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An Economic Analysis of the Good Roads Movement

September 2012

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DISCLAIMER

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ABSTRACT

Chapter 1: The Road to Development: Empirical Evidence of the Effect of Roads on the U.S. Economy: 1904-1921.
A cross-sectional county data set is created, using decennial census data and rural road data published by the Office of Public Roads, to analyze the effect of road infrastructure investment on U.S. aggregate output. Estimates of output elasticity with respect to road input are calculated utilizing a translog production function. Elasticity estimates range between -0.069 and 0.209. The results show that road capital had a small but positive effect on aggregate output in developing states with poor initial road networks. However, in states with a relatively high level of road infrastructure, additional spending on roads had a negative effect on aggregate output. The results suggest that investment in road spending is most effective in regions with a paucity of good roads.

Chapter 2: The Political Economy of the Rural Roads in the Early 20th Century
Local expenditures on the rural roads in the United States increased dramatically in the first two decades of the 20th century. By 1920, total expenditures on roads and bridges were on par with total spending on public education. This study examines the determinants of road demand, as measured by levels of local road expenditures, using county-level expenditure data from road surveys conducted by the Office of Public Roads. The results indicate that increased amounts of state-aid on roads was associated with increased local road expenditures in the Mountain/Pacific region, but had relatively little effect in the North Atlantic and North Central regions. This suggests that state-aid may have been viewed as complementary with local road expenditures in the Mountain/Pacific region. The paper also found that the presence of farmers led to a significant reduction in the amount of local road expenditure. The opposition by farmers may explain a significant amount of the observed variation in local road expenditures across counties.

Chapter 3: Paving the Way To Educational Success: Road Improvement and School Outcomes: 1900-1920
In the early twentieth century, U.S. consolidated schools were a key to improved educational attainment. However, consolidated schools would not have been possible without the necessary road improvements to transport rural students to distant centralized schools. Here I show that road improvements explain 10 percent of the observed change in the fraction of rural schools consolidated in the Midwest. I also measure roads direct impact on educational outcomes. While roads had a modest effect on school attendance rates, I find that roads can explain a significant portion of the observed rise in the average number of days attended per pupil and teacher quality. There was thus a significant social externality associated with investments in road capital in the early U.S. in the form of better educational outcomes.

Preface

The economic importance of transportation is without question. At the macroeconomic level, the transportation sector is seen as a key component in generating economic development. At the microeconomic level, transportation systems affect firm and production costs as well as household expenditures. In the United States, expenditures on transportation accounted for approximately 16 percent of total household expenditures in 2010, making it the second highest expenditure category behind housing.[1]

Throughout its history, transportation innovations in the United States, such as canals, steamboats and railroads, have spurred periods of economic growth. A recent innovation was the creation of the Interstate Highway System in 1956, which ushered in a new era of safer, faster and cheaper mode of road transportation. A wide body of literature exists that have examined the economic consequences of interstate highways. These studies generally support the view that the construction of a network of superhighways in the 1950s and 1960s led to large economic benefits. Few, however, are aware of a similar revolutionary innovation in the U.S. road network that occurred 50 years prior the construction of the first mile of interstate highway.

Between 1890 and 1930, a national crusade consisting of academics, bicycle and automobile manufacturers, railroad companies, farming interests and educational reformers agitated for the improvement of the nation's rural roads. This agitation for good roads, known as the Good Roads Movement, led to an exponential increase in road expenditures and innovations in the construction, maintenance and management of the rural roads.

The modern network of transcontinental interstate highways obscures the fact that the rural roads of the United States were in a deplorable condition at the turn of the 20th century.

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[1] The data was compiled by the Bureau of Labor Statistics, Table 3. *Age of Reference Person: Average annual expenditures and characteristics, Consumer Expenditure Survey*, 2010.

