus package. Columns 2 and 3 suggest that economic prosperity in the 1920s is negatively correlated with the change in the number of general stores, as the expansion of chain stores and department store naturally gravitated toward prosperous counties and pushed more general stores out of business there. These two pieces of evidence combined suggested that OLS regressions might underestimate the impact of highway spending.

In Appendix Tables B-2 and B-3, I reran the regressions reported in Table 1.8 and 1.9 with one additional instrument— the number of lakes plus the number of swamps. In the first stage, the “water” instrument predicts more highway expenditure, which is consistent with the notion that the presence of lakes or swamps require building bridges, which the highway spending. With the added instrument, the F-stat increased moderately. The point estimates in the second stage are strikingly similar to those in Table 1.9, with the standard errors being a bit larger. To interpret the results in Table B3 in the Appendix, doubling highway spending in the 1920s would result in a 24 to 52 percent more decline in the number of general stores and a 39 to 73 percent greater decline in the number of rural general stores relative to their respective average rates of decline.

One may be worried about the robustness of 2SLS estimation in the weak instrument context. It has been generally accepted in econometrics that limited information maximum likelihood (LIML) is often less biased than 2SLS. So I reran regressions reported in Tables 1.8 and 1.9 using LIML. The results were tabulated in Appendix Tables B-4 and B-5. The results prove to be very similar: on the first stage, LIML estimators yield similar F-stats and coefficients; on the second stage, the highway coefficients are also with of similar magnitudes compared to those 2SLS estimates and are highly significant. All these evidence alleviate the concern about weak instruments and robustness of those 2SLS estimates above.

1.6 Confounding Factors

Many other factors could have affected the evolution of the retail sector and the decline of the general store. One potential concern is the effect of railroads. Highways tend to be built adjacent to railroads. One frequently-discussed highway safety issue in state highway department reports was the railroad crossing. However, it would be anachronistic to attribute the decline of the general store in the 1920s to the expansion of railroads. Aggregate time series suggest that national freight volume and mileage of the railroad system did not change in the 1920s.[39] Moreover, during the 1920s there were no big technological innovations in equipment or in railroad operation. Therefore, a largely unchanged railroad sector could not have explained such a rapid transformation in the retail sector.

Another concern is the effect of adoption of the automobile. One reason why highway spending led to a significant decline in the number of rural general stores and the decline of rural trade centers was that improved highways enabled villagers to drive to county seats to shop. Increased connectivity was only meaningful when people owned automobiles and had increased mobility. However, disentangling the automobile effect and the highway effect is challenging both theoretically and empirically. Theoretically, the growth in automobile ownership and the investment likely constitute a feedback loop.

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[39] *Recent Economic Changes* (1929), page 255 to 271.

Empirically, they and their interaction are highly multilinear. Thus, I purposefully omitted the automobile in the regression analysis.

Yet another concern is the expansion of chain stores. In 1925, Sears opened their first retail outlet because Sears' executives saw that improved roads would enable shoppers to travel directly to county seats instead of relying on their catalogue. Sears' outlets quickly expanded to more than 100 locations by 1930. Sears took advantage of the expansion and improvements of highways. The switch to outlets and the profitable expansion of outlets would not be necessary or possible without the highway boom. Rather than thinking about the Sears effect and the highway effect separately, it is helpful to regard the Sears effect as part of the composite highway effect that I have identified.

1.7 Conclusions

Drawing on newly collected county-level data, I identified that highway spending had a sizable effect on the decline in the number of general stores, particularly in rural communities. The evidence is consistent with the historical narrative during this era: retail trade shifted away from small stores at crossroads to stores at county seats and bigger cities. The decline of general stores did not necessarily mean there was a welfare loss. The demise of general stores might have freed some tenant farmers from perpetual indebtedness. Scattered general stores were replaced with retail outlets in more concentrated areas, which might be a more efficient way of industrial organization. This study does highlight, however, that investment in transportation infrastructure might not have brought universal prosperity or growth. Oftentimes, the economic consequences are uneven for different communities and different types of business entities.

The highway effect on the general store identified in this chapter may work itself through several mechanisms. First, highway spending reduced transportation costs, which would enable more consumers to travel farther to shop, and lead to fewer retail establishments. This is consistent with predictions by models such as Salop (1979). Second, reduced transportation costs facilitated the growth and expansion of chain stores at the expense of general stores. Compared to independent retailers such as general stores, chain stores could take better advantage of vastly improved highways because it was easier for them to establish new supplier networks to adapt to changes in transportation costs. Third, highway construction provided local laborers with extra dispensable income. Retailer outlets such as women's apparel shops or shoe stores had superior supply chains and offered more variety and more high-end and fashionable merchandise. Many generic products that the traditional general store carried could be regarded as inferior goods. So general stores lost out as people got richer. Finally, the decline in the number of general stores did not mean all those unaccounted-for general stores went out of business. Between 1922 and 1930, some unproductive general stores were wiped out. Others might have been turned into another business and were counted under a different category in 1930. The recorded decline in general stores might overestimate the consolidation of the retail sector. This study invites more research on the impact of highway construction during the interwar years.

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Table 1.1: Retail Sales, by Type of Outlet, 1909-29

	Markup Method						Census Data	
	1909		1919		1929		1929	
Independent Grocers	2,934	18.1%	7,602	17.7%	6,826	13.2%	5,320	12.1%
Chain Grocers	751	4.6%	2,588	6.0%	3,335	6.5%	2,834	6.5%
General Stores	1,721	10.6%	3,986	9.3%	3,183	6.2%	2,571	5.9%
Department Stores	676	4.2%	2,501	5.8%	3,898	7.5%	3,903	8.9%
Meat Markets	654	4.0%	1,616	3.8%	1,621	3.1%	1,337	3.1%
Milk Dealers	504	3.1%	1,119	2.6%	1,348	2.6%	691	1.6%
Dry Good Stores	638	3.9%	1,217	2.8%	1,118	2.2%	1,186	2.7%
Apparel Stores	1,315	8.1%	3,400	7.9%	3,662	7.1%	3,268	7.5%
Total	16,186		43,069		51,634		43,824	

Note to Table 1.1: This table presents retail sales (in millions of dollars) of selected types of outlets and their shares from 1909 to 1929. For each year, the first column reports retail sales, the second column reports its share. Data come from Barger (1955), pp 148-149. I excluded restaurants and bars from total retail sales. All sales numbers are in current dollars (with no adjustment for inflation). Retail sales numbers using the markup method were estimated based on volume of trade in surveys, whereas retail sales numbers reported in Census were estimated based on enumeration of volume of sales. Both methods included estimation; neither observed actual ledgers. The disparity between estimates for 1929 retail sales reflects two estimation methods. Kuznets offered some explanations of the disparity, including that the markup method failed to exclude direct sales by farmers and service establishments, and that Census which took place in April 1930 could not include the sales of retailers who went out of business between January 1, 1929 and April 1930. For more explanations on the disparity, see Barger (1955), pp 121-124.

Table 1.2: Channels of Retail Distribution, by Retail Outlets, 1909-29

	1909		1919		1929	
	W	D	W	D	W	D
Manufactured Food Products						
General Stores	15	0	14	0	10.3	0
Independent grocers	24	7	31	6	30.1	5.3
Chain grocers	2	11	3	14	3.2	18.9
Tobacco Products						
General stores	20	0	19	0	17.3	0
Drugstores	21	0	23	0	22.9	0
Cigar/Tobacco stores	30	6	34	2	36.4	0
Dry Goods and Notions						
General stores	16	0	16	0	14.3	0
Department stores	15	0	22	0	29.2	11.8
Dry good stores	48	6	39	0	27.3	0
Shoes						
General stores	20	0	15	0	11.1	0
Department stores	0	10	0	14	0	18.5
Independent shoe stores	31	9	30	8	25.9	7.2
Chain shoe stores	0	10	0	15	0	19.6
Farming Equipment						
General Stores	17	0	16	0	14.0	0.0
Farm Implement Dealers	47	16	48	13	46.8	17.5
Total						
General Stores	98	2	98	2	98	2
Independent grocers	68	32	77	23	80	20
Chain grocers	12	88	17	83	20	80
Dry good stores	88	12	96	4	92	8
Department stores	19	81	19	81	21	79
Independent shoe stores	79	21	79	21	80	20
Chain shoe stores	0	100	0	100	0	100

Note to Table 1.2: This table presents how different types of goods were distributed in the early twentieth century. “W” denotes sold through a wholesaler; “D” denotes sold directly to a retailer. The first number in the second row, 24, means that in 1909, 24 percent of manufactured food products were sold through a wholesaler to independent grocery stores. And the number next to it, 7, means that in 1909, 7 percent of manufactured foods were sold by producers directly to independent grocery stores. In the “Totals” panel, the two numbers for independent grocers in 1909, 68 and 32, mean that independent grocers. got 68 percent of all their merchandise through wholesalers and the remaining 32 percent directly from producers. Source: Barger (1955), pp 132-140..

Table 1.3: Overview of Federal-Aid Highway Construction, 1921-30

	All	South	Midwest
Number of Counties	946	480	466
Number of Counties Having Federal-Aid Highways	846	422	424
Share of Counties Having Federal-Aid Highways	89%	88%	91%
Number of Counties Type of Surface Information	726	480	246
Number of Counties Having Paved Federal-Aid Highways	385	186	199
Shared of Counties Having Paved Federal-Aid Highways	53%	39%	81%
Total Highway Expenditure (in millions of 2009 dollars)	5,402	2,446	2,957
Share of Expenditures on Paved Highways	49%	33%	69%
Number of Counties that Had U.S. Route in Rand-McNally (1939)	824	407	417
Number of Counties Having Primary Interstate Highways	230	114	116

Note to Table 1.3: This table gives an overview of Federal-Aid Highway construction in the sample that I study. Southern states include Texas, Georgia, and Alabama; Midwestern states include Michigan, Indiana, Wisconsin, Missouri, and Kansas. Kansas and Missouri do not have type of surface information in most years. So “share of counties having paved highways” and “share of expenditures on paved highways” calculations exclude Kansas and Missouri. “Pave highways” meant asphalt-or-concrete-surfaced highways. Rand-McNally Road Atlas (1939) data come from Paul Rhode. Primary Interstate Highways data come from Michaels (2008). All other data are from state highway department reports from 1921 to 1930.

Table 1.4: Total Number of Retail Establishments from Different Sources

	WW	Crowell	Census	Curtis
"Country General Stores"	34,555	-	26,248	21,926
"General Merchandise"	-	35,769	3,223	-
"Departmentalized Stores"	-	15,703	-	-
Total Number of General Stores	34,555	51,472	29,471	21,926
Total Number of Grocery Stores	55,369	64,657	72,687	79,701
Number of Dry Goods Stores	8,573	-	5,593	2,713
Number of Clothing Shops	4,193	12,135	7,746	4,032

Note to Table 1.4: This table compares total numbers of various retail establishments from different data sources with the goal of finding a consistent measure of "general stores". There are four potential data sources for number of retail establishments: "WW" denotes *Women's World County Hand Book on National Distribution* published in 1923; "Crowell" denotes *National Markets and National Advertising* published by the Crowell Publishing Company in 1923; "Census" are from the 1929 Census of Distribution (Report Volume 1: *Retail Distribution*, "County-level Statistics by Types of Outlet"). "Curtis" denotes *Markets and Quotas, A Study of Counties and of Cities with Population of 10,000 and Ove*r published by the Curtis Publishing Company in 1932. WW and Curtis did not report the number of general merchandise stores. (Curtis had data for "General Merchandise Group") In Crowell's tabulations, dry goods stores were combined with clothing shops. (The difference between dry goods stores and clothing shop is that the latter only carried ready-to-wear clothes whereas the former primarily carried cloths and notions.)

Table 1.5: Summary Statistics

	Nodal Counties N = 35		Remaining Counties N = 911		All Counties N = 946	
	Mean	S.d.	Mean	S.d.	Mean	S.d.
Highway Construction						
Total Expenditures (1921-30), in millions	15.14	12.85	5.35	5.21	5.71	5.96
Log Total Expenditures (1921-30)	15.37	3.92	13.49	4.82	13.56	4.80
Log Distance to Straight-line Network	-0.05	2.30	3.16	1.24	3.05	1.44
Log Distance to The Nearest Big City	1.34	2.00	4,24	0.72	4.14	0.97
Number of General Stores						
No. of General Stores in 1922	217.17	297.98	48.16	33.04	54.41	72.56
No. of Rural General Stores in 1922	59.03	52.15	37	27.56	37.81	29.1
No. of Urban General Stores in 1922	158.14	292.26	11.16	13.06	16.6	63.31
No. of General Stores in 1930	60.77	50.55	30.02	21.24	31.15	23.67
No. of Rural General Stores in 1930	44.37	37.28	27.11	19.97	27.75	21.09
No. of Urban General Stores in 1930	127.71	179.61	13.88	12.02	18.09	41.98
% Change in the No. of General Stores	-56.42	20.17	-30.79	37.54	-31.72	37.35
% Change in the No. of Rural General Stores	-42.11	24.33	-27.49	36.82	-28.03	36.52
% Change in the No. of Urban General Stores	-72.69	30.99	-63.32	42.77	-63.68	42.41
Natural Characteristics						
No. of Lakes	25.94	66.27	16.83	44.09	17.17	45.08
No. of Swamps	1.2	2.85	1.29	4.93	1.29	4.87
% of Coastal Counties	17.14	38.24	8.45	27.83	8.77	28.31
No. of Rivers that Pass Through 11-20 Counties	0.17	0.38	0.2	0.43	0.2	0.43
No. of Rivers that Pass Through 21-50 Counties	0.11	0.32	0.15	0.36	0.15	0.35
No. of Rivers that Pass Through 51+ Counties	0.06	0.26	0.29	0.57	0.07	0.28
Difference between Highest and Lowest Elevations, in feet	679.6	626.7	642.3	792.1	643.7	786.4
Demographic Characteristics						
% of White Population	89.0	13.8	86.7	20.6	86.8	20.4
% of Foreign-born White Population	9.9	9.2	5.6	7.9	5.7	8.0
% of Black Population	10.8	13.6	13.1	20.6	13.1	20.4
% in School Among People Aged 6-20	65.5	5.3	67.3	9.1	67.2	9.0
Share of Illiterate Population	4.6	3.8	7.6	8.3	7.5	8.2
Socioeconomic Characteristics						
Total Population	176,710	237,348	19,902	16,210	25,704	56,186
Share of Urban Population	59.44	31.61	15.42	20.97	17.05	22.99
Population Growth Rate (1910-20), in %	31.42	30.91	7.40	28.65	8.29	29.08

Population Growth Rate (1920-30), in %	34.7	34.5	14.52	65.01	15.28	64.28
Growth Rate of Urban Population (1920-30), in %	50.97	59.41	14.11	36.21	15.53	37.99
Value of Farmland, per Square Mile	121.21	107.91	47.82	38.02	50.54	44.76
Log Manufacturing Output	17.6	2.2	12.39	4.9	12.58	4.93
% of Workforce in Manufacturing	11.24	7.67	3.47	4.82	3.76	5.16

Note to Table 1.5: This table presents summary statistics for variables used in the regression analysis of this chapter. The two distance variables in the first panel respectively measure distances from each county seat to the nearest top-100 city and the nearest straight line on the virtual highway network. See Section 1.4.1 of the paper for more. Rural general stores are general stores in places with population less than 10,000. Urban general stores are general merchandise stores in places with more than 10,000 people but with annual sales of less than $100,000 (in current dollars). “Urban population” counts number of people living in places with more than 2,500 other people. The other variables are self-explanatory. Source notes: Highway variables are from state highway department reports. General store variables in 1922 are from "Crowell". General store variables in 1930 are from "Census". (To see what these abbreviations mean, check notes under Table 1.4.) Natural characteristics variables are Fishback et al (2007). Demographic and socioeconomic characteristics variables are from ICPSR 2896. All monetary variables are converted to 2009 dollars using the GDP deflator established in Kendrick (1961). All time-varying variables are measured at their 1920 levels unless otherwise noted.

Table 1.6: OLS Estimates of the Effects of Highways on General Stores

	(1)	(2)	(3)	(4)
Panel A: Percentage Change in the Total Number of General Stores				
log(Expenditure)	-1.232***	-0.485**	-0.546***	-0.387**
	(0.235)	(0.218)	(0.208)	(0.191)
Observations	906	906	906	905
R-squared	0.077	0.101	0.124	0.128
Panel B: Percentage Change in the Number of Rural General Stores				
log(Expenditure)	-1.267***	-0.733*	-0.621**	-0.536***
	(0.406)	(0.402)	(0.295)	(0.225)
Observations	906	906	906	905
R-squared	0.247	0.292	0.318	0.326
State FE	Y	Y	Y	Y
No. of Stores in 1922, Pop Density, Land Mass	N	Y	Y	Y
Demographic + Geographic Controls	N	N	Y	Y
Economic Controls	N	N	N	Y
S.E. Clustered at Regional Level	Y	Y	Y	Y

Notes to Table 1.6: The table presents estimated coefficients from OLS regressions in which the dependent variables are percentage changes of the number of total/rural general stores, which is defined as 100 times the change in the number of stores divided by the number of stores in 1922. The dependent variable in Panel A is the percentage change in the total number of general stores. The dependent variable in Panel B is the percentage change in the number of general stores that were in places with population less than 2,500. The key independent variable is log of total highway expenditures on Federal-Aid Highways from 1921 to 1930. The first column only includes state fixed effect as controls. The second column adds in the number of stores in 1922, population density in 1920, and the county's land mass. The third column adds in demographic and geographic controls, which include percentage of black population, percentage of foreign-born population, percentage of illiterate population among people aged 20 or above, all measured in 1920; number of swamps, lakes, number of rivers of different lengths, coastal dummy, and difference in altitude between the highway and lowest points. Finally, the fourth column adds in pre-trend (population growth rate from 1910-20), economic conditions in 1920 (average value of an acre of farm land, log of manufacturing output). Observations are weighted using 1920 population. “Nodal” counties and selected suburban counties are excluded, for reasons described in the text. Standard errors are clustered at the regional level. See Appendix A-4 for the list of excluded counties.
*** p<0.01, ** p<0.05, * p<0.1

Table 1.7: OLS Estimates of Heterogeneous Effects of Highways

	(1)	(2)	(3)	(4)
Panel A: Percentage Change in the Total Number of General Stores				
log(Expenditure)	-0.754**	-0.597**	-0.774**	-0.616**
	(0.313)	(0.300)	(0.309)	(0.313)
Population Density (1920)	-0.247***	-0.173**	-0.187**	-0.157***
	(0.0886)	(0.0768)	(0.0737)	(0.0598)
log(Expenditure) * Population Density	0.00269*	0.00310*	0.00626**	0.00619**
	(0.0158)	(0.00184)	(0.00297)	(0.00302)
Observations	906	906	906	905
R-squared	0.093	0.112	0.125	0.134
Panel B: Percentage Change in the Number of Rural General Stores				
log(Expenditure)	-0.960**	-0.817*	-0.755**	-0.665*
	(0.408)	(0.419)	(0.384)	(0.361)
Population Density (1920)	-0.145**	-0.139*	-0.118*	-0.0783*
	(0.070)	(0.078)	(0.0698)	(0.0403)
log(Expenditure) * Population Density	0.00126***	0.00231**	0.00366***	0.00358**
	(0.00061)	(0.00115)	(0.00155)	(0.00181)
Observations	906	906	906	905
R-squared	0.247	0.292	0.318	0.326
State FE	Y	Y	Y	Y
No. of Stores (1922), Pop Density, Land Area	N	Y	Y	Y
Demographic + Geographic Controls	N	N	Y	Y
Economic Controls	N	N	N	Y
S.E. Clustered at Regional Level	Y	Y	Y	Y

Notes to Table 1.7: The sample and the dependent variables are both the same as they are in Table 1.6. The first column only includes state fixed effect as controls. From the second to the fourth column, controls are added sequentially in the same way as they are in Table 1.6. Observations are weighted using 1920 population. "Nodal" counties and selected suburban counties are excluded and standard errors are clustered at the regional level. See Appendix A-4 for the list of excluded counties. *** p<0.01, ** p<0.05, * p<0.1

Table 1.8: 2SLS Estimates of the Effects of Highways on General Stores, First Stage

	(1)	(2)	(3)	(4)
Panel A: *1st Stage DV: log(Expenditure), 2nd-stage DV: % Change in Total Gn'l Stores*				
log(d_Network)	-0.0874	-0.256***	-0.278***	-0.329***
	(0.0490)	(0.101)	(0.115)	(0.0827)
log(d_Network) * log(d_City)	0.0313	0.0510***	0.0622***	0.0200***
	(0.0198)	(0.0215)	(0.0218)	(0.00434)
Observations	906	906	906	905
1st-stage F-stat	6.300	7.123	7.561	8.312
Panel B: *1st Stage DV: log(Expenditure), 2nd-stage DV: % Change in Rural Gn'l Stores*				
log(d_Network)	-0.0977**	-0.284***	-0.351***	-0.412***
	(0.0421)	(0.0985)	(0.120)	(0.0446)
log(d_Network) * log(d_City)	0.0249**	0.0508***	0.0694***	0.0319***
	(0.0126)	(0.0199)	(0.0204)	(0.00911)
Observations	906	906	906	905
1st-stage F-stat	6.214	8.011	8.058	8.701
State FE	Y	Y	Y	Y
No. of Stores (1922), Pop Density, Land Area	N	Y	Y	Y
Demographic + Geographic Controls	N	N	Y	Y
Economic Controls	N	N	N	Y
S.E. Clustered at Regional Level	Y	Y	Y	Y

Note to Table 1.8: The table presents estimated coefficients from the first-stage of instrumental variables specifications, where the dependent variable is log highway expenditures, and the excluded instruments are the log distance from each county seat to the nearest segment of the straight-line network and its interaction with log distance from county seat to the nearest top-100 city. For each column, the same set of controls as Table 1.6 are included. From column 1 to 4, more controls are added in the same order as they do in Table 1.6. Observations are weighted using 1920 population for all regressions. "Nodal" counties and selected suburban counties are excluded from the sample and standard errors are clustered at the regional level. See Appendix A-4 for the list of excluded counties. Because observations are weighted and standard errors clustered, the F-stat I used here is Kleibergen-Paap Walk rk F-stat, as specified by the Stata command "ivreg2". *** p<0.01, ** p<0.05, * p<0.1

Table 1.9: 2SLS Estimates of the Effects of Highways on General Stores, Second Stage

	(1)	(2)	(3)	(4)
Panel A: Percentage Change in the Total Number of General Stores				
log(Expenditure)	-2.129***	-1.873***	-1.539***	-0.921***
	(0.668)	(0.809)	(0.650)	(0.261)
Observations	906	906	906	905
p-value of Overid Test Stat	0.519	0.345	0.801	0.465
Panel B: Percentage Change in the Number of Rural General Stores				
log(Expenditure)	-2.521***	-1.929***	-1.625***	-1.153***
	(0.703)	(0.755)	(0.419)	(0.310)
Observations	906	906	906	905
p-value of Overid Test Stat	0.598	0.629	0.774	0.690
State FE	Y	Y	Y	Y
# of Stores (1922), Pop Density, Land Area	N	Y	Y	Y
Demographic + Geographic Controls	N	N	Y	Y
Economic Controls	N	N	N	Y
S.E. Clustered at Regional Level	Y	Y	Y	Y

Note to Table 1.9: The table presents estimated coefficients from the second-stage of instrumental variables specifications, where the dependent variables are percentage change in the number of general stores, and log highway expenditure is instrumented by 1) the log distance from each county seat to the nearest segment of the straight-line network and 2) its interaction with log distance from county seat to the nearest top-100 city. For each column, the same set of controls as Table 1.6 are included. From column 1 to 4, more controls are added in the same order as they do in Table 1.6. Observations are weighted using 1920 population for all regressions. "Nodal" counties and selected suburban counties are excluded and standard errors are clustered at the regional level. See Appendix A-4 for the list of excluded counties. Because observations are weighted and standard errors clustered, the over-identification test statistic used here is Hansen's J statistic. *** p<0.01, ** p<0.05, * p<0.1.

Table 1.10: Endogenous Placements of Highways

Dependent Variables	log(Expenditure)	% Change, General Stores	% Change, Rural General Stores
	(1)	(2)	(3)
Growth of Manufacturing	-0.116***	-1.183**	-0.285
	(0.0306)	(0.480)	(0.241)
Observations	911	906	906
R-squared	0.101	0.056	0.232
Change in Land Value	-0.0142**	-0.131***	-0.0525*
	(0.00669)	(0.0473)	(0.0310)
Observations	911	906	906
R-squared	0.095	0.050	0.233
State FE	Y	Y	Y
Geographical controls	Y	Y	Y
Clustered S.E.	Y	Y	Y

Notes to Table 1.10: This table presents estimated coefficients from OLS regressions on the effect of economic prosperity in the 1920s on the placement of highways as well as the decline of general stores. The key variables are defined as follows: "growth in manufacturing" is the change in log manufacturing output from 1920 to 1930; "change in land value" is change in the value of an average acre of farmland from 1920 to 1930; "log(expenditure)" is the log of total expenditures on Federal-Aid Highways from 1921 to 1930. "% change in general stores" and "% change in rural general stores" are the same variables used in Table 1.6 to 1.9. All monetary variables are properly converted to 2009 dollars using Kendrick (1961). All regressions include state fixed effects and those geographical controls used in Table 1.6 to 1.9, and are weighted by 1920 county population. All standard errors are clustered at the regional level. *** p<0.01, ** p<0.05, * p<0.1

Appendix A: Data Appendix to Chapter 1

Appendix A-1: Data Sources

Highway Data

Data from the following reports were used in this study: Biennial Reports of State Highway Commission of Texas, 1920–30, Annual Reports of the State Highway Engineer to the State Highway Board of the State of Georgia, 1921–30, Annual Reports of the State Highway Commission of Alabama, 1921–30, Annual Reports of the State Highway Commission of Indiana, 1921–30, Biennial Reports of the State Highway Commissioner of Michigan, 1921–30, Biennial Reports of the Wisconsin Highway Commission, 1924–30, Biennial Reports of the Kansas Highway Commission, 1920–30, Biennial Reports of the State Highway Commission of Missouri, 1920–30. They were stored at the Buhr Shelving Facility of the University of Michigan Library under the call number group "TE 24." I located and digitized these reports. Here are a couple of scans of these highway reports:

Figure 1.14: A Snapshot of Highway Reports from Texas

FEDERAL AID PROJECTS COMPLETED, DECEMBER 1, 1924, TO SEPTEMBER 1, 1926—Continued.