Although rural roads were vital arteries through which the flow of agricultural goods traveled, few of the roads were maintained at a high level of standard. The Commissioner of Agriculture declared in his annual report in 1888 that "the common roads of the United States have been neglected and are inferior to those of any other civilized country in the world. They are deficient in every necessary qualification that is attribute to a good road; in direction, in slope, in shape and service, and, most of all, in want of repair."[2] In the early decades of the 20th century, vast amounts were expended on the construction of improved rural roads. Local and state expenditures of rural roads increased from $62 million in 1904 to $476 million by 1920.[3]

However, the construction of improved rural roads was just one facet of the revolution occurring in the rural roads. Concurrent with the increased expenditures on roads, there were significant changes in road machinery technology, road building techniques, road management and the professionalism of road workers. Innovative road machinery such as steam traction engines, steamrollers, rock crushers, and advanced road drags made possible the rapid construction and resurfacing of the roads. Newly developed civil engineering programs resulted in trained road engineers building the roads. According to one source, prior to 1890, there were no engineers who were especially trained for highway construction.[4] The re-emergence of state governments (and later the federal government) into the field of highway administration was of particular importance in the development of improved roads. State highway departments were created in the early 20th century which brought some much-needed oversight over local road districts. These newly created state road agencies promoted scientific methods in road construction through the dissemination of knowledge. In addition, state-aid and federal-aid

[2] U.S. Department of Agriculture (1888), *Report of the Commissioner of Agriculture* (Washington, DC: GPO), p. 47.
[3] Expenditure figures are measured in constant 1910 dollars using the CPI from *Historical Statistics of the United States Millennial Edition Online*. Table Cc1-2. Source data comes from various reports of the U.S. Department of Agriculture, *State Highway Mileage and Expenditures*.
[4] Mason (1957), p. 2.

programs were developed which contributed to the improvement of the local rural roads. While in the mid-1890s only a handful of states had such state-aid road laws, by 1914, 42 states had some form of state-aid. At the federal level, the Federal Highway Act of 1916, the first highway bill passed by Congress, appropriated $75 million in funding for the construction of postal roads. This bill paved the way for future federal road projects.

It is therefore somewhat surprising that only scant attention has been focused on this period of dynamic change in the transportation network of the United States. Although several historians have traced the progress of the Good Roads Movement in the early 20th century, these papers tended to focus on the political campaign for road reform rather than the economic benefits of rural road improvement. Some contemporary studies were conducted by the Department of Agriculture attempting to measure the economic benefits of road improvement. However, these studies were limited in scope as they focused only on the economic conditions of eight counties.

The purpose of this study is to measure the economic impact that rural road improvement in the early 20th century may have had. Although a number of important issues are raised by this study, one prevailing issue links each chapter: What was the impact of rural road improvement on economic growth? The first chapter focuses on directly measuring the contribution of investment of road infrastructure on U.S. aggregate output. Using a translog production function, estimates of output elasticity with respect to roads are estimated for each state. By using the estimated output elasticities some conclusions may be drawn on the efficacy of additional investments in road infrastructure. The chapter's central conclusion is that investment in road spending is most effective in increasing aggregate output in poor regions with an under-developed road network. However, in wealthier regions with a good road network, the marginal benefit of an additional dollar of road expenditures is found to be lower. The role of different groups in the campaign for good roads is addressed in the second chapter. Given that road improvement has some beneficial impact on aggregate output, why was there such strong opposition to road improvement in some regions? Utilizing a median voter model, the determinants of road demand are considered in detail. The chapter finds that farmers, who should have been the primary beneficiaries of improved rural roads, were among its most strident opponents. Some discussion follows as to why farmers may have been opposed to good roads. The third chapter looks at an indirect way that roads may have generated economic growth. Some economic historians consider the rise in human capital to be a leading factor in explaining economic growth in the early 20th century. Much of the rise in school outcomes were occurring in rural schools, as a movement to consolidate one-room schools became widespread. There is strong evidence to believe that the Good Road and school consolidation movements were linked and that rural road improvement made school consolidation possible. The construction of consolidated schools provided a higher quality of education over traditional one-room schoolhouses. Roads may have had a large social externality, through its impact on education, which traditional cost-benefit analysis may have overlooked

While the improvement of the rural roads may not have captured the attention of economic historians the way that railroads or the interstate highways may have had, its effect on the U.S. economy was no less important. There is a considerable amount of untapped data concerning rural roads. Indeed, the availability of little used data was an important factor to the author in the selection of this topic. It is hoped that this analysis will act as a springboard for future areas of study on the economic impact of the Good Roads Movement.

Contents

List of Figures

List of Tables

CHAPTER 1

The Road to Development: Empirical Evidence of the Effect of Roads on the U.S. Economy, 1904-1921.

"The dirt roads of America are heavy drinkers. They lead a staggering and uncertain course from town to town; smear themselves with thick mire; and for four months in the year are unfit for the company of respectable people."

Editorial, *Good Roads Magazine* (1892)

1. Introduction

The rural roads of the United States have long served as the backbone of the transportation network. Roads were a necessary complement to the revolutionary transportation innovations that were reshaping the United States in the 19th century. Whether transported by steamboats, canals or railroads, goods had to be hauled to and from shipping points over the rural roads. The volume of goods that could be shipped depended on the quality of the rural road network. Despite the critical importance of roads in the transport of goods, the overall quality of the road network in the United States at the turn of the 20th century was in a deplorable state. In 1904, over 90 percent of the roads outside of incorporated areas were either unpaved or ungraded.[1] Starting in the 1890s, a movement to improve the rural roads, known as the Good Roads Movement, began to campaign for the improvement of the rural road network. Within a span of three decades, the percentage of surfaced roads tripled and total rural highway expenditures increased over tenfold.

Figure 1.1 shows how the quality of the road networks varied drastically across states. In 1904, only 7.1 percent of all roads in the United States had some type of improved surface.[2] As shown in Figure 1.1, good roads were concentrated principally in

[1] U.S. Department of Agriculture, Office of Public Roads (1907), *Public Road Mileage, Revenues, and Expenditures in the United States in 1904.*

[2] The term "improved" is somewhat misleading. Paved surfaces such as concrete or asphalt were rare during this period. Improved road surfaces consisted primarily of macadam or gravel roads. Macadamized

the Northeast, Upper Midwest, and Pacific regions. The states who were early leaders, in terms of the percentage of total roads improved, were Massachusetts, Rhode Island, Indiana and Ohio. In direct contrast, the public road infrastructure in the Southern and Plains states were generally in poor condition. In 1904, 11 states and the territories of New Mexico and Oklahoma had less than 1 percent of their total roads improved.

However, by 1921, many areas of the country made great strides in improving their road networks. Figure 1.2 shows that many southern states saw large increases in the percentage of total miles improved. For example, North Carolina jumped from 2.53 percent of roads surfaced in 1904 to 24.57 percent by 1921. The average percentage of surfaced roads for the southern states increased from 4.1 percent to 13.8 percent during the period. Other regions such as the Rocky Mountain and Plains states continued to see little improvement in their road infrastructure. As late as 1921, six states still had improved less than one percent of their total road networks.

The amount spent on public roads closely mirrored the quality of the road network illustrated in Figures 1.1 and 1.2. Table 1.1 shows the rapid increase in road expenditures per mile of existing road stock in the United States in the early 20th century. States with a larger fraction of total roads paved tended to spend more on infrastructure than states with few paved roads. Oftentimes, local road officials considered earth roads as "only dirt roads" since they spent only a small amount of money on its construction. As a result, local communities usually did not expend the necessary funds to keep their unpaved roads in good condition.[3] On the other hand, given the large construction costs associated with building a mile of high-class hard surfaced road, such as macadam roads,

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roads were roads constructed from crushed stone. Dirt roads that were properly drained and graded were also considered as improved roads.

[3] "Dirt Roads as Good Roads." *Municipal Journal* 5 April 1917: 495-496.

local officials would be more likely to expend resources on draining and maintaining their expensive investment. As the mileage of hard surfaced roads increased, total public road expenditures increased dramatically between 1904 and 1921. Across the United States, the average expenditure on rural roads went from $30.84 to $186.44 per mile of road in a span of just 17 years.[4] Given the massive increase in road spending during this period a natural question to ask is whether the increase in spending was an appropriate use of public resources. In other words, if one of the goals of policymakers in the early 20th century was to promote economic growth, was investing in public infrastructure an effective means towards achieving that goal?