Federal Aid Project No.	State Aid Project No.	Unit No.	County.	Highway No.	Length in Miles.	Date Completed.	Type Constructed.	Total Cost.	Federal Aid.	State Aid.
360-A	403-A	I	Uvalde	3	5.81	Aug. 1, 1925	Gravel	$ 60,430.75	$ 28,749.00	$ 10,200.00
360-B	403-B	I	Uvalde	10	5.36	Aug. 1, 1925	Gravel	38,067.61	14,393.73	8,883.84
362	484		Morris	35	5.08	April 17, 1925	Iron ore	36,111.80	18,055.90	9,027.95
363-C	496-C		Van Zandt	15	5.61	April 18, 1925	Plain concrete	112,977.35	27,318.23	37,659.12
364			Marion	49	14.70	April 22, 1925	Gravel	118,682.88	59,341.44	0.00
365	567		Marion	49	20.55	Feb. 19, 1926	Graded earth	183,873.85	91,500.00	436.92
367-A	464-A	I	Brazoria	19	6.59	Mar. 20, 1926	Shell	52,834.59	22,777.51	7,775.82
367-B	464-B	I	Brazoria	19	10.88	June 23, 1926	Shell	96,707.19	34,601.16	18,430.97
367-B	464-B	II	Brazoria	19	10.88	April 13, 1925	Bituminous Macadam	203,528.99	72,604.64	55,000.00
369	509	II	Palo Pinto	1	9.81	Feb. 25, 1925	Bituminous Macadam	39,361.78	16,300.00	8,600.00
370-A	446-A		Montgomery	19	7.92	Feb. 12, 1926	Gravel	47,756.97	23,567.56	7,153.72
370-B	446-B		Montgomery	19	13.57	May 31, 1926	Graded earth	161,087.20	77,000.00	22,817.86
371			Coleman	7-A	5.87	April 7, 1925	Gravel	52,746.06	26,373.03	0.00
373-B			Lavaca	3-B	14.23	Sept. 7, 1925	Waterbound Macadam	163,122.07	81,561.03	0.00
374-B	512-B	1&II	Hidalgo	12	3.26	June 30, 1926	Bituminous Macadam	145,019.03	30,000.00	29,869.09
375	469		Hidalgo	12	9.65	Dec. 20, 1924	Sheet asphalt	301,093.95	26,200.00	62,302.00
378-C	524-C		Brewster	3	15.15	July 20, 1926	Gravel	98,000.16	46,640.18	7,189.75
378-E	524-E		Brewster	3	5.13	April 22, 1926	Graded earth	91,345.31	29,222.90	44,122.41
379	487	I	Sutton	30	12.04	Mar. 1, 1925	Graded earth	148,709.85	62,458.14	36,681.76
379	487	II	Sutton	4	10.57	June 13, 1925	Gravel	21,387.03	10,239.02	3,431.86
381-B	409-B		Lamar	39	4.12	July 1, 1925	Reinforced concrete	118,813.62	56,800.00	22,409.08
382-A	431-A	I	Palo Pinto	1	15.47	Aug. 15, 1925	Graded earth	233,040.51	111,880.00	36,400.00
382-A	431-A	II	Palo Pinto	1	15.47	Oct. 31, 1925	Bituminous Macadam	223,473.43	104,454.66	44,151.22
383	508	II	Palo Pinto	1	3.37	May 16, 1925	Graded earth	27,022.88	13,060.91	2,207.15
383	508	II	Palo Pinto	1	3.37	Mar. 25, 1925	Vitrified brick	67,880.63	17,066.43	26,513.38
384	384		Ellis	14	3.04	Feb. 24, 1925	Gravel	52,668.32	25,347.50	9,305.91
385-B		I	Ellis	34	5.87	July 10, 1926	Graded earth	26,239.51	13,119.75	0.00
385-D		I	Ellis	34	4.83	June 15, 1926	Graded earth	48,951.85	24,475.92	0.00
387			Brazoria	19	7.76	Mar. 23, 1925	Shell	92,429.68	46,214.84	0.00
390-A	521-A		Reeves	1	13.19	Nov. 18, 1925	Gravel	135,370.51	64,067.13	39,158.88
390-B	521-B		Reeves	1	0.04	July 15, 1925	Bridge	15,477.17	6,372.79	5,452.65
392	485		Val Verde	4	12.72	Feb. 28, 1925	Gravel	118,197.54	40,000.00	19,098.77
393	475		Harris	19	1.56	Feb. 3, 1926	Bituminous Macadam	87,076.86	17,000.00	1,513.32
394-A	497-A		Milam	43	11.36	July 15, 1925	Graded earth	73,966.00	36,000.00	3,627.68
394-B			Milam	43	4.20	July 15, 1925	Graded earth	28,659.29	14,329.64	0.00
396	553		Ward and Reeves	1	0.036	Sept. 30, 1925	Bridge	32,991.37	15,948.65	13,055.56
398-B	552-B	I	Bexar	3	3.16	Dec. 29, 1925	Bituminous Macadam	98,230.31	39,535.09	35,137.65
398-D			Brewster	3	13.88	Dec. 9, 1925	Gravel	72,438.64	34,323.82	0.00
401-A	595-A		Robertson	6	10.88	Sept. 10, 1925	Graded earth	115,556.84	56,381.57	15,242.64
401-C	595-C		Robertson	6	1.14	May 18, 1926	Graded earth	13,003.68	3,740.00	1,406.38
401-D			Robertson	6	0.23	Mar. 7, 1926	Graded earth	22,261.70	6,640.00	0.00
402	428	I	Collin	6	6.19	June 15, 1925	Reinforced concrete	198,449.95	80,087.50	37,657.26

Note to Figure 1.14: This page shows some completed Federal-Aid projects, which would be sections of the Federal-Aid Highways, for Fiscal Years 1925 and 1926, in Texas. This is a page from *Texas Highway Commission (Biennial) Report, 1925-26.* Courtney of the Buhr Facility of the University of Michigan Library.

Figure 1.15: A Snapshot of Highway Reports from Wisconsin

TABLE III

STATUS OF FEDERAL AID CONSTRUCTION FUNDS AS OF JUNE 30, 1924

Detailed by counties to show projects completed and under way, source of funds provided, cost of completed projects, amounts allotted to projects under construction, and balance available for future construction.

ADAMS COUNTY

Funds Available—Act of Congress July, 1916, and February, 1919:		
Federal government		$69,008.77
State of Wisconsin		69,008.77
County of Adams		69,008.77
Funds Available—Act of Congress November, 1921, and June, 1922:		
Allotted under Sec. 84.03(3) (a) Wisconsin Statutes (State and federal)		64,984.62
Total funds available		$272,010.93
Expended on Completed Projects:		
Project No. 54—Kilbourn-Friendship road, 5.75 miles—Grading, draining and surfacing with topsoil	$51,053.95	
Project No. 54-S—Kilbourn-Friendship road, 5.75 miles—Reshaping and surfacing with gravel	15,301.97	
Project No.131—Kilbourn-Friendship road, 6.21 miles—Grading, draining and surfacing with topsoil	57,792.06	
Project No. 182—Friendship-Arkdale road, 7.30 miles—Grading, draining and surfacing with topsoil	44,539.60	
Project No. 250—Arkdale-Wisconsin Rapids road, 3.08 miles—Grading, draining and surfacing with topsoil	12,470.48	
Project No. 279—Friendship-Kilbourn road, 3.73 miles—Grading, draining and surfacing with topsoil	23,019.14	
Sub total	$204,177.20	
Allotted to Projects Under Construction:		
Project No. 1039—Kilbourn-Plainville road, 3.6 miles—Surfacing with gravel	18,151.08	
Total expenditures and allotments		$222,328.28
Balance available for construction		$49,682.65

Note to Figure 1.15: This page shows some completed Federal-Aid projects, which would be sections of the Federal-Aid Highways, for Fiscal Years 1923 and 1924, in Wisconsin. This is a page from *Wisconsin Highway Department (Biennial) Report, 1925-26.* Courtney of the Buhr Facility of the University of Michigan Library.

As one can clearly see, these reports were very heterogeneous from wording to format, making building a consistent database difficult.

Retail Establishments Data

Four different data sources were used in this study: *National Markets and National Advertising,* published by the Crowell Publishing Company in 1923; *Women's World County Hand Book on National Distribution,* published by the Women's World Magazine Company in 1923; *Markets and Quotas, A Study of Counties and of Cities with*

Population of 10,000 and Over, published by the Curtis Publishing Company; and *Census of Distribution Reports: Volume 1: Retail Distribution,* published by United States Government Printing Office in 1933.

Locations of County Seats, Cities, and Military Bases:

Paul Rhode generously shared the coordinates of county seats. Coordinates of the top-100 most populous cities and military bases are taken from Wikipedia and verified using Google Maps. See Appendix A-4 for more information on these cities and military bases.

Natural, Demographic, and Socio-economic Characteristics of Counties:

County-level economic and demographic variables are from "Historical, Demographic, Economic, and Social Data: the United States, 1790–2002" (ICPSR 2896). County climate and geographical variables are from http://www.u.arizona.edu/~fishback/Published_Research_Datasets.html

Appendix A-2: A Note on County Boundary Changes

Data used in this study ranged from the years 1910 to 1930. In those two decades there were a number of county boundary changes which, if not taken into account, would render long-difference comparisons problematic for those counties. In my analysis, I used 1930 county boundaries and adjusted for county boundary changes using the procedures described in this note.

I ignored all county boundary changes that did not lead to new counties being created, or existing counties becoming defunct. This should not be a serious problem because no big cities changed jurisdiction. That left us with two types of changes: (1) splits that resulted in the creation of new counties, and (2) mergers that resulted in defunct counties. In situations where new counties were carved from one or several older counties, I imputed the new county information in 1910 and 1920 using the relative ratios from its 1930 information, and information from the older counties in 1930. In situations where older counties were merged into a new county, I combined their 1910 and 1920 information to the county in existence in 1930.

Specifically, for those new counties born between 1910 and 1930, I utilized population information in 1930 to impute 1920 and 1910 populations, as well as all demographical variables in 1920 and 1910. I used urbanization information in 1930 to impute urbanization in 1920 and 1910. I used the share of farmland (as a percentage of county land mass) in 1930 to impute the amount of farmland in 1910 and 1920. Lastly, I applied the imputed 1920 populations and the number of retail establishments in 1930 to impute the number of retail establishments in 1920.

The following are all county boundary changes in the 1910s that resulted in new counties being created. Each case is separated by a comma. For each case, new county/counties come first and pre-existing county/counties are in parentheses.

Texas: Hudspeth and Cuberson (El Paso), Kleberg and Jim Wells (Nueces), Brooks and Jim Hogg (Hidalgo and Starr), Real (Edwards and Bandera), Willacy (Cameron).

Georgia: Bleckley (Pulaski), Atkinson (Coffee and Clinch), Bacon (Ware, Pierce, and Appling), Barrow (Gwinnett, Walton, and Jackson), Candler, Evans, Wheeler, and Treutlen (Bulloch, Emanuel, Tattnall, and Montgomery).

The following are all county boundary changes in the 1920s that resulted in new counties. Again, for each case, newly-created county/counties come first and pre-existing county/counties are in the parentheses.

Texas: Kenedy (Willacy).

Georgia: Brantley (Wayne, Pierce, and Charlton), Lamar (Pike and Monroe), Lanier (Berrien, Lowndes, and Clinch), Long (Liberty), Peach (Houston), Seminole (Decatur).

Milton and Campbell counties were the only two defunct counties in this period. They merged into Fulton County in 1931, but their data were missing for 1930. For all pre-1930 variables, I added Milton and Campbell numbers into Fulton's before dropping them.

Appendix A-3: A Note on How the Straight-Line Virtual Highway Network Was Constructed

This note is about the construction of the straight-line virtual highway network used for the instrumental variable design. I first describe the list of cities and forts that I used as "nodes" of the network. Then, I presented graphs that showed how the nodes were connected in three steps.

As explained in section 1.4.1, I chose (a) the top 100 most populous cities in 1920, (b) state capitals (if they are not already on the top-100 list), and (c) permanent military forts established during 1914-1918 to be "nodes" of the straight-line virtual highway network. First, the list of top-100 most populous urban places in 1920 can be found here: https://www.census.gov/population/www/documentation/twps0027/tab15.txt. Note "Lynn, MA" is incorrectly listed das "Lynn, LA" in that document.

Second, the list of state capitals can be found here: https://en.wikipedia.org/wiki/List_of_capitals_in_the_United_States#State_capitals

The coordinates (latitude-longitude) of top-100 cities and state capitals are obtained from Wikipedia and verified using Google Maps. The coordinate data are available upon request.

An official comprehensive list of military fortifications built between 1914 and 1918 was not included in Annual Reports of Secretaries of War or Annual Reports of Secretaries of Navy. So for the list of permanent military facilities built for World War I, I relied on information from the following webpages, which provide both names and coordinates of these military facilities[40]:
https://en.wikipedia.org/wiki/List_of_United_States_military_bases,
https://www.fortwiki.com/World_War_I,
http://www.fortwiki.com/Category:World_War_I_Forts

I first selected among all currently active military bases those that were established between 1914 and 1918 using the first link. I then used the second and the third link to

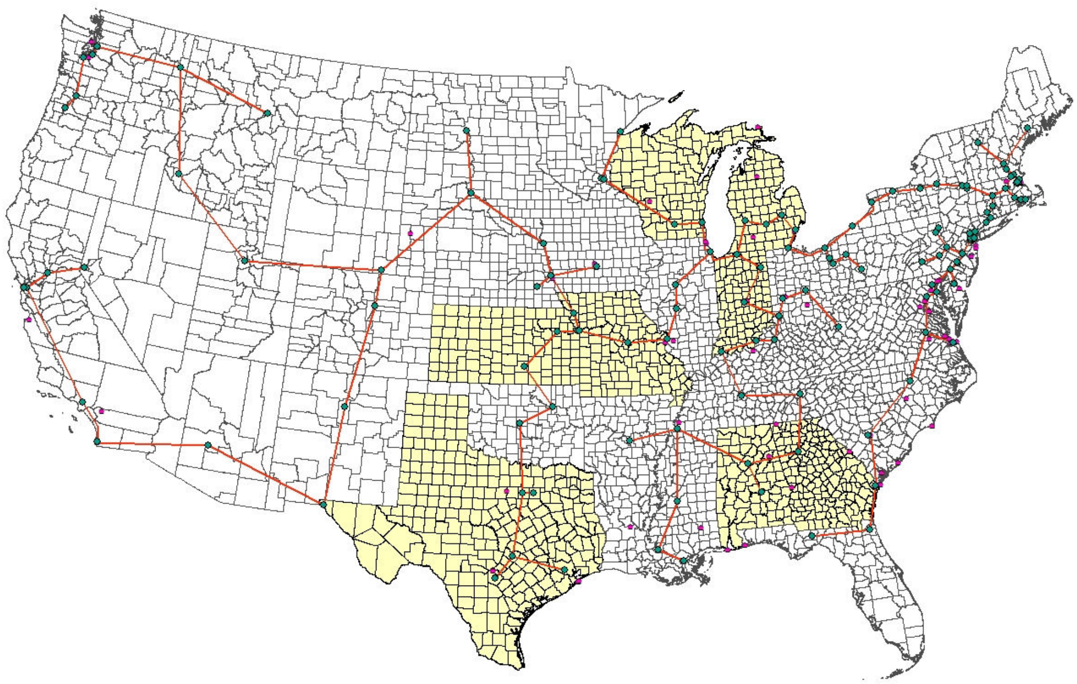
[40] All five links are still accessible as of August 9, 2016.

add to the list those inactive or abandoned bases built between 1914 and 1918. I did not include temporary training camps facilities that were only used during one of the World Wars. Through these steps, I obtained the list of permanent military bases constructed for World War I, which I used as nodes. (In cases of name changes and mergers, I only list merged bases under current names.)

Alabama: Fort McClellan, Fort Gaines, Maxwell AFB;
California: Fort Ord, Fort Winfield Scott, March ARB, NB San Diego, MCRD San Diego, MCAS Miramar;
District of Columbia: Joint Base Anacostia-Bolling;
Delaware: Fort Saulsbury;
Florida: NAS Pensacola;
Georgia: Fort Oglethorpe, Augusta Arsenal, Fort Benning (partially in Alabama), Fort Screven;
Iowa: Fort Des Moines, Camp Dodge;
Illinois: Fort Sheridan, Scott AFB, Naval Station Great Lakes;
Indiana: Fort Benjamin Harrison, Jeffersonville Quartermaster Depot;
Kentucky: Fort Knox;
Louisiana: Camp Beauregard;
Massachusetts: Fort Devens, Fort Duvall, East Point MR;
Maryland: Fort Meade, Aberdeen Proving Ground, Edgewood Arsenal;
Michigan: Fort Brady, Fort Wayne, Camp Grayling, Fort Custer;
Missouri: Jefferson Barracks;
Mississippi: Camp Shelby;
North Carolina: Fort Bragg, Fort Caswell;
Nebraska: Fort Robinson, Offutt AFB;
New Jersey: Highlands MR, Fort Monmouth, Joint Base McGuire-Dix-Lakehurst;
Ohio: Fort Hayes, Wright-Patterson AFB, Camp Sherman;
South Carolina: Fort Jackson, Fort Moultrie, Fort Sumter, MCAS Beaufort;
Tennessee: NSA Mid-South;
Texas: Camp Stanley, Camp Bullis, Fort Sam Houston, Leon Springs MR, Fort Crockett, Fort Travis, Fort San Jacinto, Fort Wolters, Fort Bliss;
Virginia: Fort Lee, Fort Story, Langley AFB, Naval Weapons Station Yorktown, Naval Surface Warfare Center Dahlgren Division, NS Norfolk, MCB Quantico, Fort Belvoir;
Washington: Fort Lewis, NB Kitsap;
Wisconsin: Fort McCoy.

Now, I described how I connected these nodes above. First, I first connected all the city nodes (top-100 most populous cities in 1920 plus state capitals that did not make that list) using Kruskal's minimum spanning tree algorithm. Kruskal's minimum spanning tree algorithm starts with connecting the two cities that were closest to each other, and then connects another pair that had the second smallest straight-line distance between them. In each iteration, one always makes sure the length of the added straight line is the smallest among all the potential undrawn lines (hence the name "minimum spanning") until all the nodes are connected with at least one other node. The straight-line network after finishing this first step can be seen in Figure 1.16 below.

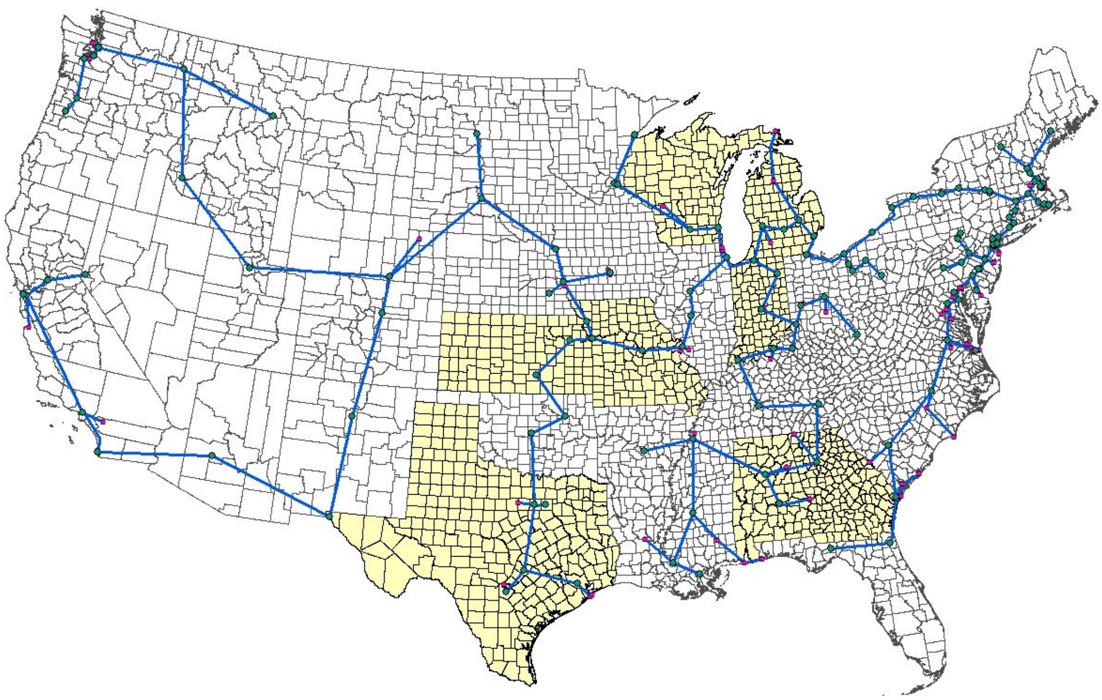
Figure 1.16 Straight-line Network, Step 1



In the second step, each permanent military base was connected to its nearest city, which could be a top-100 city in the state that the military base it was located in, or the state capital, or a city in the nearby state. Military bases on an island are not connected. This step added some "feeder routes". The straight-line network after finishing the second step can be seen in Figure 1.17 below.

To compensate for the loss of route precision caused by having too few lines, I added routes to ensure that at least one line connects every city node with its nearest neighbor within the state, for example, a line was added to connect El Paso with San Antonio, and another line was added between Nashville and Memphis. I also added routes to ensure that each state is connected with all its neighboring states on land, with a few exceptions: 1) At the Four Corners, I did not connect Colorado with Arizona, New Mexico with Utah, diagonally; 2) At the Oklahoma panhandle, I did not connect Oklahoma with New Mexico and Colorado; 3) I did not draw a straight line connecting Michigan's Upper Peninsula with Wisconsin; 4) Nebraska (Omaha) was connected with South Dakota (Pierre) via Sioux City, Iowa, not directly; 5) Virginia (Richmond) was connected with Kentucky (Lexington) via Charleston, West Virginia, not directly. The completed straight-line network can be seen in Figure 1.10 in the main text.

Figure 1.17 Straight-line Network, Step 2



The decision of adding additional routes to increase the precision of this network admittedly subjective, but it is also an intuitive one because the Federal Government's intervention in this whole highway building process was mainly to ensure different states were connected through highways. I acknowledge that with these additional routes, some states in the West may look too "connected", but this stop does provide the necessary precision so that the distance from county seats to this network of straight lines can be a strong-enough instrument. If I were to expand the study to cover the West, I will take into topography into account so that I can reasonably reduce the number of virtual routes in the West.

Appendix A-4: Counties Excluded from Regression Analysis

The following counties are excluded from the sample for regression analysis because they contain a state capital or one of the top-100 most populous cities in 1920:

Alabama: Jefferson, Montgomery;
Georgia: Chatham, Fulton;
Michigan: Genesee, Ingham, Kent, Wayne;
Texas: Bexar, Harris, Tarrant, Travis, Dallas, El Paso;
Kansas: Sedgwick, Shawnee, Wyandotte;
Indiana: Marion, St. Joseph, Allen, Vanderburgh;
Wisconsin: Brown, Dane, Milwaukee;
Missouri: Buchanan, Cole, Jackson, St Louis City.

The following suburban counties are also excluded. In order to be considered suburban, they need to be a large share of urban population and be adjacent to a county containing a city of more than 150,000 people.

Michigan: Macomb, Oakland;
Wisconsin: Waukesha, Washington, Ozaukee;
Missouri: Clay, Dent, Platte, St. Louis;
Georgia: Cobb, Clayton, DeKalb, Douglas.

Appendix B: Supplementary Tables to Chapter 1

Appendix Table B-1 OLS Estimates Clustered at County Level

	(1)	(2)	(3)	(4)
Panel A: Percentage Change in the Total Number of General Stores				
log(Expenditure)	-1.232***	-0.485**	-0.546***	-0.387***
	(0.125)	(0.119)	(0.175)	(0.116)
Observations	906	906	906	905
R-squared	0.077	0.101	0.124	0.128
Panel B: Percentage Change in the Number of Rural General Stores				
log(Expenditure)	-1.267***	-0.733*	-0.621**	-0.536***
	(0.210)	(0.267)	(0.137)	(0.135)
Observations	906	906	906	905
R-squared	0.247	0.292	0.318	0.326
State FE	Y	Y	Y	Y
No. of Stores (1922), Pop Density, Land Mass	N	Y	Y	Y
Demographic + Geographic Controls	N	N	Y	Y
Economic Controls	N	N	N	Y
S.E. Clustered at County Level	Y	Y	Y	Y

Note to Appendix Table B-1: The only difference between this table and Table 1.6 is that standard errors are clustered at the county level not at the regional level in this table. *** p<0.01, ** p<0.05, * p<0.1

Appendix Table B-2 2SLS Estimates with Three Instruments, First-stage

	(1)	(2)	(3)	(4)
First Stage of Panel A. DV: log(Expenditure)				
log(d_Network)	-0.0894*	-0.252**	-0.279**	-0.301***
	(0.0489)	(0.112)	(0.133)	(0.0961)
log(d_Network) * log(d_City)	0.0320**	0.0587**	0.0681**	0.0802***
	(0.0154)	(0.0269)	(0.0314)	(0.0356)
Number of Bodies of Water	0.0468***	0.0715***	0.0639***	0.0619***
	(0.0164)	(0.0202)	(0.0191)	(0.0193)
Observations	906	906	906	905
1st-stage F-stat	7.741	8.276	9.687	10.750
First Stage of Panel B. DV: log(Expenditure)				
log(d_Network)	-0.0875**	-0.242***	-0.281**	-0.306***
	(0.0438)	(0.109)	(0.129)	(0.0932)
log(d_Network) * log(d_City)	0.0212**	0.0608**	0.0697*	0.0781***
	(0.0107)	(0.0281)	(0.0314)	(0.0311)
Number of Bodies of Water	0.0414***	0.0710***	0.0684***	0.0617***
	(0.0117)	(0.0192)	(0.00177)	(0.0189)
Observations	906	906	906	905
1st-stage F-stat	7.840	9.501	9.619	10.451
State FE	Y	Y	Y	Y
No. of Stores (1922), Pop Density, Land Area	N	Y	Y	Y
Demographic + Geographic Controls	N	N	Y	Y
Economic Controls	N	N	N	Y
S.E. Clustered at Regional Level	Y	Y	Y	Y

Note to Appendix Table B-2: The table presents estimated coefficients from the first-stage of instrumental variables specifications, where the dependent variable is log highway expenditures, and the excluded instruments are, in addition to the two used in Table 1.8 and 1.9 (the log distance from each county seat to the nearest segment of the straight-line network and its interaction with log distance from county seat to the nearest top-100 city), the number of lakes plus swamp in a county. Everything else is the same as Table 1.8.
*** p<0.01, ** p<0.05, * p<0.1

Appendix Table B-3 2SLS Estimates with Three Instruments, Second-stage

	(1)	(2)	(3)	(4)
Panel A: Percentage Change in the Total Number of General Stores				
log(Expenditure)	-1.945**	-1.701***	-1.328***	-0.867***
	(0.838)	(0.574)	(0.428)	(0.311)
Observations	906	906	906	905
p-value of Overid Test Stat	0.439	0.336	0.783	0.447
Panel B: Percentage Change in the Number of Rural General Stores				
log(Expenditure)	-2.290***	-1.989***	-1.795**	-1.142**
	(-0.601)	(0.688)	(0.739)	(0.352)
Observations	906	906	906	905
p-value of Overid Test Stat	0.565	0.624	0.725	0.441
State FE	Y	Y	Y	Y
No. of Stores (1922), Pop Density, Land Area	N	Y	Y	Y
Demographic + Geographic Controls	N	N	Y	Y
Economic Controls	N	N	N	Y
S.E. Clustered at Regional Level	Y	Y	Y	Y

Note to Appendix Table B-3: The table presents estimated coefficients from the second-stage of instrumental variables specifications, where the dependent variables are percentage change in the number of general stores, and log highway expenditure is instrumented by 1) the log distance from each county seat to the nearest segment of the straight-line network, 2) its interaction with log distance from county seat to the nearest top-100 city and 3) the number of lakes plus swamp in a county.. Other than adding another instrument, everything else is the same as Table 1.8. *** p<0.01, ** p<0.05, * p<0.1.