To answer this question, I use county level data on road mileage and road expenditures to estimate the relative contribution of road capital in explaining economic growth in the United States in the first two decades of the 20th century. Specifically, this paper employs a translog production to estimate the effect of road infrastructure investment on aggregate output. Output elasticities are then calculated to estimate the effect of public road investment on economic growth. The results from the paper show that investment in public capital, as measured by road expenditures, provides a modest stimulus in states with initially low levels of output per capita. While the contribution of roads is small relative to other inputs such as labor and private capital, it is on par with the return to investment from land inputs. The estimated output elasticities of road capital are comparable to estimates found in other studies which have looked at the effect of public infrastructure on aggregate output. This paper also finds that the relative contribution of road investment on economic growth is smaller in wealthier states. The

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[4] The expenditure figures are measured in constant 1910 dollars using the CPI from *Historical Statistics of the United States Millennial Edition Online*, Table Cc1-2.

results suggest that increased investment on roads was unproductive at the margin for states with well-developed road networks. The implication is that additional road expenditures in high income states would have been a misallocation of public resources.

The contribution of this paper to the existing literature is twofold. First, most papers focus on the effect of overall public capital expenditures on aggregate output. These expenditures include non-military governmental spending such as highways and bridges, mass-transit systems, airports, water/sewer systems and public services such as health and education. This paper will narrow the focus and isolate the effect of spending on road infrastructure. Secondly, previous studies that have utilized U.S. data have only examined the effect of public capital investment since World War II. This paper will be one of the first studies to gauge the relative contribution of public road spending on economic growth in the early 20th century. In some ways, the road network in the United States during this time mirrors the road networks in developing countries today. Table 1.2 illustrates how the road network of the United States in the years between 1904 and 1921 compares to the road networks that exist in modern-day developing nations.[5]

Evaluating the rate of return on infrastructure investment in an earlier period in the United States may provide some guidance to policymakers in developing nations concerning the effectiveness of road investment in achieving economic growth. The failure of private markets and the necessity for the government to provide for public goods such as roads is well understood. However, all governments face a central problem of deciding how to allocate scarce public expenditures among the various public

[5] One should be careful about drawing too close of a comparison between roads in the early 20th century and roads in the early 21st century. Roads that were considered improved in 1912 would be considered primitive in 2012. Many of the early improved roads lacked shoulders, proper grading and drainage.

goods. This problem is of fundamental importance to policymakers in developing countries who must decide how best to promote economic growth.

2. Literature Review

The literature on public infrastructure investment and economic growth is large and well established. Many of the papers that have looked at the effect of public spending on aggregate output have generally found a positive relationship.[6] Barro (1988) extended the existing models of endogenous economic growth to incorporate the government sector into the production function. The paper found that increases in the share of government expenditures to national income led to an initial increase in the growth rate of an economy. However, as spending on public services continued to increase, the rate of economic growth eventually declined.

Aschauer (1989) was one of the first empirical studies to examine the role of public capital on economic growth. Using data from the United States, he looked at the effect of investment of non-military capital stock, including highways, on various measures of private sector productivity. He found that the estimated output elasticity with respect to public capital ranged between 0.38 and 0.56. The estimated elasticity of public capital was similar in magnitude to the elasticity calculated for private capital. Critics of the study argued that the estimated elasticity was implausibly high as it implied a rate of return of over 100 percent for public capital. A potential flaw with the estimates of output elasticity was that Aschauer did not address the possibility of reverse causality

[6] Ligthart and Suarez (2005) conducted a meta-analysis of 49 papers that measured the output elasticity of public capital. These studies yielded 248 separate estimates. Taking a simple average, the authors found that the output elasticity of public capital was approximately 0.20. Using a fixed effects model, it was estimated that the mean value of output elasticity was 0.04, while using a random effects specification yielded an estimate of 0.14. The general conclusion of the meta-analysis was that public capital had a small, but positive effect on aggregate output.

between public capital and productivity. The failure to take endogeneity into account could have led to an upward bias of the estimated coefficients.