Appendix Table B-4 LIML Estimates with Two Instruments, First-stage

	(1)	(2)	(3)	(4)
First Stage of Panel A. DV: log(Expenditure)				
log(d_Network)	-0.0833	-0.224**	-0.261***	-0.311***
	(0.0478)	(0.0992)	(0.109)	(0.0797)
log(d_Network) * log(d_City)	0.0298	0.0490***	0.0622***	0.0193***
	(0.0181)	(0.0188)	(0.0218)	(0.00429)
Observations	906	906	906	905
1st-stage F-stat	6.250	7.231	7.264	7.854
First Stage of Panel B. DV: log(Expenditure)				
log(d_Network)	-0.0945**	-0.277***	-0.345***	-0.403***
	(0.0381)	(0.0897)	(0.118)	(0.0418)
log(d_Network) * log(d_City)	0.0242**	0.0508***	0.0681***	0.0304***
	(0.0121)	(0.0199)	(0.0203)	(0.00849)
Observations	906	906	906	905
1st-stage F-stat	6.301	7.987	7.861	8.401
State FE	Y	Y	Y	Y
# of Stores (1922), Pop Density, Land Area	N	Y	Y	Y
Demographic + Geographic Controls	N	N	Y	Y
Economic Controls	N	N	N	Y
S.E. Clustered at Regional Level	Y	Y	Y	Y

Note to Appendix Table B-4: The table presents estimated coefficients from the first-stage of instrumental variables specifications. Other than the estimated coefficients, the only difference between this table and Table 1.8 is the estimation method used, instead of two-stage least square (2SLS), I use the limited information maximum likelihood (LIML), which is considered to be the more conservative choice if there is weak IV concern. Everything else carries through from Table 1.8: the same two instruments, the same set of controls, the same weights, sample, and clusters are used. *** p<0.01, ** p<0.05, * p<0.1

Appendix Table B-5 LIML Estimates with Two Instruments, Second-stage

	(1)	(2)	(3)	(4)
Panel A: Percentage Change in the Total Number of General Stores				
log(Expenditure)	-1.738***	-1.421***	-1.371***	-0.831***
	(0.601)	(0.474)	(0.408)	(0.214)
Observations	906	906	906	905
p-value of Overid Test Stat	0.312	0.346	0.563	0.619
Panel B: Percentage Change in the Number of Rural General Stores				
log(Expenditure)	-2.190***	-1.719***	-1.495***	-1.012***
	(-0.501)	(0.458)	(0.539)	(0.252)
Observations	906	906	906	905
p-value of Overid Test Stat	0.491	0.621	0.581	0.541
State FE	Y	Y	Y	Y
# of Stores (1922), Pop Density, Land Area	N	Y	Y	Y
Demographic + Geographic Controls	N	N	Y	Y
Economic Controls	N	N	N	Y
S.E. Clustered at Regional Level	Y	Y	Y	Y

Note to Appendix Table B-5: The table presents estimated coefficients from the second-stage of instrumental variables specifications. The only difference between this table and Table 1.9 is the estimation method used, instead of two-stage least square (2SLS), I use the limited information maximum likelihood (LIML), which is considered to be the more conservative choice if there is weak IV concern. Everything else carries through from Table 1.8: the same two instruments, the same set of controls, the same weights, sample, and clusters are used. *** p<0.01, ** p<0.05, * p<0.1

Chapter 2: Highways, Schooling, and Race in the South: 1920-1932

2.1 Introduction

In the first forty years of the twentieth century, the expansion of free public high schools (“high school movement”) caused educational attainment of Americans to improve quite substantially: high school graduate rate grew exponentially from 9 percent in 1910 to 50 percent by 1938 (Black and Sokoloff (2006)). During this time, Southern states, which had lagged behind in the provision of public education as compared to the rest of the country since the second half of the nineteenth century, also witnessed dramatic growth in educational spending. As a result, enrollment rates and years of education obtained among young people in the South increased substantially. On the other hand, the segregated school system in the South was “separate but *not* equal” (Ashenfelter et. al (2006)). Local school boards invested most of their resources in white schools. Even though black schools also experienced huge improvements in funding as well as in educational outcomes during this period, racial disparity in absolutely terms increased from 1900 to 1940. (Aaronson and Mazumder (2011), Anderson (1988), and Margo (1990)).

Analyses using county-level data from Georgia and Alabama establish a positive, significant, and robust relationship between Federal-Aid Highways spending and increase in per student spending for both white and black schools: a 1 percent increase in highway spending is associated with a $33 increase in per student spending in white schools from 1920 to 1930, equivalent to 24 percent of median per student spending among white schools in 1920.[41] On the other hand, the same 1 percent hypothetical increase in highway spending is only associated with a $1.8 increase in per student spending for blacks from 1920 to 1930, equivalent to 7 percent of median spending per black student

[41] All monetary variables used in this chapter have been converted to 2009 dollars. so any quoted figures should be thought of in present dollar terms.

in 1920. As a result, a 1 percent increase in highway spending would widen the per student spending gap between whites and blacks by 18 percent over ten years. Greater highway expenditure is also associated with an expansion of public school enrollment and the lengthening of the school year in black schools.

There are many possible mechanisms through which the construction of highways could lead to improvement in education. On the demand side, economic integration and restructuring of local economy could increase people's perceived benefit of education, which would encourage families to send their children to school and demand better education. (Jensen (2010)) In this era of Great Migration, African Americans moved to the North for better job opportunities tend to be more educated. (Collins, Wanamaker (2014)). It is plausible that the information flows brought by highways encouraged young people, or their parents to go to school to increase their chances of getting a good job in the North. On the supply side, highways could have lowered the transportation costs of going to school, although this channel might be minor given the low automobile ownership per capita in the South, especially among African Americans, and the lack of school buses in the South in this era. Another supply-side channel might be through the impact of highways on land or property values: land values tend to increase in the vicinity of transportation infrastructures (Mohring (1961), Edel and Sclar (1974)), giving local governments more money to spend on education.

A comprehensive evaluation of mechanisms from both the demand side and the supply side is beyond the scope of this study. These data admit a test of the hypothesis that highways encouraged investment in education by private philanthropy, which improved educational outcomes. Operating from 1913 to 1948, the Julius Rosenwald Fund aimed to improve African American education and reduce racial disparity in education in the South. From 1914 to 1933, the Rosenwald Fund bankrolled the construction of nearly 5,000 schools for rural black students across 15 Southern states, 644 of which in the states of Georgia and Alabama.[42] I find a very strong and sizable relationship between highway spending and the number of Rosenwald schools and the

[42] Basic facts about the Rosenwald Fund come from the online catalogue of Special Collection and Archives in Fisk University Library. https://www.fisk.edu/academics/library/special-collections-and-archives#R

amount of contribution from the Rosenwald Fund. Moreover, consistent with prior studies such as Aaronson and Mazumder (2011) and Carruthres and Wanamaker (2013), I find that measures of Rosenwald schools and funding are very predictive of changes in educational spending per student, enrollment, and length of school year.

While the tradeoff between government expenditure on road versus education has been studied in the context of India (Chaudhary, 2006), this study may among the first to examine this choice in the United States. More work is needed to better understand the mechanisms by which highway spending affects education. I suggest in Section 2.5 several possible improvements to this study.

2.2 Historical Context

2.2.1 Race and education in early twentieth century U.S. South

In the early twentieth century, as it is today, education in America was highly decentralized. Decisions concerning school finance, hiring of teachers, and curriculum were made locally by school districts. In the early twentieth century, the level of decentralization was even higher than it is today: one-room school houses were still prevalent in the countryside; the number of elementary and secondary schools went down from about 275,000 in 1930 to about 130,000 in 2012, and the number of school districts dropped from about 128,000 in 1932 to a little more than 16,000 in 2004.[43] The biggest change to occur in U.S. primary and secondary education in this period was the "high school movement" that established free and accessible high schools nationwide (Goldin, 2005). From 1910 to 1940, the national average of per capita spending in primary and secondary education increased by more than 200 percent, and the high school graduation rate nationwide rose from 8.8 percent to 50.4 percent.[44]

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[43] See series Bc1-6 in the *Historical Statistics of the United States, Millennium Edition*, and the National Center for Education Statistics' "Digest of Education Statistics" for 2013-14, Table 105.50 and "Local Education Agency Universe Survey in 2003-04".

[44] Per capita spending in 1910 and 1940 are taken from of the 1935 and 1943 editions of the *Statistical Abstract of the United States*. "Per capita spending" is defined as total expenditures in public elementary and

Due to its agricultural economy and its aristocratic cultural traditions, the South fell far behind the rest of the nation in education since at least 1840. (Sokoloff and Engerman (2000), Barnard and Burner (1975)). Figure 2.1 shows that between 1910 and 1940, per student expenditure on elementary and secondary education in states in the Deep South was about one third that of the Midwestern states.[45] Educational outcomes were also much weaker in the South: in 1920, the high school graduation rate was 16 percent for all 48 states and 20 percent for the 32 non-Southern states; in 1938, the same numbers were 48 percent and 56 percent (Goldin and Katz (2009)). By 1920, a significant portion of both white and black children aged 10 to 14 did not attend school, and a significant portion of African Americans aged 10 and above were illiterate (Margo (1990)). Figure 2.2 shows that by 1940, white schools in the South still had had a school year that was on average 30 days shorter than the average school year in the Midwest. But Figures 2.1 and 2.2 also show impressive improvement in the quality of education: in the interwar years, a three-fold increase in per student spending was not uncommon among Southern states, the average length of school year grew from less than 90 days to almost 130 days.

As of 1940, 17 Southern states had school segregation laws. Segregation was "separate but *not* equal" (Ashenfelter et. al (2006)). Education funding was allocated according to the size of school-age population. However, funds for black schools were often diverted to white schools. Monetary and in-kind contributions from black parents supplemented meager resources provided by local school boards and kept black schools running. For black families striving to send their children to school, it was essentially a system of double taxation (Margo (1990), Anderson (1988)). There were profound gaps between white and black public schools in expenditures per student, attendance, length of

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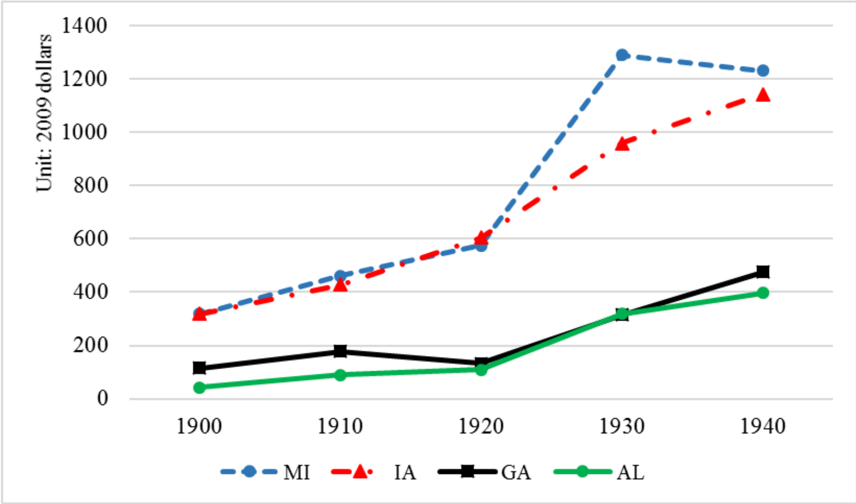
secondary schools divided by number of young people aged 5 to 17. Graduation rate data are from Goldin and Katz (2009). Graduation rates are expressed as a proportion of 17-year olds.

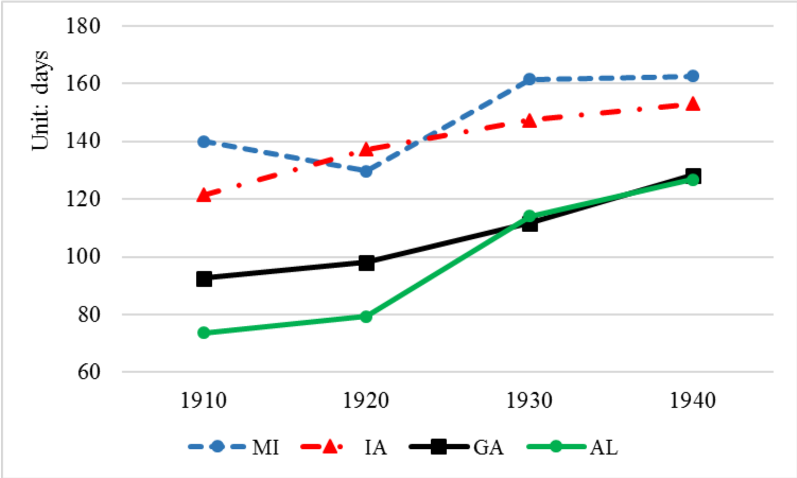
[45] There is some heterogeneity among Southern states. For example, Virginia and Louisiana spent much more than Georgia and Alabama per student. There is also within-group heterogeneity among Midwestern states. For Figures 2.1 and 2.2, I choose Georgia, Alabama, Michigan, and Iowa because Georgia, Alabama, and Michigan are in my highway dataset and Iowa is a quintessential Midwestern state that can represent the "average" education funding and attainment in the West North Central census division in this period.

Figure 2.1: Education Expenditures per Pupil, 1900 to 1940



Sources: Education expenditures per student is defined as all expenditures on public elementary and secondary schools divided by the number of enrolled students of all races. Total expenditure includes new buildings as well as operation and equipment expenditures, but does not include expenditures of any kind in private schools. The data sources are Table 124 in U.S. Statistical Abstracts (1929), Table 117 in U.S. Statistical Abstracts (1935), and Table 226 in U.S. Statistical Abstracts (1943). The unit on the vertical axis is real 2009 dollars.

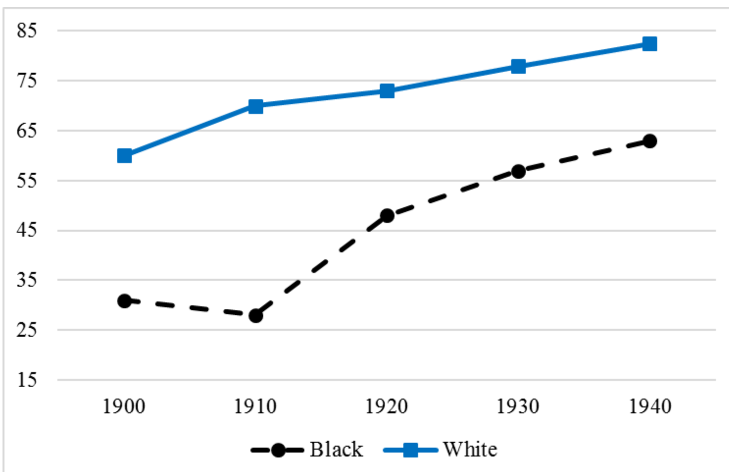
Figure 2.2: Length of School Year, 1910 to 1940



Source: Length of school year represents a state-average among public elementary and secondary schools, it did not reflect the length of school year in private schools. Table 122 in U.S. Statistical Abstracts (1929), Table 116 in U.S. Statistical Abstracts (1935), and Table 224 in U.S. Statistical Abstracts (1943). Unit on the vertical axis: days.

school year, and teachers' salaries.[46] Racial disparity between 1900 to1940 was the worst in history as a result of both the disfranchisement of African Americans and the demand for better white schools (Margo (1990)). Figures 2.3 plots the attendance rates among white and black school-age children in 12 southern states from 1900 to 1940. While rates seem to converge, the huge racial gap persists. Figure 2.4 shows per capita spending for the education of white and black children in 1914-15 and 1929-30.[47] One can see that there is some heterogeneity in absolute levels of per capita spending between states: North Carolina for example invested more heavily in education than Alabama, Mississippi, and Georgia. But the per capita spending gap is massive for all states.

Figure 2.3
Percentage of White and Black Children aged 5 to 18 Attending School, 1900 to 1940



Source: Bullock (1967), page 170. This is the average attendance rate across the following southern states: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Texas, and Virginia.

Many studies have tried to explain the overall improvement that was accompanied by a persistent racial gap in Southern education expenditures and outcomes in the early twentieth century. Bleakley (2007) pointed out the eradication of hookworm disease raised return to schooling, thereby encouraging more people to go to school. Lingwall

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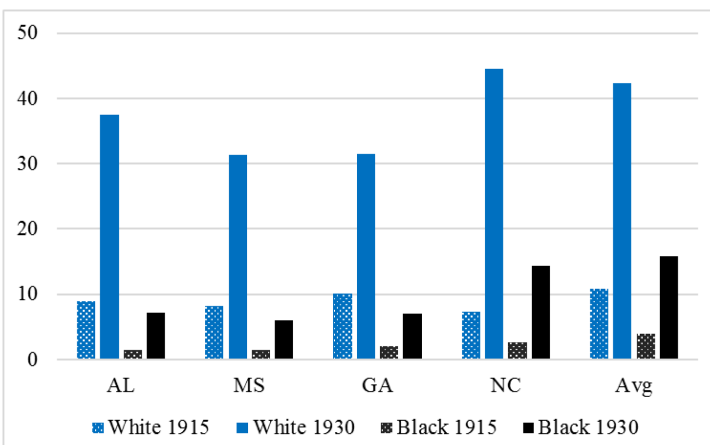
46 See for example in Bullock (1967), Margo (1990), and U.S. Statistical Abstracts in various years in the 1930s and 40s.

47 Here I use the numbers provided by Bullock (1967). "Per capita spending" is defined as total expenditures in public schools divided by total population. This is not to be confused with the concept of "per student spending", which I use for my regression results. "Per student spending" is defined as total expenditures in public schools in a given year divided by number of enrolled students that year.

(2014) analyzed the impacts of compulsory attendance and child labor laws on changes in Southern education. Donohue, Heckman, and Todd (2002) identified both NAACP's legal action and private philanthropy as factors contributing towards improved educational outcomes for African Americans.

The Julius Rosenwald Fund was a private charitable foundation dedicated to black education in the South that has been the subject of much contemporary economic research. The Rosenwald Fund began as a collaboration between Booker T. Washington, the principal of the Tuskegee Institute in Alabama, and Chicago businessman and philanthropist Julius Rosenwald, one of the founders of Sears, Roebuck, and Company. The Rosenwald Fund facilitated the construction of almost 5,000 schoolhouses for black children from 1914 to 1932, most of which were located in rural communities. These Rosenwald schools were constructed following several standardized floorplans, had adequate lighting, sanitation, and ventilation and were equipped with appropriate learning materials. By 1932, an estimated 36 percent of southern rural blacks of school age could have attended a Rosenwald school (Aaronson and Mazumder (2011)).

Figure 2.4 Per Capita Annual Expenditures for the Education of White and Black Children, 1914-15 versus 1929-30



Source: Bullock (1967), page 180. Unit on the vertical axis: current dollars, not converted by CPI or GDP deflator. The "average" is the average over Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Texas, Virginia.

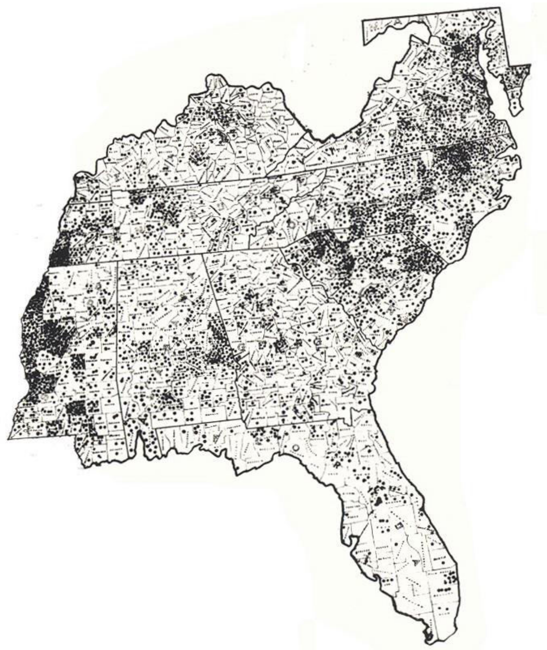
Quite a few recent economics studies estimated on the impacts of Rosenwald schools. Donohue, Heckman, and Todd (2002) pointed out Rosenwald schools improved both blacks' access to schools and quality of education. Aaronson and Mazumder (2011) found significant effects on school attendance, educational attainment, northern migration, and narrowing the racial gap. Carruthers and Wannamker (2013) showed that Rosenwald schools did not clos the racial gap in education. Eriksson (2015) found Rosenwald schools reduced black-white incarceration gap primarily by increasing the opportunity cost of committing a crime. Kreisman (2016) compared the effects of Rosenwald Fund, which focused on improving physical infrastructure of black schools, and Jeanes Fund, which focused on supporting black schools through teacher training, administrative work and fundraising and found that the Rosenward program was considerably more effective dollar-for-dollar.

Figure 2.5 shows that there is great variation in the density of Rosenwald schools within and across states. The geographical distribution of African Americans was one key determinant of where people at the Rosenwald Fund decided to build their schools. The Rosenwald Fund was a matching grant. Matching contributions were required for the financial backing from the Fund to construct any Rosenwald school. This funding scheme meant that the support from local community and local government was an important determinant of where Rosenwald schools were built. Aaronson and Mazumder (2011) showed that white literacy rates predict the presence and the number of Rosenwald schools and speculated that more educated white communities were more likely to see the benefits of a more educated African American labor force.

2.2.2 Highway Construction in the South

The United States experienced a transportation revolution during the interwar period. As a response to the exponential growth of automobile ownership and an ever-increasing demand for road transportation, the federal government started the Federal-Aid Highway program. The nation (federal, state, and local governments combined) spent an average of 0.3 percent of GDP on highway building in the 1920s

Figure 2.5 Rosenwald Fund Schoolhouse Construction Map, 1932



Source: Fisk University, John Hope and Aurelia E. Franklin Library Special collection, Julius Rosenwald Fund Archives. Each dot on the map represents one Rosenwald School regardless of its size or type. This zoomed-in image only covers the east part of the map. This image is made available through http://www.historysouth.org/schoolmap/ (Last accessed July 31, 2016).

and 30s. Over 90,000 miles of roads were constructed or improved. By 1939, this network of Federal Highways was largely completed. The nation became much more connected as a result of it.

The internal improvements and the subsequent socio-economic changes brought by these Federal-Aid highways might be more dramatic in the South. After the Civil War, the South had been poor and had not been integrated to the rest of the country economically. By 1920, the density of railroads in the South was far lower than in other regions of the United States except for the Mountain West, and good quality intercity roads were rare. Given this initial low level of transportation networks in the South, the "treatment" of Federal-Aid Highways likely had a greater effect in the South than in other parts of the country.

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Prior to World War II, the federal government's involvement and fiscal commitment to highway finance was limited. The decision of where to build highways was jointly made by the state highway authority and the Bureau of Public Roads under United States Department of Agriculture. The Bureau of Public Roads made sure routes were connected at state borders and they formed a national network. Federal aid came as a matching grant covering between 30 and 40 percent of the construction cost. The poor or the more sparsely populated the state, the grater the share of construction costs covered by Federal-Aid grants. Federal government wrote out grants to state highway authorities to reimburse part of the construction cost. State governments bore the largest share of the fiscal burden of highway construction and were solely responsible for maintenance. Local governments (county and below) were neither consulted in the decision of where to locate highways or were they expected to directly contribute to highway construction or maintenance. Highways were funded through federal grants and the gasoline tax and automobile registration fees that states levied.

2.3 Data

County-level public school data are from annual reports issued by state Departments of Education, or equivalent governmental units at the state level. These state government agencies compiled educational statistics on an annual or biennial basis based on reports from local school districts. This newly transcribed dataset covering 10 Southern states from 1919 to 1939 were generously shared by Celeste Carruthers. The statistics used in this study include county-level enrollment, expenditures, number of schools, and length of school year (in days). All variables were reported separately for white and African American schools. In the online appendix of Carruthers and Wanamaker (2013), they discussed in the various quality checks that they did.

County-level statistics of Federal-Aid Highway projects come from state Highway Department reports. I used the same highway data in the first chapter of this dissertation. The nature of the highway dataset and the data collection process was extensively discussed in that chapter and its data appendix. For reasons explained in the first chapter, I continue to use “total expenditures on Federal-Aid Highway projects from 1921 to 1930” as the preferred measure of highway activity in the following analyses.

This study also draws evidence from a variety of other data sources. Demographical and economic characteristics of counties, such as total population, urban population, population density, population aged 7 to 20 years, share of population that were black, foreign-born white, and Catholic, manufacturing variables (value-added of manufactured goods, manufacturing wages per worker, share of population working in manufacturing), total value of crops, and total value of farmland, buildings, and equipment are from decennial censuses compiled in “Historical, Demographic, Economic, and Social Data: United States, 1790—2002” (ICPSR 02896). Number of people aged 7 to 20 by race are imputed using IPUMS 1% sample in 1910, 1020, and 1930. County-level automobile registration data published by the Tuttle Company are generously shared by Paul Rhode. Rosenwald school data, including year and location of Rosenwald school projects, expenditures on those projects by type and by source, are stored at the Rosenwald Fund’s archives at Fisk University. The digitized Rosenwald data are publicly available per the Journal of Political Economy’s data disclosure policy.[48]

There are some limitations of these data. First, the public school data are county-level aggregations and neither the Rosenwald school dataset nor the highway dataset is geo-coded, so the analysis has to be conducted at the county level. Second, all schooling data were aggregated across grades K-12. There was still considerable age-in-grade retention (Goldin (2005)), so breaking down children by grade is not possible with these data. Third, very few states have both high-quality highway and public school data, which limits the geographical coverage of the study. As of now, this study only draws evidence from counties in Georgia and Alabama in the 1920s. The public school data are available from 1920 to 1939 for ten southern states. In the future, this study can be expanded geographically to that had more comprehensive education data, such as North Carolina, Louisiana, and Tennessee. This study can also be extended longitudinally to the end of the 1930s.

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[48] These data can be downloaded as a part of Aaronson and Mazumder (2011)’s supplementary materials at DOI: 10.1086/662962.

2.4 Evidence from Alabama and Georgia

Table 2.1 presents descriptive statistics for the sample of Georgia and Alabama counties. These counties were predominantly rural, sparsely populated, did not have much manufacturing activity, had a significant share of African American population but very few foreign-born persons, and the dominant religion practiced was Protestantism. Summary statistics also showed the scale of the Federal-Aid Highway program: half of the counties obtained more than 25 miles of newly built or improved highways. In terms of educational outcomes, county-level statistics painted a picture of both significant improvement and significant racial disparity. For both white and black students, per-student expenditures more than doubled, and the length of school year increased by more than 20 percent. Both indicated great improvement in the quality of education.[49] White and black enrollments each expanded modestly by about 5 percent. Improvements in black schools seemed to happen at a faster pace compared to white schools, but significant improvements also took place in white school, and hence the absolute gap between white and black children widened. The median white-to-black ratio of per student expenditures grew from 5.2 to 6.7, and the gap in the length of school year also increased by a week.

To estimate the effects of highways on education, I use the following specification

$$\Delta y_i = \beta_0 + \beta_1 \cdot Hwy_i + \gamma X_i + d_s + \varepsilon_i$$

in which Δy_i is the change in the dependent variable from 1920 to 1930, Hwy_i is log total expenditure in Federal-Aid Highways from 1921 to 1930, d_s is the Georgia state dummy, and ε_i is the residual. X_i is a vector of likely determinants of the outcome of interest. The standard errors are clustered at the county level.

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[49] Per-student expenditure measures the amount of resources put in to education. While resources would not translate to educational attainment unambiguously and ubiquitously (Card and Krueger (1996)), resources should still be considered a proxy for quality of education. Following Card and Krueger (1992), many papers consider term length (i.e. length of school year) to be a predictor of quality of education, along with annual teacher salary, and student-teacher ratio,

I run first-difference regressions with a little over 200 observations. Degrees of freedom necessitate parsimony in the choice of control variables, which I am largely guided by the literature. First, many studies have found that communities with more ethnical and cultural homogeneity were more likely to overcome collective action problems and support more spending on club goods like public education (Alesia, Baqir, and Easterly (1999), and Goldin and Katz (1999)). I therefore include shares of blacks, foreign-born whites, and Catholics to control for ethnical and cultural homogeneity as controls. For “share of black population”, past studies have found that racial relationship changed dramatically when the share of black population reached a certain critical mass. (Anderson (1988).) So instead of using one continuous measure, I use two dummies: whether the share of black population exceeds 25 percent but below 50 percent, whether the share of black population is above 50 percent.

I also control for economic determinants of schooling. For example, the opportunity cost of education would be constantly on the minds of students and parents alike. Following the literature, (Goldin and Katz (1999), Collins and Margo (2005)), I use average manufacturing wage as a proxy for the opportunity cost of education for children 10 or 12 and above. Holding other factors equal, richer communities tend to be more willing and able of spending more in public education. (Black and Sokoloff (2006), Aggarwal (2015)) In absence of home value, tax return, or income data, log change in value of farmland and improvement from 1920 to 1930 is the best proxy for wealth that I can use as a control variable.

2.4.1 Highways and Per-Pupil Spending

I first evaluate the effects of highway funding on resources devoted to education. As highways were largely the responsibility of state and federal governments, whereas public schools were funded locally, they did not compete for funding from the same source. These regressions reflect how communities reallocated their resources for education as a response to shocks of highway construction and better road conditions thereafter.

Table 2.2 presents the regression results on the relationship between highway spending and per student education spending. The dependent variables are the change in overall (black and white combined) per student spending per student from 1920 to 1930 for columns 1 to 4, the change in per student spending in white schools from 1920 to 1930 for columns 5 to 8, the change in per student spending in black schools from 1920 to 1930 for columns 9 to 12, and finally the change in per capita spending gap between white and black schools from 1920 to 1930 for columns 13 to 16. The highway measure is log total Federal-Aid Highways expenditure from 1921 to 1930.

The highway spending coefficient (20.07) in column 1 of Table 2.2 indicates that spending 1 percent more on Federal-Aid Highways in the 1920s is associated with $20 increase the education spending per student, which is roughly one eighth of the standard deviation of per-student expenditures in public schools in 1920. As I add in other likely determinants of education spending, the highway coefficient becomes smaller in size. The highway coefficient in column (4) is only 35% the size of the same coefficient in column (1), but it remains statistically significant at the 10% level, and its magnitude is economically non-trivial.

Columns 5 to 12 of Table 2.2 show the relationships between highway spending and change in per student spending in white schools and in black schools separately. Columns 13 to 16 present the relationship between of highway spending and the change in per-student spending gap between white and black schools. The results suggest that highway spending seems to have a much larger effect on per student spending in white schools than in black schools. For example, the highway coefficient in column 8 suggests that one percent increase of Federal-Aid Highways expenditure is associated with a nearly $32 increase—24 percent of the median level of spending on whites in 1920— in per student spending in white schools, but column 12 suggests a one percent increase in highway expenditures is only associated to a less than $2 increase—7 percent of the level of spending on blacks in 1920— in per student spending in black schools. Hence, a one percent increase in highway spending would widen the per-capita spending gap by $31—or about 17 percent—over ten years.

From columns 5 to 16 of Table 2.2, we also see that the coefficients on the two black concentration dummies are huge and highly significant. This means that the higher the African American concentration, the greater increase in per student funding in white schools, the greater decrease in per student spending in black schools, thus the wider per student spending gap between white and black schools. Many have documented that places with high concentration of African Americans tend to be where African Americans faced the most severe racial discrimination. One explanation that has been putting forward was that minority whites were possibly be more willing to aggressively maintain social control and their entrenched economic interests (Bond (1994), Anderson (1988), Ng and Halcoussis (2003)).

Given the way dependent variables in Table 2.2 are defined, both an increase in educational spending and a decrease in enrollment from 1920 to 1930 can result in a positive change in per student spending in 1930. To distinguish between these two channels, Table 2.3 presents results where the per student variables are normalized by an unchanged denominator—1920 enrollment level. For example, the dependent variable for columns 1 to 4 of Table 2.3 is defined as total public school spending (black and white combined) in 1930 minus total public school spending in 1920 divided by total enrollment in 1920, and the dependent variable for columns 5 to 8 of Table 2.3 is defined as total spending in white schools in 1930 minus total spending white schools in 1920 divided by white enrollment in 1920, and so on. Highway spending coefficients from columns 1 to 8, and 13 to 16 of Table 2.3 are all bigger than their corresponding coefficients in Table 2.2, suggesting that results in Table 2.2 are mitigated by increase in enrollment from 1920 to 1930. Highway spending coefficients for black schools reported in columns 9 to 12 of Table 2.3 become much smaller and statistically insignificant compared to the same columns in Table 2.2. This suggests that highway spending may not be correlated with changes in per student spending on black children; results in Table 2.2 are largely driven by smaller black enrollment in 1930 as seen in Table 2.1.

2.4.2 Highways and Enrollment

After presenting the correlation between highway spending and funding for education, I now turn to estimating the relationships between highway spending and educational output. I first I look at the correlation between highways and the expansion of education measured by log change in enrollment from 1920 and 1930.

Table 2.4 reports the estimated effects of highway expenditures on the change in public school enrollment. The first five columns report change in overall enrollment, columns 6 to 9 report log change in white enrollment, and the last four column report log change in black enrollment. In addition to the usual set of controls, I add log change in number of people aged 7 to 20 years as a control. The highway spending coefficients in columns 1 through 5 suggests a positive and statistically significant relationship between highway spending and change in enrollment. These coefficients are moderate in size: a 10 percent increase in highway spending in the 1920s is associated with 0.25 to 0.5 percent of enrollment growth, which is about 10 to 20 percent of the standard deviation of the dependent variable (0.22). Out of all the control variables, the coefficient on log change in farm value is particularly significant and sizable. A one percent appreciation in the value of farmland is associated with about 0.35 percent of enrollment growth. This suggests that household finance situation was still crucial in their decision of whether to let the children continue schooling.

The remaining columns of Table 2.4 present the estimated effects of highway expenditures on changes in public school enrollment by race. After controlling for change in white population aged 7 to 20, change in farm value, and other demographic and economic factors, the relationship between highway expenditure and change in white enrollment is still positive and moderate in size, but statistically insignificant. On the other hand, the highway coefficients on change in black enrollment remain positive and statistically significant across the board.

One concern is that change in education funding may affect school quality and thusly affect the marginal parent's decision to send their children to school. As a robustness check, I added the change in public school spending variable and reran regressions in Table 2.4. Comparing Table 2.4 and Appendix Tables C-1 and C-2, the highway coefficients in corresponding columns are very similar. Different change in education spending variables are positive and statistically and economically significant. Change in population variables become insignificant because of multicollinearity.

2.4.3 Highways and Length of School Year

I now turn to a proxy for quality of education—length of school year. Length of school year is commonly used as a proxy for quality of education before standardized tests became universal and test scores data systematically recorded because the amount of time children spent at school is strongly correlated to the amount of education they received (Card and Krueger (1992)).

In this period, school years in white schools were much longer than black schools: black schools ended much earlier in spring so that black children could do work in the field. Thus, the effect of highway on length of school year must be investigated separately for white and black schools. Table 2.5 presents the effects of highways on changes in the length of school year for white and black schools as well as change in length of school year gap between white and black schools. Highway spending and change in average length of school year among white schools are negatively correlated and statistically insignificant. It is possible that the school year for white schools was lengthened independent of highway expenditure. In marked contrast, highway spending is strongly correlated with the change in length of school year in black schools: a one-percent increase in highway spending in the 1920s is associated with a two-day-longer school year among black schools, where the average increase was 12 days. As a result, the school year gap between white and black schools narrows.

As in the last subsection, one may be concerned that length of school year is directly related to the amount of resources available for schools. To alleviate this concern, I reran regressions in Table 2.5 with a new control variable—log change in public school spending from 1920 to 1930 as a robustness check. The results are reported in Appendix Table C-3. Comparing Table 2.5 and Appendix Table C-3, adding that change of spending variable did not change the results reported in Table 2.5.

2.4.4 Highways and Number of Schools

In light of the results presented in Chapter 1 of this dissertation, one may wonder whether highways led to more consolidation of schools the same way they led to more concentration in retail trade. In Table 2.6, I present OLS regression results of the relationship of highway spending and the change in the number of public schools. The dependent variable in Panel A is the number of public schools in 1930 minus the number of public schools in 1920. The dependent variables in Panel B and C are changes in the number of white and black schools from 1920 to 1930 respectively. Different panels in the same column use the same specification. From column 1 to column 4, more controls are sequentially. The highway coefficients are decidedly insignificant. Necessary conditions for school consolidation included good-quality roads, widespread of automobiles, and development of a school bus system. Given that these necessary conditions were not met in the South during the time period of this study, the lack of significant results comes as no surprise.

2.4 A Discussion of Mechanisms

Public spending in roads versus schools is not a new topic for economists. Chaudhary (2006) provided evidence from colonial India that local land-owning elites favored roads and disliked schools because roads led to appreciation of land and they could extract more rents, but schools led to more bargaining power of the peasants and more economic migration. But roads and schools can also be complements. More highway spending can encourage more education investment and lead to better educational outcomes. My results above are definitely consistent with the "complement" interpretation.

The simple framework laid out in Goldin and Katz (1999) is helpful in thinking about people's schooling decisions. Theirs is a simple static two-period public choice model. In the first period, an individual can choose to work and earn w_1, or to attend school at a cost of C. In the second period, the unskilled worker (who makes w_1 in Period 1) makes w_2 and the skilled worker (who attends school in Period 1) makes E_2. If the interest rate is r, then the individual will choose to go to school if and only if

$$E_2 > w_2 + (1 + r) \cdot (C + w_1)$$

To re-arrange the terms,

$$\frac{E_2 - w_2}{C + w_1} > 1 + r$$

Improvements in highways could affect educational outcomes by reducing the explicit cost (C) or the opportunity cost (w_1, wage of unskilled labor) of attending school. It could also affect wage premium E_2/w_2. All these terms can and probably should be interpreted as subjective, or perceived costs and benefits. For example, transportation costs is a part of the explicit cost (C) of going to school. The term C can also mean a perceived mental cost of attending school, which can be negatively correlated with school quality. The wage premium E_2/w_2 may be observed on local labor markets, or it can be the wage premium in destination cities for migrants.

When thinking about how highways can affect education, it is useful to discuss potential demand and supply side channels separately. We can start with the demand side. One factor on the demand side is the job opportunities that highways may bring. If highways bring jobs that require some high school education or a high school diploma, then this will increase the perceived benefits of education and encourage more people to go to school. If on the other hand, highways bring in low-skill jobs, then we should expect more teenagers drop out to work (Aggarwal (2015)). Another factor is migration. It is well-documented that proximity to railroads encouraged migration (Black et al (2015)) and African Americans who migrated to the North tend to be more educated than those who stayed. (Collins, Wanamaker (2014)) it is not far-fetched at all to hypothesize that the new world opened up by highways may encourage some people living in rural areas, especially African Americans, to get the best education that they could so that they could migrate to big cities or to the North for better job opportunities.

Highways could influence education on the supply side too. One channel is that after highways were built, land values rose, causing property tax revenue to increase, and thus a corresponding increase in educational funding. Another channel is the reduction of transportation costs: better highways could have made it easier for children to go to school and led to improvements in enrollments and other educational outcomes. However, highways would only effectively reduce the transportation costs if per capita automobile ownership and the availability of school buses reached a critical threshold, which the

South in the 1920s did not. Yet another channel on the supply side is the Rosenwald school-building program. The Rosenwald program was a major effort to improve the quality of public education for African Americans in the early twentieth-century South. The presence and the quality of highways might have influenced the Rosenwald Fund's decision of where to build those schools, thus influence the educational outcomes.

A comprehensive evaluation of all the mechanisms and using quantitative or structural techniques to estimate the relative importance of these mechanisms in explaining the link between highways and education is beyond the scope of this chapter. For the remainder of this section, I offer more evidence on the Rosenwald school hypothesis.

2.4.6 Highways, Rosenwald Schools, and African-American Education

As mentioned before, the Rosenwald School program was a massive philanthropic undertaking with the goal of improving African American education in the South from the 1910s to late 1940s. Most of the Rosenwald schools were small schoolhouses serving rural African American communities. Concentration of African Americans, level of support of local communities (black and white) and government, were all crucial determinants of the location of Rosenwald schools. In addition to these factors mentioned above, Table 2.7 shows that indeed there seems to be a systematic relationship between the intensity of highway activity and the location of and expenditures on Rosenwald schools. Column 1 to 4 of Table 2.7 use total number of Rosenwald schools built in the 1920s as the dependent variable, and column 5 to 8 use log of total spending on Rosenwald schools as the dependent variable. More control variables are added sequentially from column 1 to column 4 and from column 5 to column 8. It is apparent that regardless of which Rosenwald school measure I use, regardless which set of controls that I use, there seems to be a robust relationship between where highway expenditures were and Rosenwald schools were, after taking into account factors like concentration of African Americans, and income level. The highway effect is quite large: a ten percent increase in highway expenditure could lead to 6 more Rosenwald schools to be built, or 15 percent more Rosenwald school funding. Most counties in my sample only had less than 4 Rosenwald schools, so the highway coefficient is massive.

Why would the presence and the quality of highways influence the decision of where to locate a Rosenwald school? It is quite possible that counties that happened to be on the highway route might be seen as places with other tangible or intangible factors that would make Rosenwald schools a bigger success. Such factors could include a more diverse economy, more educated African American communities, more vocal activists demanding better education, more tolerant white communities, and so on. On the other hand, from Chapter 1, there was suggestive evidence presented that more highways were built in economically stagnant counties as part of an economic relief program. Similarly, Rosenwald may have built schools in places most in need.

After showing the close and robust relationship between highway expenditure and funding for and location of Rosenwald schools in Table 2.7, Table 2.8 shows the relationship between number of Rosnewald schools and various educational outcomes. Column 1 and 2 show that the number of Rosenwald schools does not predict more per-student funding for black schools, but it does predict more funding for white schools thusly widening the per-student spending gap. Moreover, the number of Rosenwald schools have a positive and statistically significant relationship with change in black enrollment.

Some of these results, like Rosenwald schools leading to improvement in African American education, are perfectly sensible. Rosenwald schools leading to more funding and better education outcomes in white schools may seem baffling at first, but the important thing to understand is that the Rosenwald program did not operate independently of the local school districts. The Rosenwald Fund contributed to local school districts, and these findings about white schools were consistent with many historical accounts that school districts controlled by whites funneled funds designated for black schools to white schools and maintained the relative advantage that white children had over their black counterparts. These findings are in line with previous studies such as Carruthers and Wanamaker (2013) and (Aaronson and Mazumder (2011).

Overall, results from Table 2.7 and Table 2.8 provide strong support for the hypothesis that highways boosted funding for education and led to substantial improvement educational outcomes through attracting private philanthropy to counties that had more highway activities.

2.5 Conclusions and Future Work

Based on evidence from Georgia and Alabama, this study documents a clear and robust relationship between highway construction and improvement in education in the 1920s: more highway spending is associated with expansion in enrollment, bigger increase in education funding per student, and longer school year. Moreover, highway spending is associated with a widening per student spending gap but a narrowing length of school year gap between white and black schools. Several explanations are proposed. I further showed that highways seemed to attract more Rosenwald schools and more Rosenwald contributions, as a result of which some educational outcomes were improved.

This study calls for more research and more robust assessment to be done exploring the effects of highways on education. One could look at the impact of highways on local labor markets or migration pattern and estimate how highways changed the perceived benefits of a high school education. One can also employ structural techniques to estimate the relative importance of these different mechanisms. More work can also be done to expand the geographic coverage of this study and cover states such as North Carolina, Louisiana, and Tennessee which either had different economies, or had higher per student expenditures in education and highways.

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Table 2.1: Summary Statistics

	(1)	(2)	(3)
	Mean	s.d.	Median
County-level Highway Statistics			
Total Federal-Aid Highways Expenditures, 1920-30, in $ m	4.495	4.102	3.518
Total Fed-aid Highways Mileage, 1920-30	31.472	27.687	24.780
Educational Outcomes for Whites			
White Enrollment, 1920	3,892	4,001	2,772
White Enrollment, 1930	4,124	5,859	2,880
Per-pupil Expenditures for Whites, 1920	181.93	164.82	139.82
Per-pupil Expenditures for Whites, 1930	428.63	266.31	374.50
Number of White Public Schools, 1920	42.7	24.6	37
Number of White Public Schools, 1930	28.9	23.2	22
Average Length of School Year for White Schools, 1920	131.4	24.5	128
Average Length of School Year for White Schools, 1930	151.9	17.1	151.0
Expenditures on White Public Schools, 1920-30, in $ m	11.979	31.590	6.553
Educational Outcomes for Blacks			
Black Enrollment, 1920	2,078	2,208	1,584
Black Enrollment, 1930	2,179	2,899	1,489
Per-pupil Expenditures for Blacks, 1920	33.70	23.39	27.71
Per-pupil Expenditures for Blacks, 1920	69.50	59.34	52.21
Number of Black Public Schools, 1920	21.6	15.9	19
Number of Black Public Schools, 1930	25.1	19.3	21
Average Length of School Year for Black Schools, 1920	111.2	26.6	114.9
Average Length of School Year for Black Schools, 1930	125.1	22.2	125.7
Expenditures on Black Public Schools, 1920-30, in $ m	1.191	3.388	0.599
Contribution from the Rosenwald Fund, 1920-30, in $ m	0.110	0.158	0.061
Number of Rosenwald Schools, 1920-30	1.8	2.2	1
Share of Rosenwald Funds in Spending on Black Schools	9.1	13.6	5.0
Black-White Comparison			
Total Education Spending (Black + White), 1920-30, in $ m	17.266	42.831	9.612
Total Enrollment, 1920	5,969	5,621	5,151
Total Enrollment, 1930	6,151	8,352	4,654
White-to-Black Ratio of Per-pupil Expenditures, 1920	6.83	8.17	5.19
White-to-Black Ratio of Per-pupil Expenditures, 1930	9.81	13.37	6.72
Change in Length of School Year Gap, 1920-30	8.1	23.3	7.8
Change in Per-pupil Expenditure Gap, 1920-30	210.7	248.6	174.2
County Socio-economic Characteristics			
Total population, 1920	24,166	28,255	20,063
Total population, 1930	25,598	38,358	19,200
% Foreign-born Whites, 1920	0.31	0.69	0.11
% Blacks, 1920	39.68	22.28	40.16

% Catholics, 1916	0.32	1.31	0
% Urban (2500+) Population, 1920	10.8	18.41	0
Population Density, 1920	54.5	90.2	40.3
% of Manufacturing Workers in Total Population, 1920	2.97	3.10	1.93
Manufacturing Wage Per Worker, 1920	5,980	1,293	5,799
Manufacturing Value-added, 1920, in $ m	17.067	50.068	4.270
Value of Farmland plus Improvements, 1920, in $ m	78.565	43.402	70.771
Value of All Crops, 1920, in $ m	32.422	20.113	29.005

Note to Table 2.1: The unit for length of school year variables is days. All monetary variables are converted to 2009 dollars using GDP deflator constructed by Kendrick (1961).

Table 2.2: Highways and Per Student Spending

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	Change in p.s. Spending, 1920-30				Change in p.s. Spending for Whites, 1920-30			
Log Highway Expenditure	20.07***	11.15*	8.291**	6.951*	34.12*	34.06*	33.29*	32.76*
	(6.340)	(6.129)	(3.917)	(3.658)	(19.59)	(19.40)	(17.37)	(17.04)
Log Change in Farm Value, 1920-30		65.38**	49.78	43.60		60.75	50.08	51.88
		(29.85)	(34.28)	(35.58)		(88.31)	(89.70)	(94.79)
% Foreign-born Whites, 1920			7.639	3.345			7.814	9.271
			(13.48)	(10.80)			(20.57)	(24.55)
Dummy (25 < % of Blacks < 50, 1920)			-36.38*	-38.97*			2.439	3.249
			(20.01)	(20.95)			(31.52)	(32.32)
Dummy (% of Blacks > 50, 1920)			-6.640	-8.416			187.9***	188.4***
			(27.44)	(27.89)			(58.40)	(58.94)
% of Catholics, 1916			9.494*	7.885*			26.39	28.45
			(5.052)	(4.287)			(24.61)	(28.60)
Manufacturing Wage, 1920, in $1000s				6.342				-3.861
				(6.391)				(21.93)
Population Density, 1920				0.0958**				-0.00522
				(0.0480)				(0.0869)
Constant Term and GA State Dummy	Y	Y	Y	Y	Y	Y	Y	Y
Observations	213	213	213	213	213	213	213	210
R-squared	0.047	0.111	0.134	0.145	0.029	0.029	0.160	0.158

Note to Table 2.2: This table reports estimated coefficients from OLS regressions. The dependent variable in the regressions reported in columns 1 to 4 is the change in per student spending (black and white combined) from 1920 to 1930. The dependent variable in the regressions reported in columns 5 to 8 is the change in per student spending for whites from 1920 to 1930. (To be continued on the next page.)

Table 2.2 (continued)

	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Dependent Variable	Change in p.s. Spending for Blacks, 1920-30				Change in p.s. Spending Gap, 1920-30			
Log Highway Expenditure	10.70***	8.456*	2.851*	1.799*	23.41*	25.61**	30.44**	30.96**
	(3.055)	(4.509)	(1.519)	(0.901)	(13.03)	(11.47)	(14.76)	(14.97)
Log Change in Farm Value, 1920-30		31.99**	7.700	1.389		-31.25	42.38	50.49
		(13.48)	(11.45)	(10.04)		(89.20)	(90.52)	(95.86)
% Foreign-born Whites, 1920			33.99***	30.13***			-26.18	-20.86
			(6.306)	(4.496)			(19.54)	(24.25)
Dummy (25 < % of Blacks < 50, 1920)			-30.44***	-32.38***			32.88	35.63
			(9.192)	(9.390)			(33.13)	(33.94)
Dummy (% of Blacks > 50, 1920)			-30.67***	-31.01***			218.6***	219.4***
			(8.605)	(8.966)			(59.85)	(60.48)
% of Catholics, 1916			14.73***	12.50**			11.66	15.95
			(4.602)	(4.949)			(24.10)	(28.96)
Manufacturing Wage, 1920, in $1000s				1.697				-5.558
				(3.662)				(21.76)
Population Density, 1920				0.0676***				-0.0729
				(0.0147)				(0.0895)
Constant Term and GA State Dummy	Y	Y	Y	Y	Y	Y	Y	Y
Observations	213	213	213	210	213	213	213	210
R-squared	0.074	0.120	0.407	0.454	0.013	0.015	0.159	0.160

Note to Table 2.2 (cont'd): The dependent variable for columns 9 to 12 is change in per student spending for blacks from 1920 to 1930. And finally, the dependent variable for columns 13 to 16 is the change in the gap in per student spending between whites and blacks from 1920 to 1930. "Log highway expenditure" is the log of expenditure on all Federal-Aid Highway projects from 1921 to 1930. "Manufacturing Wage" is average wage per worker (total manufacturing wage divided by average number of manufacturing workers in 1920). "Log Change in Farm Value" is log value of farmland and improvement (excluding buildings) in 1930 minus log value of farmland and improvement (excluding buildings) in 1920. Other independent variables are self-explanatory. To make sure the table can fit in one page, the constant term and the Georgia state dummy are omitted. The sample includes all Alabama and Georgia counties that had a Federal-Aid Highway project in the 1920s. All regressions are unweighted and standard errors clustered at the county level. All monetary variables are converted to 2009 dollars using GDP deflator constructed by Kendrick (1961). *** p<0.01, ** p<0.05, * p<0.1

Table 2.3: Highways and Per Student Spending, 1920 Enrollment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	Change in Total Spending Over 1920 Total Enrollment				Change in White Spending Over 1920 White Enrollment			
Log Highway Expenditure	38.68***	20.54***	14.11*	11.80*	59.44***	45.90**	37.51*	38.60*
	(7.768)	(7.425)	(7.232)	(6.036)	(21.94)	(20.47)	(21.21)	(21.36)
Log Change in Farm Value, 1920-30		161.6***	136.1***	121.6***		192.8*	221.0**	222.2**
		(39.19)	(39.60)	(36.81)		(100.4)	(105.2)	(110.7)
% Foreign-born Whites, 1920			25.79	8.288			60.85	38.29
			(27.60)	(13.58)			(44.82)	(32.83)
Dummy (25 < % of Blacks < 50, 1920)			8.145	-7.243			39.27	33.30
			(18.70)	(15.93)			(35.63)	(35.80)
Dummy (% of Blacks > 50, 1920)			3.169	17.23			145.1**	154.8**
			(20.41)	(19.78)			(64.39)	(63.16)
% of Catholics, 1916			18.54*	15.43**			60.36*	49.60
			(11.09)	(6.574)			(35.81)	(31.99)
Manufacturing Wage, 1920, in $1000s				5.136				-7.149
				(6.602)				(23.16)
Population Density per sqmi, 1920				0.528***				0.429***
				(0.0683)				(0.118)
Constant Term and GA State Dummy	Y	Y	Y	Y	Y	Y	Y	Y
Observations	213	213	213	210	213	213	213	210
R-squared	0.106	0.268	0.343	0.458	0.064	0.110	0.234	0.252

Note to Table 2.3: This table reports estimated coefficients from OLS regressions. The dependent variable in the regressions reported in columns 1 to 4 is the total spending (black and white combined) in 1930 minus total spending in 1920 divided by from 1920 enrollment. The dependent variable in the regressions reported in columns 5 to 8 is the change in total spending for whites from 1920 to 1930 divided by from 1920 white enrollment. (To be continued on the next page.)

Table 2.3 (continued)

	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Dependent Variable	Change in Black Spending Over 1920 Black Enrollment				Change in p.s. Spending Gap, 1920-30			
Log Highway Expenditure	0.174***	0.125**	0.0465	0.0496	60.54***	46.74**	39.24*	40.30*
	(0.0547)	(0.0558)	(0.0579)	(0.0568)	(22.34)	(20.82)	(21.70)	(21.68)
Log Change in Farm Value, 1920-30		0.738***	0.463	0.405		207.5**	230.0**	228.3**
		(0.279)	(0.286)	(0.291)		(104.2)	(107.9)	(112.5)
% Foreign-born Whites, 1920			0.890***	0.766***			57.02	36.49
			(0.147)	(0.174)			(43.49)	(32.23)
Dummy (25 < % of Blacks < 50, 1920)			-0.220	-0.272			39.46	35.23
			(0.269)	(0.278)			(36.83)	(35.97)
Dummy (% of Blacks > 50, 1920)			0.104	0.148			145.1**	154.5**
			(0.180)	(0.184)			(64.40)	(63.10)
% of Catholics, 1916			-0.135	-0.220			60.57*	50.45
			(0.156)	(0.172)			(35.33)	(32.49)
Manufacturing Wage, 1920, in $1000s				0.0783				-8.700
				(0.0855)				(24.18)
Population Density per sqmi, 1920				0.00167***				0.424***
				(0.000444)				(0.118)
Constant Term and GA State Dummy	Y	Y	Y	Y	Y	Y	Y	Y
Observations	213	213	213	210	213	213	213	210
R-squared	0.041	0.091	0.239	0.267	0.065	0.118	0.236	0.255

Note to Table 2.3 (cont'd): The dependent variable for columns 9 to 12 is the change in total spending for blacks from 1920 to 1930 divided by from 1920 black enrollment. And finally, the dependent variable for columns 13 to 16 is the dependent variable for columns 5 to 8 minus the dependent variable for column 9 to 12. "Log highway expenditure", "Manufacturing Wage", and "Log Change in Farm Value" are the same as they are in Table 2.2. Other independent variables are self-explanatory. To make sure the table can fit in one page, the constant term and the Georgia state dummy are omitted. The sample includes all Alabama and Georgia counties that had a Federal-Aid Highway project in the 1920s. All regressions are unweighted and standard errors clustered at the county level. All monetary variables are converted to 2009 dollars using GDP deflator constructed by Kendrick (1961). *** p<0.01, ** p<0.05, * p<0.1

Table 2.4: Highways and Enrollment

	(1)	(2)	(3)	(4)	(5)
Log Highway Expenditure	0.0483***	0.0427***	0.0265**	0.0189	0.0227*
	(0.0116)	(0.0146)	(0.0130)	(0.0129)	(0.0126)
Log Change in Pop. Aged 7-20		0.0272	0.0591**	0.0486*	0.0288
		(0.0387)	(0.0278)	(0.0279)	(0.0299)
Log Change in Farm Value, 1920-30			0.361***	0.360***	0.338***
			(0.0451)	(0.0458)	(0.0452)
% Foreign-born Whites, 1920				0.0266	0.0190
				(0.0195)	(0.0170)
Dummy (25 < % of Blacks < 50, 1920)				0.0448	0.0468
				(0.0298)	(0.0301)
Dummy (% of Blacks > 50, 1920)				0.0349	0.0446
				(0.0300)	(0.0303)
% of Catholics, 1916				-0.00326	-5.64e-05
				(0.00956)	(0.00850)
Manufacturing Wage, 1920					-0.0120
					(0.00912)
Pop. Density per 1,000 sqmi, 1920					0.416***
					(0.123)
Constant Term and GA State Dummy	Y	Y	Y	Y	Y
Observations	213	213	213	213	210
R-squared	0.140	0.145	0.368	0.380	0.408

Note to Table 2.4: This table reports estimated coefficients from OLS regressions in which the dependent variable is the difference between log enrollment in 1930 minus log enrollment in 1920. "Log Highway Expenditure" is the log of all Federal-Aid Highway spending from 1921 to 1930. “Manufacturing Wage” is average wage per worker (total manufacturing wage divided by average number of manufacturing workers in 1920). “Log Change in Farm Value” is log value of farmland and improvement (excluding buildings) in 1930 minus log value of farmland and improvement (excluding buildings) in 1920. Other independent variables are self-explanatory. All specifications have the constant term and the Georgia state dummy as dependent variables, which are omitted. The sample includes all Alabama and Georgia counties that had a Federal-Aid Highway project in the 1920s. All regressions are unweighted and standard errors clustered at the county level. All monetary variables are converted to 2009 dollars using GDP deflator constructed by Kendrick (1961).*** p<0.01, ** p<0.05, * p<0.1. (To be continued on the next page.)

Table 2.4 (continued): Highways and Enrollment

	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Dependent Variable	Log Change in White Enrollment, 1920-30				Log Change in Black Enrollment, 1920-30			
Log Highway Expenditure	0.0461***	0.0451***	0.0235**	0.0169	0.0583**	0.0463***	0.0272	0.0301*
	(0.0122)	(0.0120)	(0.0117)	(0.0113)	(0.0246)	(0.0173)	(0.0170)	(0.0167)
Log Change in White Population Aged 7-20		0.102**	0.0635*	0.0650*				
		(0.0412)	(0.0381)	(0.0372)				
Log Change in Black Population Aged 7-20						0.117**	0.0751	0.0640
						(0.0541)	(0.0524)	(0.0596)
Log Change in Farm Value, 1920-30			0.289***	0.267***			0.298***	0.354***
			(0.0470)	(0.0469)			(0.0803)	(0.0753)
Constant Term and GA State Dummy	Y	Y	Y	Y	Y	Y	Y	Y
Demographic Controls	N	N	N	Y	N	N	N	Y
Economic Controls	N	N	N	Y	N	N	N	Y
Observations	213	213	213	210	213	213	213	210
R-squared	0.068	0.100	0.251	0.327	0.055	0.229	0.285	0.349

Note to Table 2.4: This table reports estimated coefficients from OLS regressions. The dependent variable for the first four columns is the difference between log enrollment of whites in 1930 minus log enrollment of whites in 1920. The dependent variable for the last four columns is the difference between log enrollment of blacks in 1930 minus log enrollment of blacks in 1920. All regressions include a Georgia state dummy and a constant term. Columns (6) to (8) and (10) to (12) do not have any additional controls. Column (9) and (13) include both demographic controls (dummies of whether black population is between 25 and 50 percent and black population above 50 percent, % of foreign-born whites in 1920, and % of Catholics in 1916) and economic controls (population density and manufacturing wage per worker in 1920). "Log Highway Expenditure" and "Log change in Farm Value" are defined in the same way as they are in Table 2.3. The sample includes all Alabama and Georgia counties that had a Federal-Aid Highway project in the 1920s. All regressions are unweighted and standard errors clustered at the county level. All monetary variables are converted to 2009 dollars using GDP deflator constructed by Kendrick (1961). *** p<0.01, ** p<0.05, * p<0.1

Table 2.5: Highways and Length of School Year

	(1)	(2)	(3)	(4)
Panel A: DV--Change in Length of School Year in White Schools, 1920-30				
Log Highway Expenditure	-0.982	-1.187	-0.581	-0.452
	(1.347)	(1.456)	(1.416)	(1.400)
R-squared	0.059	0.061	0.156	0.190
Panel B: DV--Change in Length of School Year in Black Schools, 1920-30				
Log Highway Expenditure	1.767**	1.279**	2.109	2.173*
	(0.789)	(0.542)	(1.405)	(1.132)
R-squared	0.270	0.275	0.360	0.363
Panel C: DV--Change in Length of School Year Gap between White and Black Schools, 1920-30				
Log Highway Expenditure	-2.973**	-2.451*	-2.759**	-2.702**
	(1.353)	(1.321)	(1.323)	(1.319)
R-squared	0.156	0.163	0.187	0.197
Constant Term and GA State Dummy	Y	Y	Y	Y
Log Change in Farm Value, 1920-30	N	Y	Y	Y
Demographic Controls	N	N	Y	Y
Economic Controls	N	N	N	Y

Note to Table 2.5: This table reports estimated coefficients from OLS regressions. All regressions have 213 observations. The dependent variable in Panel A is the change in average length of school year (in days) for white schools from 1920 to 1930, the dependent variable in Panel B is the change in average length of school year for black schools from 1920 to 1930, and the dependent variable in Panel C is the gap between lengths of school year in white versus black schools measured in 1930 minus that the same gap measured in 1920. All regressions include a Georgia state dummy and a constant term. Column (1) does not have any additional control other than those two. Column (2) adds "Log Change in Farm Value”. Column (3) adds demographic controls. Column (4) further adds economic controls. The sample includes all Alabama and Georgia counties that had a Federal-Aid Highway project in the 1920s. All regressions are unweighted and standard errors clustered at the county level. All monetary variables are converted to 2009 dollars using GDP deflator constructed by Kendrick (1961).*** p<0.01, ** p<0.05, * p<0.1

Table 2.6: Highways and Number of Schools

	(1)	(2)	(3)	(4)
Panel A: DV--Change in Total Number of Schools, 1920-30				
Log Highway Expenditure	0.830	0.0742	-0.191	-0.109
	(1.062)	(1.098)	(1.178)	(1.184)
R-squared	0.008	0.039	0.080	0.084
Panel B: DV--Change in Number of White Schools, 1920-30				
Log Highway Expenditure	0.0400	-0.636	-0.976	-0.984
	(0.798)	(0.835)	(0.912)	(0.922)
R-squared	0.031	0.073	0.092	0.097
Panel C: DV-Change in Number of Black Schools, 1920-30				
Log Highway Expenditure	0.790	0.711	0.785	0.875
	(0.600)	(0.636)	(0.645)	(0.660)
R-squared	0.126	0.127	0.227	0.231
Constant Term and GA State Dummy	Y	Y	Y	Y
Log Change in Farm Value, 1920-30	N	Y	Y	Y
Demographic Controls	N	N	Y	Y
Economic Controls	N	N	N	Y

Note to Table 2.6: This table reports estimated coefficients from OLS regressions. All regressions have 213 observations. The dependent variable in Panel A is the change in the total number of public schools (elementary, middle, and high schools, black and white combined) from 1920 to 1930, the dependent variable in Panel B is the change in the number of white schools from 1920 to 1930, and the dependent variable in Panel C the change in the number of black schools from 1920 to 1930. All regressions include a Georgia state dummy and a constant term. Column (1) does not have any additional control other than those two. Column (2) adds "Log Change in Farm Value”. Column (3) adds demographic controls. Column (4) further adds economic controls. The sample includes all Alabama and Georgia counties that had a Federal-Aid Highway project in the 1920s. All regressions are unweighted and standard errors clustered at the county level. All monetary variables are converted to 2009 dollars using GDP deflator constructed by Kendrick (1961).*** p<0.01, ** p<0.05, * p<0.1.

Table 2.7: Highways and Palcement of Rosenwald Schools

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	Number of Rosenwald Schools, 1920-30				Log Rosenwald School Expenditure, 1920-30			
Log Highway Expenditure	0.757***	0.736***	0.625***	0.613***	1.649***	1.642***	1.541***	1.498***
	(0.190)	(0.198)	(0.195)	(0.192)	(0.474)	(0.454)	(0.460)	(0.457)
# of Rosenwald Schools, Pre-1920	0.0988	0.0486	0.0165	0.0162				
	(0.0646)	(0.0629)	(0.0651)	(0.0663)				
Log Rosenwald School Expenditure, Pre-1920					0.307***	0.195**	0.185**	0.208**
					(0.0949)	(0.0882)	(0.0896)	(0.0882)
Black Enrollment Rate in 1920	-0.647**	-0.197	-0.127	-0.275	-1.247	-0.281	-0.135	-0.507
	(0.324)	(0.328)	(0.334)	(0.334)	(0.976)	(1.027)	(1.013)	(0.989)
Dummy (25 < % of Blacks < 50, 1920)		0.663	0.555	0.709		2.214*	1.994	2.293*
		(0.446)	(0.429)	(0.447)		(1.308)	(1.283)	(1.295)
Dummy (% of Blacks > 50, 1920)		1.548***	1.569***	1.636***		2.890**	2.902**	3.088**
		(0.515)	(0.506)	(0.520)		(1.382)	(1.375)	(1.366)
Constant Term and GA State Dummy	Y	Y	Y	Y	Y	Y	Y	Y
Log Change in Farm Value, 1920-30	N	Y	Y	Y	N	Y	Y	Y
Other Demographic Controls	N	N	N	Y	N	N	N	Y
Economic Controls	N	N	N	Y	N	N	N	Y

Note to Table 2.7: This table reports estimated coefficients from Tobit regressions. The dependent variable for Columns (1) to (4) is the total number of Rosenwald schools built from 1920 to 1930; the dependent variable for Column (5) to (8) is log total expenditures on Rosenwald schools in the 1920s. All regressions include a Georgia state dummy, a constant term, and black enrollment rate in 1920, which is defined as black enrollment divided by number of black persons aged 7 to 20 in 1920. All regressions also include a pre-trend variable, which is the number of Rosenwald schools built before 1920 for column (1) to (4), and log total expenditures on Rosenwald schools before 1920 for column (5) to (8). Column (1) and (5) do not have more controls. Column (2) and (6) add "log change in farm value". Column (3) and (7) also include demographic controls as specified in all previous regression tables, among which the two back population dummies are reported. Finally, column (4) and (8) add economic controls to the mix. The sample includes all Alabama and Georgia counties that had a Federal-Aid Highway project in the 1920s. All regressions are unweighted and standard errors clustered at the county level. All monetary variables are converted to 2009 dollars using GDP deflator constructed by Kendrick (1961). *** p<0.01, ** p<0.05, * p<0.1

Table 2.8: Rosenwald School and Educational Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	Per-student Spending, Whites	Per-student Spending, Black	Per-student Spending Gap	School Year, Black School	School Year Gap	Black Enrollment
Number of Rosenwald Schools	18.46**	0.536	17.92**	-0.752	0.562	0.0282***
	(8.457)	(0.921)	(8.393)	(0.652)	(0.771)	(0.0103)
Constant Term and GA State Dummy	Y	Y	Y	Y	Y	Y
Log Change in Farm Value, 1920-30	Y	Y	Y	Y	Y	Y
Other Demographic Controls	Y	Y	Y	Y	Y	Y
Economic Controls	Y	Y	Y	Y	Y	Y
R-squared	0.152	0.453	0.155	0.359	0.185	0.074

Note to Table 2.8: This table reports estimated coefficients from OLS regressions. Each column uses a different dependent variable. The independent variable of interest is the number of Rosenwald schools built in the 1920s. The dependent variable of column (1) is change in in white public school spending per white student from 1920 to 1930. The dependent variable of column (2) is change in black public school spending per black student from 1920 to 1930. The dependent variable of column (3) is change in per student spending gap between white and black schools from 1920 to 1930. The dependent variable of column (4) is log change in the average length of school year among black schools 1920 to 1930. The dependent variable of column (5) is change in length of school year gap between white and black schools from 1920 to 1930. The dependent variable of column (6) is log change in black enrollment from 1920 to 1930. The same set of control variables are used across all columns, which include a constant term, Georgia state dummy, demographic controls (dummies of whether black population is between 25 and 50 percent and black population above 50 percent, % of foreign-born whites in 1920, and % of Catholics in 1916) and economic controls (population density and manufacturing wage per worker in 1920). All regressions are unweighted and standard errors clustered at the county level. All monetary variables are converted to 2009 dollars using GDP deflator constructed by Kendrick (1961).*** p<0.01, ** p<0.05, * p<0.1

Appendix C: Supplementary Tables to Chapter 2

Appendix Table C-1: Highways and Enrollment, with Change in Education Expenditure

	(1)	(2)	(3)	(4)	(5)
Log Highway Expenditure	0.0438***	0.0353**	0.0144**	0.00800*	0.0125**
	(0.0114)	(0.0142)	(0.00726)	(0.0440)	(0.00601)
Log Change in Education Expenditure	0.0988***	0.104***	0.0574***	0.0661***	0.0643***
	(0.0249)	(0.0255)	(0.0200)	(0.0200)	(0.0205)
Log Population Aged 7-20, 1920		0.0405	0.0638**	0.0513*	0.0299
		(0.0356)	(0.0269)	(0.0266)	(0.0280)
Log Change in Farm Value, 1920-30			0.330***	0.328***	0.310***
			(0.0455)	(0.0457)	(0.0451)
% Foreign-born Whites, 1920				0.0287*	0.0206
				(0.0170)	(0.0145)
Dummy (25 < % of Blacks < 50, 1920)				0.0585**	0.0591**
				(0.0290)	(0.0294)
Dummy (% of Blacks > 50, 1920)				0.0474	0.0556*
				(0.0304)	(0.0305)
% of Catholics, 1916				-0.00322	-9.03e-05
				(0.00936)	(0.00837)
Manufacturing Wage, 1920					-0.0110
					(0.00899)
Pop Density per 1,000 sqmi, 1920					0.402***
					(0.119)
Constant Term and GA State Dummy	Y	Y	Y	Y	Y
Observations	213	213	213	213	210
R-squared	0.204	0.214	0.387	0.405	0.432

Notes to Appendix Table C-1: This table reports estimated coefficients from OLS regressions in which the dependent variable is the difference between log enrollment in 1930 minus log enrollment in 1920. All specifications have the constant term and the Georgia state dummy as dependent variables, which are omitted. The sample includes all Alabama and Georgia counties that had a Federal-Aid Highway project in the 1920s. All regressions are unweighted and standard errors clustered at the county level. All monetary variables are converted to 2009 dollars using GDP deflator constructed by Kendrick (1961).*** p<0.01, ** p<0.05, * p<0.1.

Appendix Table C-2: Highways and Enrollment by Race, with Change in Education Expenditure

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	Log Change in White Enrollment, 1920-30				Log Change in Black Enrollment, 1920-30			
Log Highway Expenditure	0.0384***	0.0384***	0.0213*	0.0142	0.0363**	0.0426**	0.0277	0.0351**
	(0.0132)	(0.0130)	(0.0126)	(0.0120)	(0.0173)	(0.0169)	(0.0168)	(0.0167)
Log Change in Spending, White Schools	0.0797***	0.0667**	0.0300	0.0464*				
	(0.0242)	(0.0263)	(0.0259)	(0.0259)				
Log Change in White Population Aged 7-20		0.0851	0.0591	0.0489				
		(0.0524)	(0.0482)	(0.0469)				
Log Change in Spending, Black Schools					0.143**	0.146**	0.115**	0.138**
					(0.0670)	(0.0652)	(0.0576)	(0.0576)
Log Change in Black Population Aged 7-20						0.115*	0.0677	0.0641
						(0.0619)	(0.0609)	(0.0737)
Log Change in Farm Value, 1920-30			0.292***	0.266***			0.303***	0.361***
			(0.0533)	(0.0522)			(0.0774)	(0.0758)
Constant and GA State Dummy	Y	Y	Y	Y	Y	Y	Y	Y
Demographic Controls	N	N	N	Y	N	N	N	Y
Economic Controls	N	N	N	Y	N	N	N	Y
Observations	213	213	213	213	213	213	213	213
R-squared	0.143	0.361	0.423	0.458	0.142	0.189	0.239	0.248

Notes to Appendix Table C-2: This table reports estimated coefficients from OLS regressions. The dependent variable for the first four columns is the difference between log enrollment of whites in 1930 minus log enrollment of whites in 1920. The dependent variable for the first four columns is the difference between log enrollment of blacks in 1930 minus log enrollment of blacks in 1920. All regressions include a Georgia state dummy and a constant term. Column (1), (2), (3), (5), (6), and (7) do not have any additional controls. Column (4) and (8) include both demographic controls (dummies of whether black population is between 25 and 50 percent and black population above 50 percent, % of foreign-born whites in 1920, and % of Catholics in 1916) and economic controls (population density and manufacturing wage per worker in 1920). "Log Highway Expenditure" and "Log change in Farm Value" are defined in the same way is they are in Table 2.3. The sample includes all Alabama and Georgia counties that had a Federal-Aid Highway project in the 1920s. All regressions are unweighted and standard errors clustered at the county level. All monetary variables are converted to 2009 dollars using GDP deflator constructed by Kendrick (1961). *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Appendix Table C-3: Highways and Length of School Year, with Change in Education Expenditure

	(1)	(2)	(3)	(4)
Panel A: DV--Change in Length of School Year in White Schools, 1920-30				
Log Highway Expenditure	-1.631	-1.364	-0.433	-0.435
	(1.521)	(1.580)	(1.513)	(1.490)
Log Change in Spending, White Schools	9.785***	10.42***	8.596***	8.617**
	(3.150)	(3.311)	(3.191)	(3.318)
R-squared	0.076	0.080	0.199	0.223
Panel B: DV--Change in Length of School Year in Black Schools, 1920-30				
Log Highway Expenditure	1.767**	1.279**	2.109	2.173*
	(0.789)	(0.542)	(1.405)	(1.132)
Log Change in Spending, Black Schools	7.432**	7.345**	10.69***	11.60***
	(3.653)	(3.494)	(3.452)	(3.288)
R-squared	0.037	0.037	0.206	0.225
Panel C: DV--Change in Length of School Year Gap between White and Black Schools, 1920-30				
Log Highway Expenditure	-2.973**	-2.451*	-2.759**	-2.702**
	(1.353)	(1.321)	(1.323)	(1.319)
Log Change in Spending, White Schools	6.566**	7.619***	7.936***	8.411***
	(2.704)	(2.621)	(2.604)	(2.819)
Log Change in Spending, Black Schools	-1.666**	-0.914**	-1.552**	-1.454**
	(0.730)	(0.440)	(0.712)	(0.700)
R-squared	0.055	0.073	0.101	0.123
Constant Term and GA State Dummy	Y	Y	Y	Y
Log Change in Farm Value, 1920-30	N	Y	Y	Y
Demographic Controls	N	N	Y	Y
Economic Controls	N	N	N	Y

Note to Appendix Table C-3: This table reports estimated coefficients from OLS regressions. The dependent variable in Panel A is the change in average length of school year (in days) for white schools from 1920 to 1930, the dependent variable in Panel B is the change in average length of school year for black schools from 1920 to 1930, and the dependent variable in Panel C is the gap between lengths of school year in white versus black schools measured in 1930 minus that the same gap measured in 1920. All regressions include a Georgia state dummy and a constant term. Column (1) does not have any additional control other than those two. Column (2) adds "Log Change in Farm Value". Column (3) adds demographic controls. Column (4) further adds economic controls. The sample includes all Alabama and Georgia counties that had a Federal-Aid Highway project in the 1920s. All regressions are unweighted and standard errors clustered at the county level. All monetary variables are converted to 2009 dollars using GDP deflator constructed by Kendrick (1961).*** p<0.01, ** p<0.05, * p<0.1

Chapter 3: Are PILOTs Property Taxes for Nonprofits?

(with James Hines and Jill Horwitz)

3.1 Introduction

Charitable nonprofit organizations are generally exempt from federal, state, and local taxes. Since nonprofits typically generate little in the way of net income, the benefits of income tax exemptions are small relative to other benefits of tax-exempt status, notably including exemptions from local property taxes (Gentry and Penrod, 2000).[50] A tax-exempt nonprofit organization that locates in a town may deliver valuable services, provide employment, and attract visitors and tax-paying residents, but its ownership of local real estate lowers the property tax base and thereby reduces resources otherwise available to town governments. Property tax exemptions thereby can distress cash-strapped towns and cities with significant numbers of nonprofits.

In recent years, local governments increasingly have asked nonprofit organizations to make payments in lieu of taxes, known as PILOTs. Some nonprofits comply with these requests and others do not. Although as a legal matter PILOTs are voluntary – state property tax exemptions for charitable nonprofits are often guaranteed by statute or state constitutions – in practice they may not exhibit all of the characteristics of truly voluntary transfers. Nonprofits benefit along with others from robust fiscal conditions in their states and localities, and some nonprofits have collaborated with municipalities to develop

[50] Following convention, we use the term nonprofit to mean tax-exempt charities. Although most nonprofit entities are exempt from federal and state taxes, not all nonprofits benefit from tax exemptions. The Internal Revenue Code grants federal tax exemptions to the subset of nonprofits that have charitable purposes and adhere to other requirements. The list of purposes includes "religious, charitable, scientific, testing for public safety, literary, or educational purposes, or to foster national or international amateur sports competition (but only if no part of its activities involve the provision of athletic facilities or equipment), or for the prevention of cruelty to children or animals…." (Internal Revenue Code §501(c)(3)). State requirements for tax exemption vary. Some follow the same requirements as the Internal Revenue Code; however, the definition of charity under state constitutional and statutory provisions is often more stringent than the requirement for federal exemption.

PILOT programs. But many nonprofits would not voluntarily divert resources from their exempt purposes to governmental purposes – indeed it is questionable whether charities laws permit them to do so – in the absence of suasion by local governments. Unhappy governments can penalize noncomplying nonprofits informally by limiting access to local public services, refusing to relieve burdensome local regulation, or challenging tax exemptions on the basis of whether nonprofits properly pursue their exempt purposes. In such environments nonprofits may be pressured to accede to local requests for PILOTs.

This chapter examines the determinants of PILOTs and the effects of PILOTs on nonprofit activity. Since nonprofits are not required to disclose PILOTs on any government filing, the available data consist of government financial disclosures identifying PILOT receipts by town. Uniquely, the state of Massachusetts reports data on PILOT receipts by its local jurisdictions, which the study analyzes to identify factors associated with PILOTs and their effects on the nonprofit sector.

The results indicate that PILOT receipts by Massachusetts communities are positively correlated with local property tax rates: a local property tax rate one percentage point higher is associated with a 0.2 percentage point higher PILOT rate, constructed as the ratio of payments to the value of local tax-exempt property. This pattern suggests that PILOTs function as informal, low-rate substitutes for property taxes to which taxable landowners would ordinarily be subject, and raises the possibility that PILOTs might have other attributes of property taxes, including that they could discourage nonprofit activity, particularly any activity associated with holding tax-exempt property. The evidence from Internal Revenue Service Form 990 filings by Massachusetts nonprofits is consistent with this interpretation of PILOTs, as higher PILOT rates are associated with reduced nonprofit assets and revenues, and most dramatically, reduced real property holdings.

3.2 PILOTs in Practice

Whether a legal entity is a nonprofit and whether it qualifies for tax exemption are related, but distinct, legal questions. Creating a nonprofit is a ministerial matter governed by state statutory and common law. Obtaining tax exemption requires more steps, including application to the Internal Revenue Service to obtain federal income tax exemption and other benefits, and application to various state and local tax authorities to obtain state and local income, property, and other tax exemptions. Because many tax-exempt nonprofits, such as those that are most likely to make PILOTs, do not earn significant profits, the benefits they derive from income tax-exemption are limited; however, they may benefit a great deal from the tax deductibility of donations, property tax exemptions, and other benefits such as the ability to issue tax-exempt debt (Horwitz, forthcoming 2016).

States and localities exempt certain categories of nonprofits, especially charities, from taxation, thereby encouraging greater nonprofit activity (Hansmann, 1987). Researchers have advanced several theories to explain why these nonprofits should receive tax exemptions (Simon et al. 2006), a common one being that tax exemption is a subsidy offered to nonprofits to encourage and reward them for providing services that the government would otherwise need to provide. Another theory is that nonprofits do not have taxable income, which under federal law arises from activities for personal gain (Bittker and Rahdert, 1976). These theories do not specifically address why local and state governments might prefer nonprofit to for-profit activities, and some local and state governments grant individual for-profit firms ad hoc tax exemptions for locating within their borders (Felix and Hines, 2013). But the blanket nonprofit tax exemption reflects broad differences between nonprofits and for-profits in the extent to which they provide services that communities value and are willing to subsidize (Hines et al., 2010).

As a practical matter, states typically exempt nonprofits from taxation based on the categories of services they provide, although they exhibit a range of approaches. In Massachusetts, nonprofits that are exempt from federal taxation under Internal Revenue Code §501 are also exempt from Massachusetts excise (income) taxes (Massachusetts General Laws Annotated, 2015). The board of assessors in each Massachusetts municipality grants exemption from local property taxes according to state statutes and administers those exemptions. Roughly speaking, the property of religious entities (Massachusetts General Laws Annotated, 2013a) and charities "established for literary, benevolent, charitable, or temperance purposes," and operated as such, are granted local property and sales tax exemptions (Massachusetts General Laws Annotated, 2013a). Other categories of nonprofits that are not charities, such as country clubs, may be exempt from property taxes under other statutes, such as those that use tax exemptions to protect open spaces (Massachusetts General Laws Annotated, 2013b). [51] PILOTs provide a mechanism for returning to local governments some of these revenues foregone due to exemptions.

PILOTs have a long lineage, particularly in Massachusetts, where the Boston PILOT program began in 1925 (Brody, 2010). Harvard University and the Massachusetts Institute of Technology, both tax-exempt, have made voluntary payments to the city of Cambridge since 1928. Although there are no comprehensive data on numbers of PILOTs or PILOT agreements nationally, there is some evidence that the implementation of PILOTs is on the rise (Langley et al., 2012).[52] For example, Boston introduced a new PILOTs program in 2011 in which the city requests payments from charities with property valued at more than $15 million with plans that, after an implementation period, these charities will make PILOTs equal to 25 percent of the full amount a property owner would owe if the property were taxable; in addition, participating charities may receive up to a 50 percent credit toward their PILOTs for providing value in the form of community benefits (Rakow, 2013). In fiscal year 2013 (July 1, 2012 – June 30, 2013), Boston received $23.2 million in cash PILOTs out of $28.2 million requested; in fiscal year 2011, Boston received $15.2 million (City of Boston, 2013).

Most recently, the Governor of Maine proposed a budget plan that would reduce corporate and individual income taxes, repeal the estate tax, and eliminate state payments to municipalities; municipalities would have some of these funds replaced by adhering to

[51] Importantly, to benefit from a tax exemption nonprofit must own their real property and the property is tax exempt only to the extent that it is occupied by the nonprofit owner or another exempt charity.

[52] Leland (2002) reports the results of March 1998 surveys of municipal finance directors and community leaders in 73 cities, representing the 50 largest cities in the United States plus the largest cities in states that did not include one of the top 50. Reliable information for 51 of these cities indicates that only seven solicited PILOTs in 1998, and among these only Boston solicited PILOTs from a wide range of nonprofit organizations (for example, Boston collected PILOTs from 38 organizations; Indianapolis only one). PILOTs have increased significantly since then.

a requirement to tax nonprofits, excluding churches and government-owned tax-exempt entities, at fifty percent of the normal tax rate on assessed value over $500,000 in property (Halper, 2015; Levitz, 2015). This proposal would require municipalities to include large nonprofits as part of their tax bases, and would be accompanied by withdrawal of state funds.

Most PILOTs represent transfers from nonprofits to the relevant government authority, and they can range greatly in size. In 2005, Harvard University agreed to a 50-year arrangement with Cambridge, under which it would pay $2.4 million to Cambridge in 2006, and increase that amount by roughly three percent each year; MIT signed a similar 40-year agreement in 2004, making a base payment of $1.5 million in 2005, with a 2.5 percent annual increase (Tartakoff, 2005).

Some PILOTs are made from one level of government to another as compensation for foregone taxes from public and charitable land. For example, Connecticut reimburses its municipalities for foregone taxes on state-owned land, including 100% reimbursement for correctional facility land, some designated Mashantucket Pequot tribal land, and for any town in which more than 50 percent of all property in the town is state-owned real property; 65% for the Connecticut Valley Hospital facility; and 45% for all other property (Connecticut Office of Policy & Management, 2014; Connecticut General Statutes Annotated, 2015a) and nonprofit-owned property (up to 77% for private, nonprofit hospitals and colleges) (Connecticut General Statutes Annotated, 2015b). Massachusetts does not make such payments; for example, in 1997 the Massachusetts legislature declined to pass a bill providing municipalities PILOTs for property owned by nonprofit hospitals and institutions of higher education (Massachusetts H.B. 624, 1997).

State and local governments offer several justifications for their PILOT demands, the primary one being the need for revenue. Removing property from the tax rolls is particularly consequential given the importance of property taxes for state and local revenue. In 2010 property taxes accounted for 35 percent of state and local tax revenues, and 18 percent of all state and local revenues (Urban Institute Tax Policy Center Database) nationwide; in contrast, state and local individual and corporate income taxes together accounted for only 16 percent of state and local tax revenues. Given this reliance on property taxes, removing charitable land from the property tax base leaves local governments short on funds, which affects expenditures and shifts additional financial burden onto other taxpayers (Deitrick and Briem, 2007). For example, in fiscal year 2013, 13.3 percent of the total property value of Andover, Massachusetts was tax exempt (Town of Andover, 2013, pg. 2). According to estimates based on Ohio Department of Taxation data, "[n]onprofit, government, tax-abated property accounted for 20.2 percent of the real property in Cuyahoga County in Tax Year 2012," and 44.9 percent of real property in Cleveland (Schiller and Hileman, 2013).

Moreover, reliance on property taxes makes it unsurprising that there are substantial estimated foregone taxes. One estimate of foregone taxes from charitable property tax exemptions ranges from $8 to $13 billion annually in 1997, or 1.3-2.1 percent of total U.S. nonprofit revenue (Cordes et al., 2002). Similarly, Cordes et al. (2002) estimates that nonprofit property tax exemptions in Philadelphia equal 6.2 percent of total nonprofit revenue. A Massachusetts Department of Revenue Survey reported that in 2003 "the value of all exempt property, governmental, religious, educational and charitable, was more than $87 billion," or about twelve percent of total property valued by municipalities (Massachusetts Department of Revenue, 2003, p. 4). More specifically, the reported value of all tax-exempt educational and charitable properties was more than $22 billion, or approximately three percent of the total property value of the reporting communities. The same source estimates forgone property taxes of $505.8 million, or 5.8 percent of the total projected levy of Massachusetts communities in Fiscal Year 2003. And Cordes et al. (2002) estimates that for the more than 150,000 U.S. nonprofits with greater than $500,000 of real property in 1997, the annual tax exemption was worth an average of 19 percent of their total revenues.

It is, however, far from certain that these valuations represent the amounts governments would obtain in property taxes if tax-exempt nonprofits were taxed on, or reduced, their property holdings. Taxpayers face different incentives to hold property than do nonprofits. Moreover, to the degree that nonprofits provide desirable goods or services that are not readily provided by for-profit alternatives, then non-taxable government agencies might need to expand their local property holdings to replace the activities of nonprofits; alternatively, governments could find themselves offering tax incentives to for-profits to replace tax-exempt nonprofits.

One of the practical reasons to consider taxing nonprofits is that governments need revenues. In addition, some scholars would justify taxing nonprofits on the basis that it is inequitable to offer tax exemptions to nonprofits that provide benefits to those who live elsewhere, such as an urban hospital that provides services to suburban patients (Pomp, 2004; Rokoff, 1973). Pomp (2004) notes that Connecticut makes payments to municipalities to offset this apparent injustice.

There are different ways to characterize PILOT payments. Some PILOTs take the form of payments for services such as police or fire protection. Others are characterized as simple donations, made for example to help a suffering locality get through a tough time, or investments intended to make the locality more attractive and thereby improve the environment for the nonprofit. And some PILOTs are made to forestall government actions that would impose costs on nonprofits. These different characterizations have legal and perceptual effects that may affect how willingly a nonprofit makes a payment.

PILOTs are typically negotiated on an ad hoc basis, raising the problem that similar charities are treated differently (Brody et al., 2012). This case-by-case negotiation makes it tempting for localities to turn what are voluntary payments into semi-coerced payments. For example, although under current policy all Massachusetts charities are asked to make PILOTs, towns have incentives to concentrate their collection efforts on charities that have disproportionately high costs of moving, such as those that have local licenses (e.g., medical organizations), large property holdings and long-standing relationships (e.g., universities), and location-specific charitable purposes (e.g., community foundations). Charities have complained to courts that tax authorities use PILOTs unfairly, threatening organizations in impermissible ways, such as with challenges to their otherwise-valid tax exemptions or denials of building permits if charities did not make financial payments or payments in kind to the authority. In the 1940s, for example, the local school districts and township agreed to withdraw their challenges to the proposed nonprofit incorporation of the Valley Forge Military Academy Foundation if the Academy agreed to make PILOTs in the amount the Academy would have ordinarily made in property taxes absent the exemption. (Radnor Township v. Valley Forge, 1970). Many years later, when the local government units sued the Academy for attempting to cease payments, the court found for the school, explaining that a taxing body may not collect taxes by contract and a government may not engage in selling or bartering its right to oppose an organization seeking nonprofit status.

There are many more recent examples of localities pressuring nonprofits for voluntary payments. In one case, the plaintiff church complained that the town supervisor and commissioners threatened to reject a request for a parking lot permit if the church did not make a PILOT or donate a fire truck (Fortress Bible Church v. Feiner, 2010). In another case, tax-exempt hospitals alleged that the government units were attempting to coerce or force tax-exempt member hospitals to make payments in lieu of taxes by "indicat[ing] that those [hospitals] which [did] not agree to such payments and/or agreement 'in lieu of taxes' [would] have their tax exempt status challenged, [would] be likely to run into difficulties in obtaining zoning approvals, and [would] not be offered the opportunity to provide services to the taxing authority." (Hospital Council v. City of Pittsburgh, 1991). In 2000, Northwestern University filed a complaint against Evanston, Illinois alleging that the city imposed a historical district ordinance on the university in retaliation for refusing to make PILOTs (Northwestern University v. City of Evanston, 2001).

Much of the previous empirical research on PILOTs is descriptive. In 1998, Leland conducted a survey of public officials in 73 large cities, and identified PILOTs in only seven cities and six states of the 51 respondents (Leland 2005). More recently, Kenyon and Langley (2010) and Langley et al. (2012) report evidence of PILOTs and draw inferences about the characteristics of localities that receive them. Using media accounts, government reports, other sources, and a survey of 599 cities and towns with the largest nonprofit sectors (171 respondents), Langley et al. (2012) report that 218 localities in 28 states received PILOTs. They find that PILOTs are concentrated in the northeastern part of the United States, with Massachusetts and Pennsylvania communities accounting for more than half of the PILOT recipients they identify. Universities and hospitals provide

92 percent of the measured PILOT revenues, which is sensible given their considerable financial resources, though this may partly reflect the survey method.

3.3 Determination and Effects of PILOTs

In the absence of external pressure nonprofit organizations are unlikely to make PILOTs: despite their interest in community welfare, nonprofits generally have much greater need for resources than funds available to satisfy those needs. Consequently, towns that seek PILOTs must offer nonprofits valuable services in return, persuade nonprofits of the importance of making such payments, or suggest the possibility of costly regulatory or other measures if they fail to provide PILOTs. Payments received under threat of a worse alternative have much of the character of compulsory taxes, with the important difference that PILOTs are individually negotiated.

It is useful to consider PILOTs in a bargaining setting that recognizes the alternatives to negotiated agreement available to towns and nonprofit organizations. If a nonprofit is dissatisfied with making the PILOT that the town demands, then it can move elsewhere or discontinue its operations; and if a nonprofit locates in a town but refuses to make a PILOT, then the town may be able to make the tax-exempt nonprofit's situation very difficult. Nonprofit *j* obtains value v_{ij} from locating in town *i* rather than its next best alternative, where v_{ij} is measured in dollar terms, so that if the nonprofit were required to make a PILOT equal to v_{ij} it would be indifferent to locating in town *i*. The town obtains service benefits of ϕ_{ij} from having nonprofit *j* locate there, hence would be willing to pay up to ϕ_{ij} to attract or retain the nonprofit.

One of the complications of having a nonprofit within its tax jurisdiction from the standpoint of the town is that nonprofit *j* by locating in town *i* is likely to reduce property tax collections by taking ownership of property that would otherwise be taxable. Denote nonprofit *j*'s otherwise-taxable property in town *i* by k_{ij}, and let the parameter γ_{ij} represent the degree of crowd-out. If all of a nonprofit's property otherwise would have been owned by a taxpaying entity, then $\gamma_{ij} = 1$; if the nonprofit's presence does not change the town's tax base, then $\gamma_{ij} = 0$; and many other values of γ_{ij} are possible, including those that lie outside the $[0,1]$ range, if the nonprofit somehow greatly encourages or discourages taxable entities to hold property in town. (The parameter ϕ_{ij} capturing town *i*'s valuation of services provided by the nonprofit should be similarly measured net of the town's valuation of any for-profit activity crowded out by nonprofit *j*.) With a property tax rate of τ_i, the presence of nonprofit *j* causes town *i* to lose property tax revenues of $\gamma_{ij}\tau_i k_{ij}$. Consequently, the net surplus that town *i* enjoys from the presence of nonprofit *j* is $\phi_{ij} - \gamma_{ij}\tau_i k_{ij}$.

In many circumstances there is an opportunity for both the town and the nonprofit to benefit from having the nonprofit locate in the town. The combined surplus of the nonprofit and the town is:

$$v_{ij} + \phi_{ij} - \gamma_{ij}\tau_i k_{ij}. \quad (1)$$

We consider a simple Nash bargaining situation in which the town and nonprofit share this surplus equally, the product of both parties threatening to eliminate the other's surplus if there is no agreement. Equal division of surplus entails nonprofit *j* making a PILOT, p_{ij}, to town *i*, where p_{ij} is given by:

$$p_{ij} = \frac{(v_{ij} - \phi_{ij}) + \gamma_{ij}\tau_i k_{ij}}{2}. \quad (2)$$

This expression for p_{ij} indicates that in a bargaining setting PILOTs are larger if the town is a particularly valuable location for the nonprofit, and smaller to the extent that the town values services provided by the nonprofit. The second term in the numerator of the fraction on the right side of equation (2) reflects that property tax reductions associated with a nonprofit increase the size of the equilibrium PILOT.

If the aggregate surplus produced by nonprofit *j* locating in town *i* (as given by expression 1) is negative, then there is no value of p_{ij} at which both the nonprofit and the town benefit, and presumably either the town will prevent the nonprofit from locating there or the nonprofit will choose to go elsewhere. If expression (1) is positive but $v_{ij} < 0$, then the town would have to offer some kind of a subsidy in order to induce the nonprofit to locate there. Since the nonprofit is tax exempt, a tax reduction would not help it, so if it is infeasible to offer other forms of subsidy, $v_{ij} < 0$ implies that nonprofit *j* will choose not to locate in town *i*.

The $\left(v_{ij} - \phi_{ij}\right)$ term in the numerator of the right side of equation (2) is the difference between nonprofit *j*'s valuation of locating in town *i* and the town *i*'s valuation of the services that nonprofit *j* brings. This is likely a function of both town and nonprofit characteristics, including, but not limited to, the size of the nonprofit's operations. Scaling this difference by the nonprofit's property ownership, and making it a linear function of town characteristics, produces $\left(v_{ij} - \phi_{ij}\right) = k_{ij}\beta_1 x_i$, in which x_i is a vector of town characteristics and β_1 is a vector of parameters to be estimated. Making this substitution in equation (2) produces:

$$p_{ij} = \frac{1}{2}\left(\beta_1 x_i + \gamma_{ij}\tau_i\right)k_{ij}. \quad (3)$$

If $\gamma_{ij} = \bar{\gamma}, \forall i, j$, then summing both sides of equation (3) across all nonprofits *j* for which $v_{ij} \geq 0$ and $v_{ij} + \phi_{ij} - \gamma_{ij}\tau_i k_{ij} \geq 0$ produces:

$$\bar{p}_i = \frac{1}{2}\beta_1 x_i + \frac{1}{2}\bar{\gamma}\tau_i. \quad (4)$$

In equation (4), $\bar{p}_i \equiv \sum_j p_{ij} \Big/ \sum_j k_{ij}$ is the average PILOT rate for town *i*, measured as the ratio of aggregate PILOT revenues to local property owned by nonprofits, in which the summations include all nonprofits *j* for which $v_{ij} \geq 0$ and $v_{ij} + \phi_{ij} - \gamma_{ij}\tau_i k_{ij} \geq 0$.

Equation (4) implies that, for values of $\bar{\gamma} > 0$, average PILOT rates should be positively correlated with property tax rates, reflecting that nonprofits and towns share the cost of diverting otherwise-taxable property from the tax rolls. Furthermore, equation (3) implies that nonprofit organizations in towns with high PILOT rates have incentives to economize on their ownership of otherwise-taxable real property, since equilibrium PILOT payments increase with k_{ij}. Finally, higher PILOT rates should discourage nonprofit activity to the extent that they reflect higher property tax rates, low town valuations of nonprofit activity (relative to tax revenue), or town errors in calculating PILOT demands.

The model implies that, all other things equal, local jurisdictions with higher property tax rates are more willing than others to demand higher PILOTs at the expense of losing nonprofit activity. Since property tax rates and PILOT demands are jointly determined, the model should not be interpreted to deliver the effect of property taxes on PILOTs. As a practical matter, however, property tax collections greatly exceed PILOT receipts, and property tax rates reflect local revenue needs, the elasticity of the local property tax base with respect to property tax rates, and possibly other factors – hence one can interpret the effect of property taxes on PILOTs as the impact of these factors together with the consequences of the property tax mechanism that towns use to collect most of their revenue. A town's valuation of nonprofit services also influences its desired PILOT demands, but to the extent that these valuations are independent of factors that influence property tax rates they should not influence the effect of property tax rates on PILOTs.

3.4 PILOTs Data

Massachusetts communities are particularly successful in obtaining PILOTs from their local nonprofits (Kenyon and Langley, 2010), and the Massachusetts Department of Revenue since 1995 has identified PILOT receipts of each of its 351 local jurisdictions as part of the state's annual financial reports.[53] These financial reports also include information on local property tax levies, assessed values of taxable and tax-exempt properties, and demographic and economic characteristics of local Massachusetts jurisdictions that are collected by Massachusetts state agencies from information reported in the 2000 Census. The demographic variables include total town population, race (African-American and Hispanic populations), and education (numbers of adult residents with high school degrees but no college education, some college education, and college graduates). The economic variables include the town unemployment rate in 2000, sizes of youth (under 20) and aged (over 65) populations, numbers of over-65 residents who live alone and in poverty, numbers of households with annual incomes below $10,000, and numbers of households with incomes above $50,000.

Data on local nonprofit organizations, including their locations and financial information, are based on Internal Revenue Service Form 990 filings assembled by Guidestar and the National Center for Charitable Statistics (NCCS) at the Urban Institute. Financial variables include the total assets of a nonprofit organization, fixed assets (the sum of land, buildings, and equipment; this information is available only since 1998), and total annual revenues. To avoid having the results unduly affected by the financial crash of 2008 and subsequent recession, the analysis is restricted to 1995-2007. The data provided by Guidestar and the NCCS were aggregated at the municipality level (based on a nonprofit's location as indicated on its Form 990 filling) for Massachusetts jurisdictions for which Massachusetts Department of Revenue data were available.

There are some limitations of these data. First, neither the Massachusetts data nor the Form 990 filings include information on PILOTs by individual nonprofits, so all of the analysis must be conducted at the town level. Second, the Massachusetts data concern PILOT collections, not requests, and therefore omit any information on PILOTs that towns demand but are not paid because nonprofits respond by locating elsewhere. Third,

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[53] PILOT receipts, property taxes, land values, property tax referenda results, and other characteristics of Massachusetts communities are available on the Department of Revenue website, http://www.mass.gov/dor/local-officials/municipal-data-and-financial-management/data-bank-reports/. Additional demographic and economic information on Massachusetts communities are reported on the state Health and Human Services web site, http://www.mass.gov/eohhs/researcher/community-health/masschip/census-2000-1990-socio-demographic-trends.html.

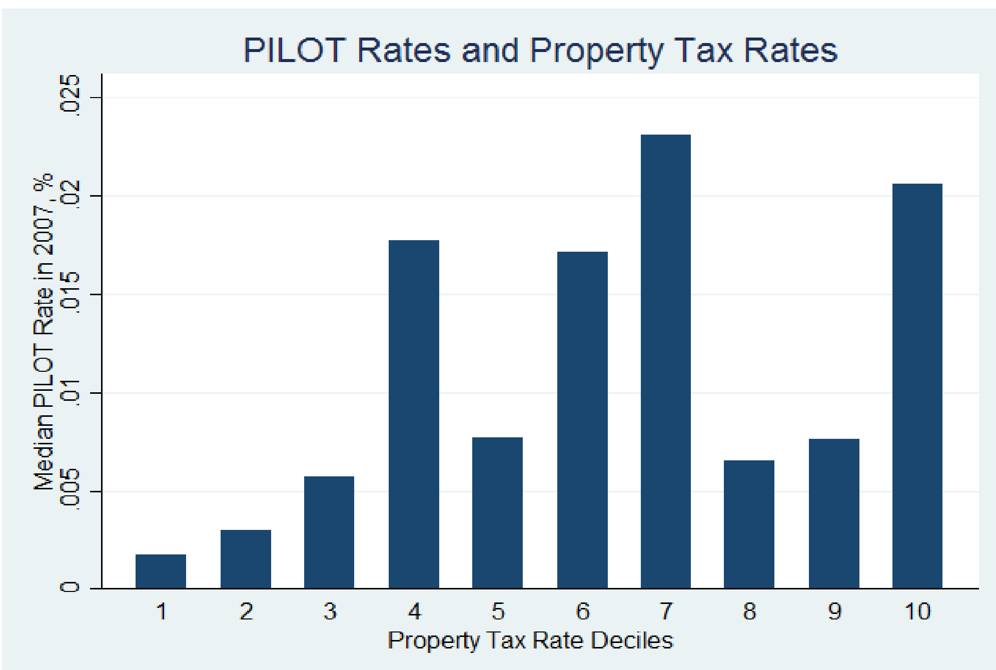
the data cover only Massachusetts, which may limit the generalizability of the results. However, Massachusetts is a particularly good state to study, as it has a long history of negotiating PILOT agreements, and appears to be one of the top PILOT-receiving states. As PILOTs spread around the country, it is valuable to understand developments in a place where PILOTs have long been established. Moreover, city and town governments are particularly strong in New England, where school districts and other government bodies that rely on local tax receipts are organized at the town level. In other states, where there are unincorporated areas and townships, county governments conduct these functions and are governing equivalents of Massachusetts towns. Therefore, the fiscal issues confronting Massachusetts towns might be treated as roughly equivalent to those facing counties elsewhere, and Massachusetts offers considerable variation since there are more Massachusetts towns (351) than counties in any other state (e.g., Texas, the state with the greatest number of counties, has only 254).

Fourth, there are challenges in matching nonprofits to Massachusetts towns. Since a nonprofit may own property and have activities in more than its home jurisdiction, the use of Form 990 data to attribute nonprofit activity to a locality has the potential to introduce measurement error into the classification of the location of nonprofit activity. Another issue is that the data coverage is incomplete, as religious nonprofits, those with annual gross revenues below $25,000, and certain other categories of nonprofits are not required to file Form 990, nor are all the Form 990s submitted to the IRS available in the Guidestar and NCSS database. Partly as a consequence, there are no Form 990 filings for a small portion of these Massachusetts towns (e.g., 23 out of the 351 towns have no Form 990 filings in 1997), which are treated in the following analysis as though they have no nonprofit assets, despite Massachusetts Department of Revenue data indicating that there are positive nonprofit property holdings and in some cases PILOTs. Notwithstanding these limitations, the data afford a reasonably accurate depiction of the distribution of nonprofit activity within Massachusetts.

3.5 PILOT Experiences in Massachusetts

Table 3.1 presents descriptive statistics for the sample of Massachusetts communities, distinguished by their history of PILOT receipts: columns 1 and 2 of Table 3.1 present descriptive statistics for the subset of 47 towns without PILOT receipts from 1995-2007 whereas columns 3 and 4 present descriptive statistics for the entire sample of 351 Massachusetts towns. Appendix Table D-1 offers detailed descriptions of these variables. Towns that never received PILOTs have per capita incomes, land areas, and unemployment that are similar to those of the whole sample of Massachusetts communities. Towns receiving PILOTs tend to be more urban, heavily populated, have more diverse populations, and have much higher property tax receipts than other towns. Towns receiving PILOTs have extensive nonprofit activity, though their nonprofits have lower average ratios of fixed assets (land, buildings, and equipment) to total assets than do nonprofits in towns without PILOTs.

Figure 3.1 PILOT Rates and Property Tax Rates (2007)



Note to Figure 3.1: The figure presents median 2007 PILOT rates for 10 groups of Massachusetts towns, distinguished by their average property tax rates in 2007. A town's PILOT rate is the ratio of its PILOT receipts to the market value of nonprofit property; its average property tax rate is the ratio of property tax collections to the market value of taxable property. Towns in the first property tax decile from the left have the lowest property tax rates, whereas those in the tenth property tax decile have the highest property tax rates. The heights of the bars depict the median PILOT rates of towns in each group.

It is possible to use the Department of Revenue data to calculate average property tax rates by town, the ratios of property tax receipts to market values of taxable properties; similarly, average PILOT rates by town are ratios of PILOTs to market values of tax-exempt property. By these calculations, PILOT rates are considerably lower than property tax rates. PILOT rates average 0.11 percent over the sample period and are of course zero in the 47 towns without PILOTs, while property tax rates average 1.40 percent over the sample period and are higher in the whole sample than they are in towns without PILOTs.[54]

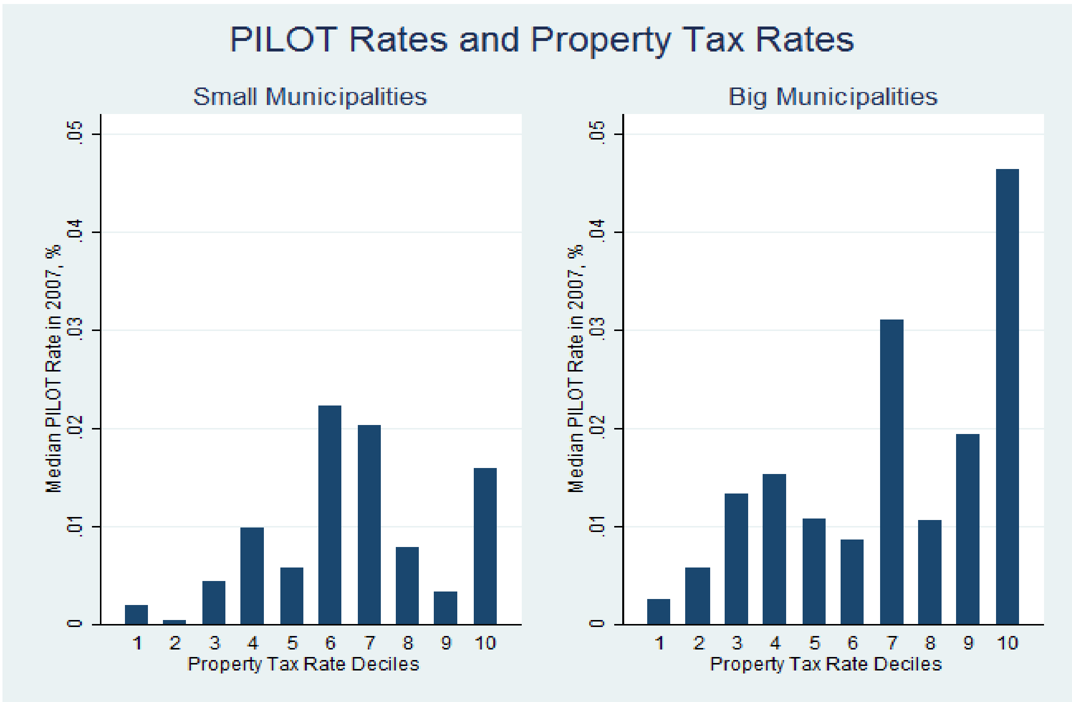
The Massachusetts Department of Revenue data can be used to estimate the extent to which towns with higher average property tax rates also have higher average PILOT rates, as implied by the model sketched in Section 3. Figure 3.1 depicts median 2007 PILOT rates of 10 groups of Massachusetts towns, distinguished by their average property tax rates in 2007, the most recent of the sample years. That is, the leftmost bar in Figure 3.1 represents the median 2007 PILOT rate of the 35 towns with the lowest property tax rates that year; the rightmost bar is the median PILOT rate of the 35 towns with the highest property tax rates. The figure exhibits a gentle upward slope, and indicates that towns with property tax rates in the three lowest deciles also have the lowest median PILOT rates. The positive association of property tax rates and PILOT rates does not control for other variables, such as town size, that might also influence PILOT rates, but is nonetheless suggestive.

Figure 3.2 plots median PILOT rates by property tax decile for two equal-sized subsets of Massachusetts communities, distinguished by size: the bars on the left of Figure 3.2 present data for towns with populations below the median of Massachusetts communities, and the bars on the right of Figure 3.2 present data for towns with

[54] The Massachusetts Department of Revenue data indicate that property taxes are the largest single revenue source for Massachusetts towns: the sample mean ratio of property taxes to town income is 4.35, whereas the sample mean ratio of state aid to town income is 1.75, and the sample mean ratio of local revenue to town income is 1.30. (Local revenue includes motor vehicle excise taxes, other excise taxes, state government payments for public lands, investment income, fines and forfeitures, and miscellaneous receipts.) Consequently, there is relatively limited scope for other revenue sources to substitute for property taxes in towns with low property tax rates.

above-median populations. It is evident from the figure that the positive relationship between property tax rates and median PILOT rates is more pronounced for larger communities.

Figure 3.2 PILOT and Property Tax Rates by Municipality Size (2007)



Note to Figure 3.2: The figure presents median 2007 PILOT rates for 20 groups of Massachusetts towns, distinguished by size of town in 2000 and average property tax rates in 2007. The left figure depicts data for Massachusetts towns with below-median populations; the right figure depicts data for Massachusetts towns with above-median populations. A town's PILOT rate is the ratio of its PILOT receipts to the market value of nonprofit property; its average property tax rate is the ratio of property tax collections to the market value of taxable property. Towns in the first property tax decile from the left in each of the two graphs have the lowest property tax rates, whereas those in the tenth property tax decile have the highest property tax rates. The heights of the bars depict the median PILOT rates of towns in each group.

than it is for smaller communities, though even among small Massachusetts towns it appears to be the case that higher property tax rates are generally associated with higher PILOT rates. One of the difficulties of analyzing PILOT rate data for small towns is that these ratios can be very sensitive to the behavior of small numbers of nonprofits, and the resulting variability in measured PILOT rates can make it difficult to draw clear inferences about the effect of property tax rates even if there is a strong causal effect. This consideration, together with the reality that larger towns have greater economic and fiscal consequences than smaller towns, motivates the use of regressions in which observations are weighted by town populations. Estimated coefficients from regressions using unweighted observations are presented in appendix tables in Fei et al. (2015).

Equation (4) suggests that the determinants of PILOT rates in Massachusetts towns can be estimated the following way:

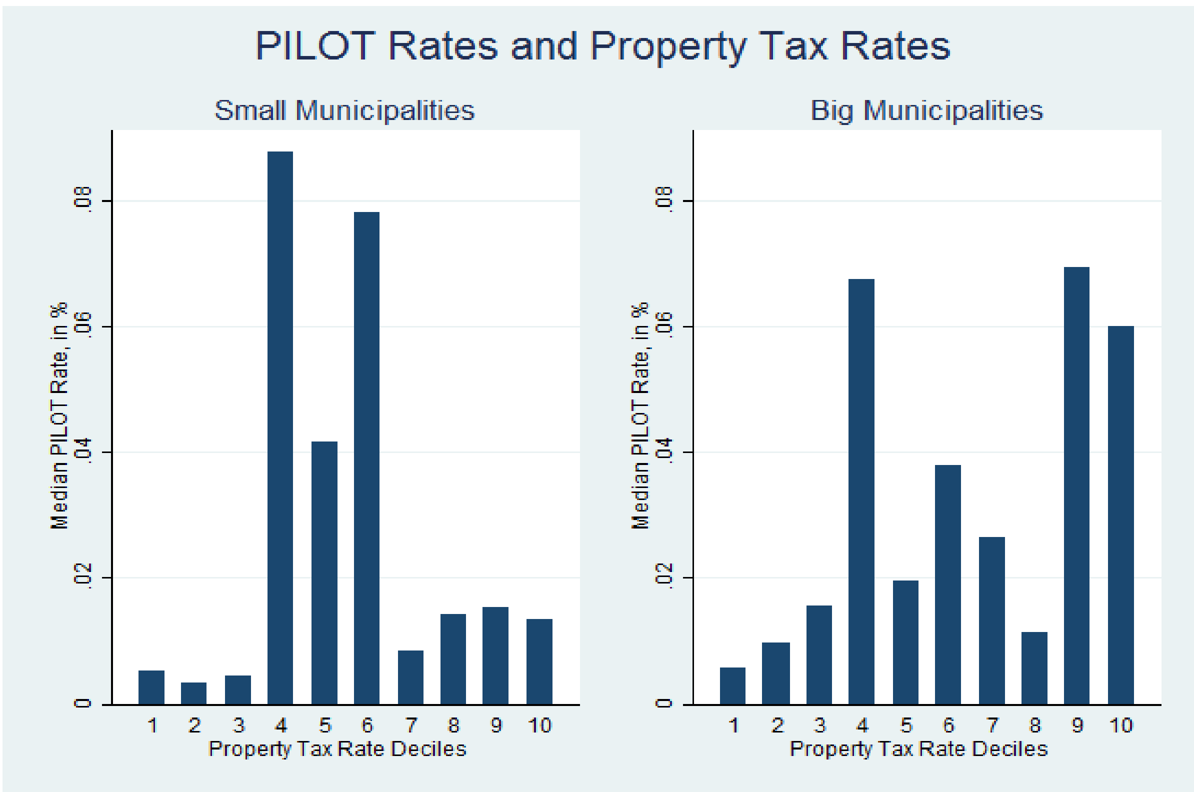
$$b_{it} = \mu\tau_{it} + \theta X_{it} + \varepsilon_{it}, \tag{5}$$

in which b_{it} is the PILOT rate in town *i* in year *t*, τ_{it} is the property tax rate in town *i* in year *t*, X_{it} is a vector of observable characteristics (population, income, demographics, and others) of town *i* in year *t*, μ is a parameter to be estimated, and θ is a vector of parameters to be estimated; ε_{it} is the residual. The empirical work in Tables 3.2, 3.3 and 3.5 presents estimates of equation (5) using data for different years and specifications that include different observable variables in the X_{it} vector.

Table 3.2 presents estimated coefficients from Tobit specifications of equation (5) for 2007, the most recent of the sample years. The dependent variable in these regressions is the ratio of PILOTs to the market value of real property held by nonprofits in each town, which can be referred to as the "PILOT rate." The 0.210 coefficient in column 1 indicates that a one percentage point higher property tax rate is associated with a 0.21 percentage point higher PILOT rate. The regression reported in column 2 adds demographic variables to the specification, as result of which the estimated property tax rate coefficient declines to 0.139, though this coefficient increases in magnitude to 0.186 with the inclusion of additional economic variables in the regression reported in column 3.

The regression coefficients reported in Table 3.2 are consistent with the model's implication that higher property tax rates are associated with higher PILOT rates. The estimated magnitude of the effect, that one percentage point higher property tax rates are associated with 0.186 percentage point higher PILOT rates, should be evaluated in the context of average property tax rates that are almost 13 times higher than average PILOT rates. This corresponds to a 2.4 elasticity of PILOT rates with respect to property tax rates, suggesting that PILOT rates are quite sensitive to property rate differences. Property taxes and PILOTs are likewise positively associated and statistically significant in supplemental regressions that add town population as an explanatory variable and in specifications that are unweighted by population.[55]

Figure 3.3 PILOT and Property Tax Rates by Municipality Size (1995-2007)



Note to Figure 3.3: The figure presents median PILOT rates for 20 groups of Massachusetts towns, distinguished by size of town in 2000 and average property tax rates from 1995-2007. The left figure depicts data for Massachusetts towns with below-median populations in 2000; the right figure depicts data for Massachusetts towns with above-median populations. A town's average PILOT rate is the average over the 13-year sample of its annual ratios of PILOT receipts to market values of nonprofit property; its average property tax rate is the 13-year average ratio of its property tax collections to the market value of its taxable property. Towns in the first property tax decile from the left in each of the two graphs have the lowest property tax rates, whereas those in the tenth property tax decile have the highest property tax rates. The heights of the bars depict the median PILOT rates (13-year averages) of towns in each group.

The positive association of property tax rates and PILOT rates in 2007 is repeated in other years. Figure 3.3 presents data on property tax rates and PILOT rates over the

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[55] These regressions are presented in Fei et al. (2015). In other regressions (not reported), lower property tax or PILOT rates were not associated with significantly greater revenue from state aid or local revenues.

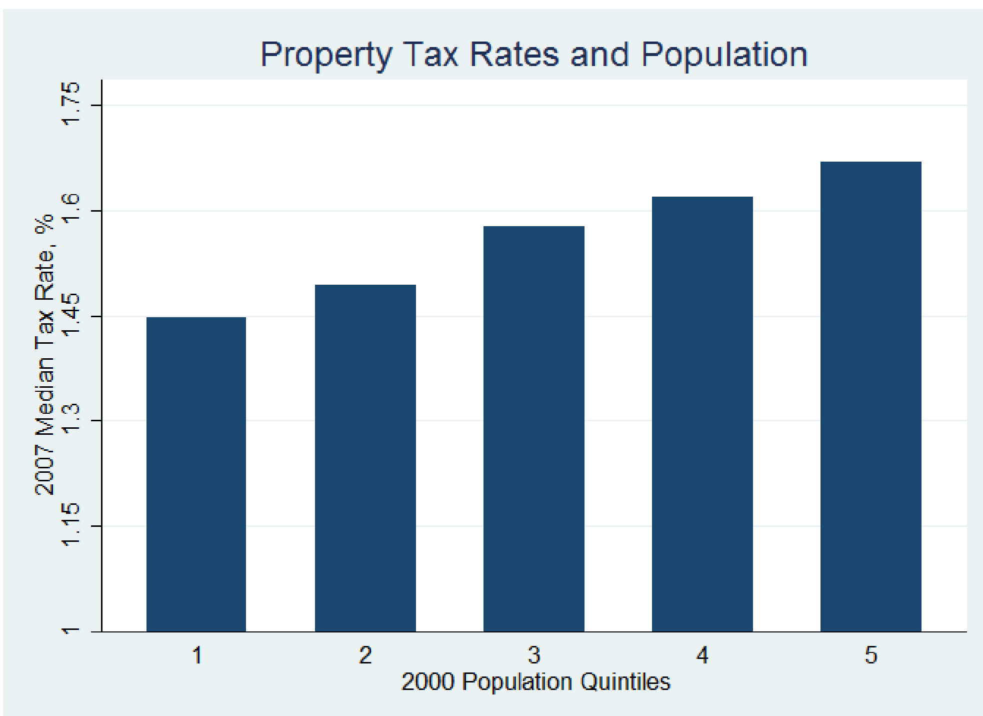
1995-2007 sample period. Towns are distinguished by average property tax rates over that period, and the heights of the bars reflect median 13-year average PILOT rates of towns in each cell. The patterns in Figure 3.3 are similar to those in Figure 3.2: among larger Massachusetts towns there is a marked positive association of property tax rates and PILOT rates, whereas among smaller Massachusetts towns the association, while still somewhat positive, is considerably noisier.

Table 3.3 presents pooled estimates for 1995-2007 of the same equations estimated in Table 3.2, including that observations are weighted by town population. The specifications reported in Table 3.3 include year dummies, and the standard errors are clustered by municipality. The results are quite consistent with those for 2007 reported in Table 3.2. The 0.289 coefficient in column 1 indicates that one percentage point higher property tax rates are associated with 0.289 percentage point higher desired PILOT rates, an effect that falls in magnitude to 0.128 with the addition of demographic controls in the regression reported in column 2, and is 0.137 with the further addition of economic controls in the regression reported in column 3. These property tax rate coefficients, while somewhat unstable across specifications, nonetheless are statistically significant and of similar magnitudes to those reported in Table 3.2.

One of the difficulties in interpreting the estimates reported in Tables 3.2 and 3.3 is that property tax rates and PILOT demands are jointly determined by various town characteristics. If important independent variables are omitted from these regressions, then they could induce positive correlations between property tax rates and PILOT rates even in the absence of a causal effect of property tax rates on PILOT demands. Local property values might influence PILOT rates, or reflect other variables that do, but as Appendix Table D-2 reports, inclusion of local average property values as explanatory variables in the regressions presented in Tables 3.2 and 3.3 has very little effect on estimated property tax coefficients. It is nonetheless possible that there remain important omitted variables that are difficult to measure.

One way to address the problem of joint determination of property tax rates and PILOT demands is to estimate a two-stage system in which instrumented values of property tax rates are used as regressors in the second stage. The challenge lies in obtaining a valid first stage instrument for property tax rates. Town size is a plausible candidate. Analytical studies of tax competition consistently find that equilibrium tax rates are higher in larger jurisdictions, reflecting their greater market power (Bucovetsky, 1991; Haufler and Wooton, 1999; Keen and Konrad, 2013). Furthermore, the international evidence is that larger countries tend to impose higher business tax rates (Hines, 2007). The evidence from Massachusetts is strongly consistent with this pattern, as illustrated by the data reported in Figure 3.4, which plots median property tax rates in 2007 for groups of Massachusetts towns distinguished by population in 2000, the sample year for which the most reliable population figures are available. It is clear from the figure that property tax rates are generally higher in larger Massachusetts towns.

Figure 3.4 Property Tax Rates by Municipality Size (2007)



Note to Figure 3.4: The figure presents median 2007 property tax rates for five groups of Massachusetts towns, distinguished by population in 2000. A town's average property tax rate is the ratio of property tax collections to the market value of taxable property. Towns in the first property tax quintile have the lowest property tax rates, whereas those in the fifth property tax quintile have the highest property tax rates. The heights of the bars depict the median property tax rates of towns in each group.

Table 3.4 presents estimated coefficients from instrumental variables specifications of the effect of property tax rates on PILOT rates, and in which the log of a town's population in 2000 is an instrument for the property tax rate in the first stage. Columns 1 and 2 present equations estimated on the 2007 cross-sectional data, whereas columns 3 and 4 present results for the pooled 1995-2007 sample. The positive coefficients on log population in regressions explaining property tax rates in columns 1 and 3 are consistent with the pattern depicted in Figure 3.4, the 0.147 coefficient in column 3 implying that a ten percent greater town population is associated with a 0.0147 higher property tax rate, corresponding to 1.1 percent of the mean property tax rate reported in Table 1.

Column 2 of Table 3.4 reports the second stage equation estimated on the 2007 data, the 0.235 coefficient implying that one percentage point higher property tax rates are associated with 0.235 percentage point higher PILOT rates, a slightly larger effect than that implied by the OLS specification that produced the 0.210 coefficient reported in column 1 of Table 3.2. Similarly, the 0.213 coefficient in column 4 of Table 3.4 implies that, in the pooled 1995-2007 data, one percentage point higher property tax rates are associated with 0.213 percentage point higher PILOT rates, a somewhat smaller effect than the OLS estimate of 0.289 reported in column 1 of Table 3.3.

The regressions presented in Table 3.4 omit the demographic and economic control variables that appear in the regressions reported in columns 2 and 3 of Tables 3.2 and 3.3. This omission reflects the need for a parsimonious specification given the small number of observations and resulting limited power of the instrument. Consequently, inferences drawn from the estimates presented in Table 3.4 rely on the validity of excluding these demographic and economic variables from the model determining PILOTs.

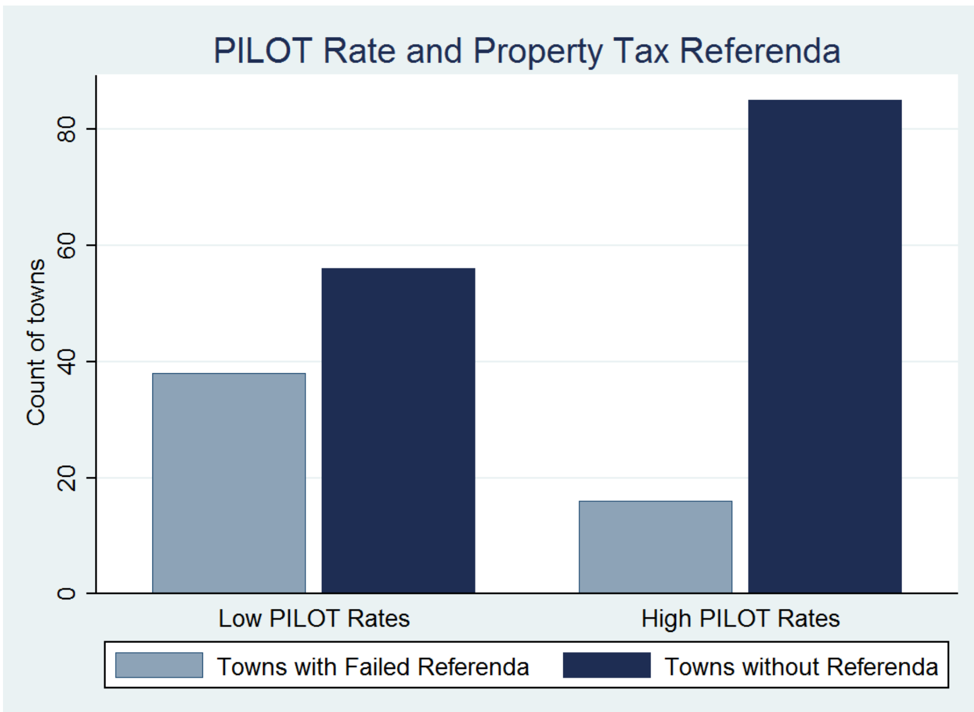
The instrumental variables estimates of property tax rate coefficients reported in Table 3.4 resemble the corresponding OLS estimates reported in Tables 3.2 and 3.3. This pattern is consistent with OLS estimates offering unbiased measures of the effect of property taxes on PILOTs, though alternatively it would also be consistent with instrumental variables estimates that are biased in the direction of the OLS estimates. There is little evidence of one potential important source of such IV bias, in that the large F statistics for the first stage equations reported in columns 1 and 3 do not raise concerns about weak identification.

The use of town population as an instrument for the property tax rate relies on the exclusion restriction that population does not directly affect PILOT rates. The model presented in section 3 is consistent with this restriction, reflecting that PILOTs are individually negotiated, whereas property taxes are not. But since alternative models, including those based on bargaining power, could have the feature that town size directly affects PILOT demands, the validity of the exclusion restriction may depend on the reasonableness of the model's conformity with behavior. In this context it is reassuring that the inclusion of property values as independent variables in the regressions reported in Appendix Table D-2 does not influence estimated property tax rate coefficients, which might have been the case if PILOT demands were functions of factors that influence demand for local property. It is nonetheless the case that the estimates reported in columns 2 and 4 of Table 3.4 reflect effects of property taxation only to the extent that town size does not directly affect PILOT rates.

The model sketched in section 3 implies that towns with higher property tax rates will have higher PILOT rates, under the assumption that towns and nonprofits have equal bargaining power and therefore share equally the potential surplus from nonprofit location in a town. It is difficult to obtain fully convincing measures of bargaining power, but municipal experience with property tax referenda offers one measure. Massachusetts limits the extent to which municipalities can increase property tax rates each year, requiring local referenda for certain rate increases. Over the 1995-2007 period, 141 of the 351 Massachusetts communities never had any property tax override referenda; 54 had one or more referenda all of which failed; 55 had one or more referenda all of which passed; and 101 had multiple referenda, some of which passed and some of which failed. Consistent failure to pass property tax referenda is a sign that voters do not support town administrators who propose these referenda, and may reflect more generally a weakness of town administrators that might empower nonprofits in negotiations over PILOTs. If so, then towns with failed referenda might have lower PILOT rates.

Figure 3.5 compares the 1995-2007 property tax override referendum experiences of Massachusetts towns with high and low PILOT rates in 2007. Two groups of towns are considered: those that had one or more referenda, all of which failed, and those that never had referenda. In both cases there was no property tax override, which would presumably have influenced property tax rates and arguably also PILOT rates, so this potential channel of influence is the same for all of the observations. As Figure 3.5 illustrates, towns in which voters consistently defeat property tax referenda had lower PILOT rates in 2007 than did towns that did not have any property tax referenda from 1995-2007.

Figure 3.5 PILOT Rates and Property Tax Referenda (2007)



Note to Figure 3.5: The figure reports numbers of towns in groups distinguished by average PILOT rates in 2007 and property tax referendum experience from 1995-2007. The two left bars depict towns with below-median PILOT rates, in which the median is calculated based on all 351 Massachusetts towns; the right figure depicts towns with above-median PILOT rates. A town's PILOT rate is the ratio of its PILOT receipts to the market value of nonprofit property. The heights of the lightly shaded bars depict numbers of towns in each group that had property tax referenda that all failed during 1995-2007; the heights of the darkly shaded bars depict numbers of towns that had no property tax referenda at all during 1995-2007.

Table 3.5 presents estimated coefficients from population-weighted regressions using 2007 data for the sample of 195 towns that either had referenda from 1995-2007 that all failed, or else never had referenda during that time period. The specifications are similar to those in the regressions presented in Table 3.2, the only difference being the inclusion of a dummy variable indicating that a town never had property tax override referenda. The estimated property tax rate coefficients are very similar to those reported in Table 3.2, and the estimated effect of the absence of failed referenda is positive in all specifications (albeit of marginal statistical significance in the regression reported in column 2). The 0.0442 coefficient in column 3 indicates that PILOT rates are significantly higher in towns that never had referenda than in towns with referenda that failed, the difference corresponding to about 41 percent of average PILOT rates for the whole sample as reported in Table 1. This suggests that towns with weaker governments are less able to make strong PILOT demands, though it is difficult to rule out that omitted variables might influence both PILOT rates and referendum outcomes, which would dampen the power of the test offered by the regressions presented in Table 3.5.

The Massachusetts data also afford some indication of the effect of PILOTs on nonprofit activity. Given the low average PILOT rate reported in Table 1, it is unclear to what extent PILOTs in Massachusetts are economically significant for the nonprofit community. Figure 3.6 presents ratios of nonprofit fixed asset holdings to nonprofit total assets for 10 groups of Massachusetts towns, distinguished by size of town in 2000 and average PILOT rates from 1998-2007; only towns with some nonprofit activity during this period are included in the data used to construct the figure. The patterns of the bars depicted in the figure suggest that ratios of fixed asset holdings to total assets decline with PILOT rates, which is consistent with incentives created by PILOTs for nonprofits to economize on property holdings that trigger PILOT obligations.[56] In the short run this effect is presumably limited to nonprofits with relatively small costs of moving or adjusting the scales of their operations, though over time PILOTs may have significantly larger effects on real property holdings to the extent that they influence initial location choices.

Table 3.6 presents estimated coefficients from OLS regressions explaining nonprofit assets, revenues, and real property holdings in Massachusetts towns. The regressions reported in columns 3-6 use data for 1995-2007, while the regressions reported in columns 1-2 and 7-8, which use information on real property holdings that

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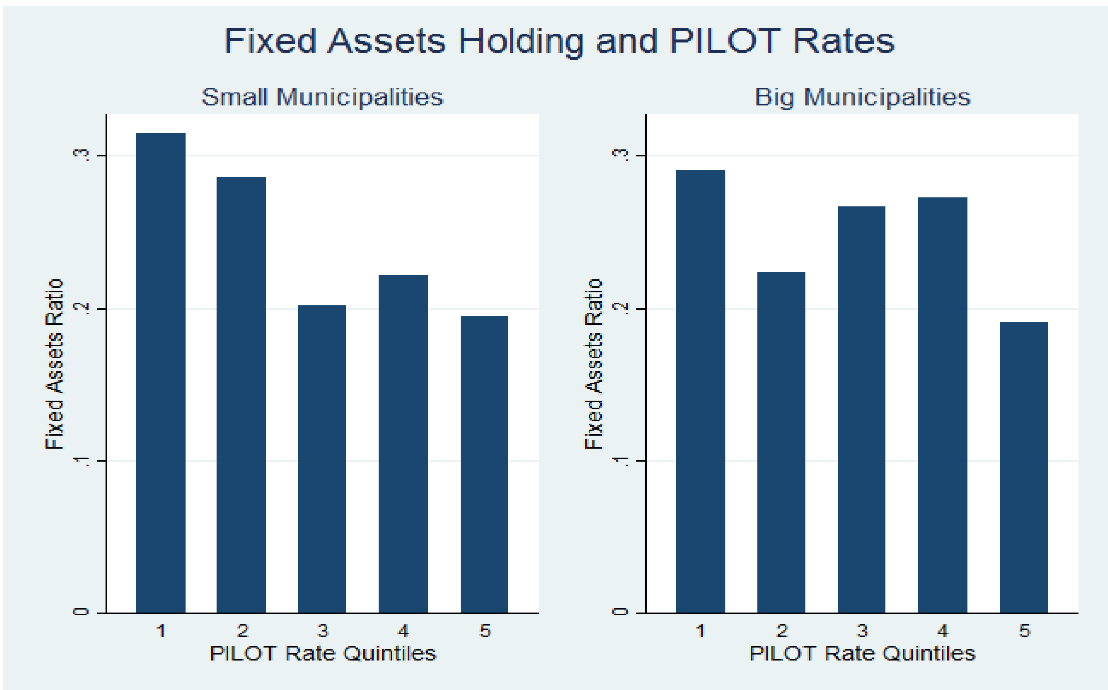
[56] The pattern in Figure 3.6 is also consistent with PILOT obligations being increasing functions of nonprofit non-fixed asset holdings, which would induce a negative correlation between measured PILOT rates and ratios of fixed to total assets. While this possibility is not an implication of the model in section 3, it is nonetheless difficult to rule out, and may affect the interpretation of the strength of the pattern in Figure 3.6 and the coefficient magnitudes in the related regressions reported in columns 7-8 of Table 3.6.

start only in 1998, use data for 1998-2005. The observations are pooled, and are weighted by population; the specifications include year dummies and cluster standard errors by municipality. All of the specifications include town population and median household income (in 1999) as control variables; regressions reported in even-numbered columns add the same demographic and economic control variables used in Tables 3.2, 3,3, and 3.4.

Figure 3.6 Fixed Asset Ratios and PILOT Rates by Municipality Size (1998-2007)



Note to Figure 3.6: The figure presents ratios of nonprofit fixed asset holdings to nonprofit total assets for 10 groups of Massachusetts towns, distinguished by size of town in 2000 and average PILOT rates from 1998-2007. The left figure depicts data for Massachusetts towns with below-median populations in 2000; the right figure depicts data for Massachusetts towns with above-median populations. A town's average PILOT rate is the average from 1998-2007 of its annual ratios of PILOT receipts to market values of nonprofit property. Towns in the first PILOT quintile from the left in each of the two graphs have the lowest PILOT rates, whereas those in the fifth PILOT quintile have the highest PILOT rates. The heights of the bars depict the median fixed-asset ratios (10-year averages) of towns in each group. Towns without any nonprofit activity from 1998-2007 are omitted from these data.

Columns 1-2 of Table 3.6 report estimated coefficients from regressions in which the dependent variable is the log of aggregate nonprofit fixed asset holdings. The -0.801 coefficient in column 1 indicates that a one percentage point higher PILOT rate is associated with a 0.8 percent reduction in nonprofit property holding over the sample period. This regression also includes as independent variables the log of local population and the log of per capita household income in 1999, both of which have positive and significant associations with nonprofit fixed assets. The magnitude of the estimated PILOT rate coefficient falls to -0.662 in the column 2 regression in which additional demographic and economic control variables are included, but remains statistically significant.

The large magnitudes of the estimated PILOT rate effects in the regressions reported in columns 1-2 of Table 3.6 are consistent with PILOTs significantly influencing nonprofit property holdings, but also raise the possibility that variable construction may influence the estimated coefficients. The PILOT rate is the ratio of PILOT receipts to nonprofit property holdings, so classical measurement error in nonprofit property holdings generates a negative correlation between the measured PILOT rate and nonprofit property. In evaluating the likely role that the resulting bias might play in this regression, it is noteworthy that the data used in constructing the dependent variable in the regressions reported in columns 1-2 (Form 990 data from nonprofit filings) differ from the data used to construct PILOT rates (Massachusetts Department of Revenue data on local property assessments). While this difference addresses part of the potential for bias it does not address all of it, since unexplained differences in true nonprofit property holdings that somehow do not translate directly into differences in PILOTs will affect both measures.

Columns 3-4 of Table 3.6 report estimated coefficients from regressions in which the dependent variable is the log of total nonprofit assets. The -0.211 coefficient in column 3 indicates that nonprofits in towns with higher PILOT rates have fewer assets, though this effect is between one-quarter and one-third as strong as the effect of PILOTs on fixed asset holdings. The -0.0741 coefficient in the regression reported in column 4 that includes additional demographic and economic controls is considerably smaller in magnitude and not statistically significant.

Columns 5-6 of Table 3.6 report estimated coefficients from regressions in which the dependent variable is the log of nonprofit revenue. The -0.204 coefficient in column 5 indicates that one percentage point higher PILOT rates are associated with 0.2 percent lower nonprofit revenue, an effect that declines significantly in magnitude to 0.08

percent, and becomes statistically insignificant, in the column 6 regression that includes additional control variables. From the evidence presented in columns 3-6 of Table 3.6 it appears that higher PILOT rates are generally associated with reduced nonprofit activity as reflected in asset holdings and total revenue, but that this effect is considerably weaker than the effect of PILOTs on fixed asset holdings.

The regressions presented in columns 7 and 8 of Table 3.6 estimate the effect of PILOT rates on ratios of fixed assets to total assets. These regressions omit observations from towns with no nonprofit activity. The -0.661 coefficient in column 7 indicates that fixed asset holdings decline significantly as a fraction of total assets as PILOT rates increase. Inclusion of additional control variables in the regression reported in column 8 has little effect on this estimated association.

Consequently, it appears that one of the primary effects of higher PILOT rates is to change the nature of nonprofit activity in a jurisdiction, moving it away from the use of property that would otherwise be subject to taxation. In the process, higher PILOT rates also appear to discourage nonprofit activity in general, suggesting that despite their low average rates (compared to property taxes) PILOTs are significant to the nonprofit community. These regressions do not distinguish whether these effects take the form of changing the places in which nonprofit organizations choose to locate, changing the local activities of nonprofits that remain despite higher PILOT rates, or changing the rates at which nonprofits are formed and dissolved, though presumably PILOTs affect all of these mechanisms.

3.6 Conclusion

The Massachusetts evidence is consistent with a model in which municipalities make PILOT demands that are increasing functions of local property tax rates, reflecting their valuation of services provided by nonprofits and the costs that nonprofits impose by reducing the local tax base. These PILOT demands have effects similar to those of property and other taxes in discouraging nonprofit activity, particularly real property holdings of nonprofit organizations. Since PILOTs are individually negotiated and nominally voluntary, it is striking that they would have such effects. This pattern implies that nonprofits are sufficiently concerned about the cost of current and future PILOT burdens that they adjust their behavior in response.

These tax-like features of PILOTs raise the possibility that, despite their voluntary nature, PILOT payments may share many of the distributional and efficiency characteristics of property taxes, including the impact of fiscal competition. Governments eager to attract nonprofit activity might limit, or avoid making, PILOT demands, much in the way that local governments compete over tax rates (Wilson, 1986; Zodrow and Mieszkowski, 1986; Bucovetsky, 1991; Hoyt, 1991; Wilson and Wildasin, 2004) and in offering business development incentives (Bartik, 1991; Anderson and Wassmer, 1995; Fisher and Peters, 1998; Man, 1999; Gibson, 2003; Felix and Hines, 2013). There has been mixed evidence of the effect of enterprise zones, property tax abatements, and other tax-related incentives on business location decisions and economic development (Papke, 1994; Boarnet and Bogart, 1996; Dye and Merriman, 2000; O'Keefe, 2004; Hanson, 2009; Neumark and Kolko, 2010), though more recent evidence that preferential tax treatment significantly increases economic activity (Busso et al., 2013; Rohlin et al., 2014) is consistent with nonprofits being attracted to locations that make fewer PILOT demands.

In other cases governments might actively seek to discourage certain nonprofits from locating in their towns, notwithstanding the potentially valuable nature of the services they provide, if towns feel that there are negative local externalities associated with hosting the nonprofits or attracting the people they serve. This suggests that there can be equilibria with jurisdictions competing to impose high PILOT rates on certain types of nonprofits.

In an era of strained public finances it is understandable that towns might seek payments from nonprofits that are otherwise exempt from local property taxes. In doing so it is important for towns to be aware of the possible consequences of PILOTs for the nature and volume of local nonprofit activity, and the extent to which nonprofits respond to PILOTs much in the way that taxable entities respond to real estate taxes. Given the fiscal challenges that many U.S. towns face, there are likely to be growing calls for

PILOTs, and growing resistance from nonprofit organizations. This process has the potential to reshape the country's nonprofit landscape, as the location of nonprofit activity is increasingly influenced by local demands for PILOTs.

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Table 3.1: Descriptive Statistics, Massachusetts Towns without PILOTs and All Towns (1995-2007)

	No PILOTs		All Towns	
Number of Towns	47		351	
	Mean	S.d.	Mean	S.d.
Property and Payments				
PILOT Receipts	0	0	0.258	2.073
PILOT Rate, in %	0	0	0.109	0.420
Property Taxes	12.822	14.043	25.239	62.341
Property Tax Rate, in %	1.289	0.399	1.402	0.382
% Property Owned by Nonprofits	7.518	3.694	9.914	6.321
Nonprofit Activities				
Total Assets, in $ m	31.028	73.254	374.025	3645.842
Total Revenue	15.923	42.665	151.475	1282.39
Fixed Assets	8.731	19.271	67.602	502.173
Share of Fixed Assets in Total Assets	32.040	24.738	27.162	21.733
Municipality Characteristics				
Population	8,374	9,390	17,957	36,502
Median Household Income	73,712	25,792	73,782	23,499
Per Capita Income	35,116	11,903	34,455	10,985
City Status	0.064	0.245	0.157	0.364
Land Area	23.606	10.967	22.336	12.431
Public Road Mileage	79.734	53.639	103.230	82.433
Demographic Variables				
% of White Population	97.422	2.855	93.868	8.684
% of Black Population	0.754	0.906	1.664	3.042
% of Hispanic Population	1.096	1.560	2.554	5.472
% of High School Graduates	28.843	9.355	28.007	8.460
% of Some College	27.017	6.483	26.148	5.049

% of College Graduates	33.438	15.579	34.515	15.574
Economic Variables				
Unemployment Rate	7.902	2.632	7.831	2.629
% of People under 20	24.058	4.103	24.342	4.173
% of People over 65, Living Alone and in Poverty	0.537	0.410	0.554	0.369
% of People over 65	0.133	0.042	0.134	0.044
% of Households with Income < $10K	5.551	3.370	6.014	3.361
% of Households with Income > $50K	54.145	15.453	55.304	13.256

Note to Table 3.1: The table presents means and standard deviations of variables used in the regressions presented in Tables 3.2-3.6 and Appendix Table D-2. The first two columns present means and standard deviations of the regression variables for the 47 towns that never collected PILOTs from 1995-2007, whereas the third and fourth columns present means and standard deviations of the regression variables for the whole sample of 351 Massachusetts towns. Variables reported in this table are defined in Appendix Table D-1.

Table 3.2: Determinants of PILOT Rates (2007)

	(1)	(2)	(3)
Property Tax Rate, in %	0.210***	0.139***	0.186***
	(0.0547)	(0.0449)	(0.0704)
% of White Population		0.00192	0.00138
		(0.00210)	(0.00234)
% of Black Population		0.00437*	0.00578*
		(0.00251)	(0.00337)
% of Hispanic Population		0.00501**	0.00630**
		(0.00243)	(0.00314)
% of High School Graduates		0.000947	-0.00201
		(0.00253)	(0.00434)
% of Some College		-0.000966	-0.00371
		(0.00307)	(0.00557)
% of College Graduates		0.000410	-0.00165
		(0.00142)	(0.00319)
Unemployment Rate			0.0145
			(0.0158)
% of People under 20			-0.00533
			(0.00451)
% of People over 65			0.156
			(0.314)
% of People over 65, Living Alone and in Poverty			-0.00484
			(0.0553)
% of Households with Income < $10K			-0.0117
			(0.0146)
% of Households with Income > $50K			0.000543

			(0.00226)
Constant	-0.182***	-0.335	-0.0290
	(0.0590)	(0.230)	(0.461)
Observations	351	350	350
Pseudo R-squared	0.169	0.235	0.270
F-stat	14.68	7.978	7.500

Note to Table 3.2: The table presents estimated coefficients from Tobit regressions in which the dependent variable is the ratio of town PILOT receipts in 2007 to the market value of its nonprofit property in 2007, expressed as a percentage. Observations are weighted by town population. Among the independent variables, the town property tax rate and town unemployment rate are all 2007 values; all other variables correspond to 2000.

Table 3.3: Determinants of PILOT Rates (1995-2007)

	(1)	(2)	(3)
Property Tax Rate, in %	0.289***	0.128**	0.137**
	(0.109)	(0.0572)	(0.0576)
Demographic Controls	N	Y	Y
Economic Controls	N	N	Y
Year dummies	1996-2007	1996-2007	1996-2007
Observations	4,547	4,534	4,534
Pseudo R-squared	0.0673	0.103	0.112
F-stat	2.280	2.315	2.104

Note to Table 3.3: The table presents estimated coefficients from Tobit regressions in which the dependent variable is the ratio of town PILOT receipts to the market value of its nonprofit property, expressed as a percentage. The sample includes observations from 1995-2007. Observations are weighted by town population, and standard errors are clustered by municipality. All of the regressions include year dummy variables; the regression reported in column 2 includes the six "Demographic Variables" listed in Table 3.1; and the regression reported in column 3 includes the six "Demographic Variables" listed in Table 3.1 plus the six "Economic Variables" listed in Table 3.1. Among the independent variables, the town property tax rate and town unemployment rate are all contemporaneous values; all other variables correspond to 2000.

Table 3.4: Determinants of PILOT Rates, IV Regressions

	2007 Cross Section		Pooled 1995-2007	
	(1)	(2)	(3)	(4)
	First-Stage	Second-Stage	First-Stage	Second-Stage
Log (Population)	0.0900***		0.147***	
	(0.0170)		(0.0159)	
Property Tax Rate, in %		0.235***		0.213**
		(0.0746)		(0.106)
Year dummies	N	N	1996-2007	1996-2007
Observations	351	351	4547	4547
Unadjusted R-squared	0.1624		0.5018	
Pseudo R-squared		0.071		0.080
Weak IV F-stat	27.93		86.40	

Note to Table 3.4: The table presents estimated coefficients from first- and second-stage instrumental variables specifications in which the dependent variable in the second stage is the ratio of town PILOT receipts to the market value of its nonprofit property, expressed as a percentage. The log of town population in 2000 serves as an instrument for the property tax rate in the first stage equation. Observations are weighted by town population, and standard errors are clustered by municipality for columns 3 and 4. The sample in the regressions reported in columns 1 and 2 consists of observations for 2007, whereas the sample in the regressions reported in columns 3 and 4 includes observations from 1995-2007. Columns 1 and 3 report first stage equations, and columns 2 and 4 report second stage equations. The regressions reported in columns 3 and 4 include year dummy variables. The weak IV F statistic is the Kleibergen-Paap Wald rk F statistic, a heteroskedastistic-and-cluster-robust weak identification test statistic.

Table 3.5: 2007 PILOT Rates and Tax Referenda Outcomes

	(1)	(2)	(3)
Property Tax Rate, in %	0.200***	0.136**	0.188**
	(0.0647)	(0.0583)	(0.0877)
Dummy (No Referendum)	0.0572**	0.0503*	0.0442**
	(0.0231)	(0.0257)	(0.0223)
% of White Population		0.00382	0.00162
		(0.00256)	(0.00310)
% of Black Population		0.00577**	0.00800*
		(0.00282)	(0.00445)
% of Hispanic Population		0.00701**	0.00790*
		(0.00279)	(0.00414)
% of High School Graduates		-0.00150	-0.00336
		(0.00296)	(0.00537)
% of Some College		0.00109	-0.00403
		(0.00375)	(0.00709)
% of College Graduates		0.000693	-0.00150
		(0.00157)	(0.00385)
Unemployment Rate			0.0196
			(0.0202)
% of People under 20			-0.00217
			(0.00631)
% of People over 65			1.082**
			(0.505)
% of People over 65, Living Alone in Poverty			0.0388
			(0.0679)
% of Households with Income < $10K			-0.0163
			(0.0194)

% of Households with Income > $50K			0.00293
			(0.00268)
Constant	-0.206**	-0.532*	-0.396
	(0.0747)	(0.270)	(0.602)
Observations	195	195	195
Pseudo R-squared	0.276	0.371	0.492
F-stat	7.740	6.270	8.716

Note to Table 3.5: The table presents estimated coefficients from Tobit regressions in which the dependent variable is the ratio of town PILOT receipts in 2007 to the market value of its nonprofit property in 2007, expressed as a percentage. The sample includes only those towns that either never had a property tax referendum from 1995-2007, or else had property tax referenda that failed. Observations are weighted by town population. The "Dummy (No Referendum)" variable takes the value 1 for towns without a property tax referendum from 1995-2007, and is zero for towns with property tax referendums that failed. Among the independent variables, the town property tax rate and town unemployment rate are all 2007 values; all other variables correspond to 2000.

Table 3.6: Effects of PILOT Rates on Nonprofit Activity (1995-2007)

Dependent Variables	log(Fixed Assets)		log(Total Assets)		log(Total Revenue)		log(Fixed Assets Ratio)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PILOT rate (in %)	-0.801***	-0.662***	-0.211**	-0.0741	-0.204**	-0.0826	-0.661***	-0.622***
	(0.237)	(0.193)	(0.103)	(0.0867)	(0.0926)	(0.0765)	(0.191)	(0.177)
Log(population)	2.654***	2.467***	2.420***	2.103***	2.353***	2.169***	0.311***	0.530***
	(0.0607)	(0.0636)	(0.0287)	(0.0397)	(0.0332)	(0.0381)	(0.0499)	(0.0488)
Log household income (1999)	0.745***	6.401***	1.154***	4.048***	0.552***	4.357***	-0.384***	2.684***
	(0.164)	(1.163)	(0.107)	(0.648)	(0.100)	(0.628)	(0.0872)	(0.787)
Constant	-19.55***	-71.69***	-20.02***	-47.38***	-12.94***	-50.44***	-0.937	-31.28***
	(2.198)	(11.63)	(1.378)	(6.496)	(1.332)	(6.352)	(1.293)	(7.854)
Year dummies	1996-2007	1996-2007	1996-2007	1996-2007	1996-2007	1996-2007	1996-2007	1996-2007
Demo+Econ Controls	N	Y	N	Y	N	Y	N	Y
Observations	3,502	3,492	4,547	4,534	4,544	4,531	3,181	3,171
R-squared	0.510	0.607	0.615	0.709	0.650	0.723	0.052	0.104
F-stat	185.7	199.3	603.1	433.2	428.7	445.4	9.288	16.62

Note to Table 3.6: The table reports estimated coefficients from OLS regressions. The dependent variable in the regressions reported in columns 1-2 is the natural log of one plus total nonprofit fixed assets (the sum of land, buildings, and equipment) in a town; the dependent variable in the regressions reported in columns 3-4 is the natural log of one plus total nonprofit assets in a town; the dependent variable in the regressions reported in columns 5-6 is the natural log of one plus total nonprofit revenues in a town; and the dependent variable in the regressions reported in columns 7-8 is the natural log of the ratio of nonprofit fixed assets to nonprofit total assets. The sample used in the regressions reported in columns 3-6 includes observations from 1995-2007. The sample used in the regressions reported in columns 1-2 and 7-8 includes observations from 1998-2007, though observations from towns without any nonprofit activity in a year are excluded from the regressions reported in columns 7-8. Observations are weighted by town population, and standard errors are clustered by municipality. All of the regressions include year dummy variables; the regression reported in even-numbered columns include the six "Demographic Variables" listed in Table 3.1 plus the six "Economic Variables" listed in Table 1. Among the independent variables, the town PILOT rate, town population, and town unemployment rate are all contemporaneous values; all other variables correspond to 2000.

Appendix D: Supplementary Tables to Chapter 3

Appendix Table D-1: Definitions of Variables Used in Chapter 3

Name of Variable	**Definition**
PILOT Rate, in %	Ratio of town PILOT receipts to the market value of its nonprofit property, expressed as a percentage.
Property Taxes	Aggregate town property tax receipts in millions of real 2005 dollars reported to Massachusetts Department of Revenue.
Property Tax Rate, in %	Ratio of town property tax receipts to the market value of its taxable property, expressed as a percentage.
% Property Owned by Nonprofits	Ratio of the market value of property owned by nonprofits to the sum of the market value of nonprofit property plus the market value of taxable property.
Total Assets	Total assets reported on Form 990 by nonprofit organizations located in a town, in millions of 2005 dollars.
Total Revenue	Total revenue of the same nonprofit organizations as reported on Form 990, in millions of 2005 dollars.
Fixed Assets	The sum of market values of land, building, and equipment owned by local nonprofits as reported on Form 990, in millions of 2005 dollars.
Share of Fixed Assets in Total Assets	The ratio of Fixed Assets to Total Assets, in percentage.
Population	Town population.
Median Household Income	Nominal median household income reported in the 2000 Census, corresponding to calendar year 1999.
Per Capita Income	Nominal per capita income reported in the 2000 Census, corresponding to calendar year 1999.
City Status	City status determined by the state of Massachusetts as of 2000: 1 for cities, 0 for towns.
Land Area	Municipality land mass in 2000 measured in square miles.
Public Road Mileage	Total public road mileage in a municipality, reported every year and measured in linear miles.
% of White Population	Ratio of a town's white population in 2000 to its total population in 2000, expressed as a percentage (ditto for all the remaining variables).

% of Black Population	Ratio of a town's black population in 2000 to its total population in 2000.
% of Hispanic Population	Ratio of a town's Hispanic population in 2000 to its total population in 2000.
% of High School Graduates	Ratio of a town's residents in 2000 who graduated from high school but did not attend college to its total population in 2000.
% of Some College	Ratio of a town's residents in 2000 who attended college but did not graduate to its total population in 2000.
% of College Graduates	Ratio of a town's residents in 2000 who graduated from college to its total population in 2000.
Unemployment Rate	Municipality-level unemployment rate, reported every year.
% of People under 20	Ratio of a town's residents in 2000 younger than 20 to its total population in 2000.
% of People over 65, Living Alone and in Poverty	Ratio of a town's residents in 2000 younger over 65 and with incomes below the poverty line to its total population in 2000.
% of People over 65	Ratio of a town's residents in 2000 over 65 to its total population in 2000.
% of Households with Income < $10K	Ratio of the number of households with total household incomes below $10,000 in 2000 to the total number of households in 2000.
% of Households with Income > $50K	Ratio of the number of households with total household incomes above $50,000 in 2000 to the total number of households in 2000.

Note to Appendix Table D-1: Those variables for which years are not specified are available on an annual basis from 1995 to 2007. Those variables measured in "2005 dollars" were calculated using the Implicit Price Deflator of State and Local Government Expenditures and Gross Investment provided by the U.S. Bureau of Economic Analysis

Appendix Table D-2: Determinants of PILOTs Regression with Land Value Variable

	2007 Cross Section			Pooled 1995-2007		
	(1)	(2)	(3)	(4)	(5)	(6)
Property Tax Rate, in %	0.203***	0.142***	0.187**	0.283**	0.113**	0.138**
	(0.0573)	(0.0464)	(0.0741)	(0.114)	(0.0502)	(0.0594)
Land value/Land Area, in billions	0.0196**	0.00392	0.000735	0.0289	-0.0356	0.00129
	(0.00912)	(0.0165)	(0.0191)	(0.0181)	(0.0376)	(0.0250)
Demographic Controls	N	Y	Y	N	Y	Y
Economic Controls	N	N	Y	N	N	Y
Year Dummies	N	N	N	1996-2007	1996-2007	1996-2007
Observations	351	351	351	4,547	4,534	4,534
Pseudo R-squared	0.184	0.236	0.270	0.0691	0.104	0.112
F-stat	19.91	12.08	7.839	3.278	2.302	2.056

Note to Appendix Table D-2: The table presents estimated coefficients from Tobit regressions in which the dependent variable is the ratio of town PILOT receipts to the market value of its nonprofit property, expressed as a percentage. The regressions reported in columns 1 to 3 are run only on 2007 observations whereas the regressions reported in columns 4 to 6 are run on observations from 1995-2007. Observations are weighted by town population, and standard errors are clustered by municipality. “Land value/Land area” measures the market value of all properties in a town per square mile. The regressions reported in column 2 and 5 include the six “Demographic Variables” listed in Table 1; and the regressions reported in columns 3 and 6 include the six “Demographic Variables” listed in Table 3.1 plus the six “Economic Variables” listed in Table 1. Among independent variables, town property tax rates, populations, assessed values of all properties, and unemployment rate are all contemporaneous values; all other variables correspond to 2000.