Other papers quickly followed which took into account some of the econometric shortcomings of Aschauer's study. Using a pooled sample of seven OECD countries over the 1963-1988 period, Nourzad and Vrieze (1995) followed Aschauer's approach. Like Aschauer, the authors found a statistically significant positive relationship between public capital and productivity. However, the estimated elasticity of public capital was significantly lower than the earlier estimates by Aschauer. Nourzad and Vrieze estimated an output elasticity with respect to public capital of only 0.05.

Canning and Bennathan (2000) extended the analysis of the effects of public infrastructure on aggregate output to include developing countries. The paper estimated an aggregate production function using physical capital, human capital, electricity generating capacity and highway stock for a set of 97 countries. The authors utilized both a Cobb-Douglas production function and a translog specification. With the translog specification the estimated output elasticity of paved roads ranged between 0.04 and 0.09. The authors found that the rates of return to paved roads were on par with the rates of return to private capital. There was also evidence that the rates of returns to paved roads were well above the rates of return to private capital in several countries. These excess returns suggest that in some countries there was a sub-optimal level of investment in road infrastructure.

A paper by Fernald (1999) suggested that road building could explain much of the observed productivity slowdown in the United States in the 1970s. Fernald argued that increases in road capital in the 1950s and 1960s, as a result of the construction of the interstate highway system, led to a one time productivity boost for certain industries. For example, industries that utilized a large number of vehicles benefitted disproportionately from road building. The study estimated that the investment in the interstate highway network led to above average rates of returns and contributed to an increase in total productivity growth before 1973. However, as the growth rate of road expenditures slowed in the early 1970s, the same industries that benefited from earlier increases in road spending experienced large declines in productivity.

Not all studies have found a positive correlation between public capital and aggregate output. Ford and Poret (1991), following Aschauer's approach, looked at the effect of non-military public capital stock on productivity growth for eleven OECD countries. They found that infrastructure productivity was positive and statistically significant for the United States, Germany, Canada, Belgium and Sweden but not significant for the United Kingdom, Norway and Australia. The estimates for France, Japan and Finland were mixed. Devarajan, Swaroop and Zou (1996) utilizing annual data from 43 developing nations between 1970 and 1990, found that the relationship between public capital investment and per-capita economic growth was negative. They found that the coefficient for the transportation and communication component of public capital was negative and statistically significant. However, when using the fixed-effects estimator the result became statistically insignificant. The authors attributed the unexpected result to the possibility that there was an overprovision of capital expenditures in the sample of developing nations. They further contended that continued funding of public transport expenditures would be a misallocation of public resources. It is evident from this brief review of the literature that there are still some disagreements concerning the effect of public capital expenditures on economic growth.

3. Methodology

3.1 Production Function Approach vs. Cost Function Approach

There are two main approaches that have been used in estimating the effect of public capital on aggregate output levels: the cost function approach and the production function approach. In the cost function approach, the estimates of output elasticities are calculated by focusing on private output rather than aggregate output. Under this approach, private firms minimize their total cost function (or equivalently maximize their total profit function) subject to several constraints. In general, the cost function approach assumes that private firms minimize their total cost subject to a given output level. The level of output is determined by the amount of private inputs, public capital and technology with input prices exogenously determined. The individual firm's problem is to choose the quantity of private inputs given the levels of public capital stock and technology.[7]

There are, however, several disadvantages of using the cost function approach. One disadvantage of using this approach is that estimation of the cost function would require the collection of a large amount of data. Input and price data for each firm (or industry) over several time periods would be required. Such detailed data is simply not available for the early 20th century United States. Additionally, if the production process requires n private inputs, then $2n + [n(n-1)]/2$ coefficients (in addition to the constant term and any dummy variable coefficients) would need to be estimated. The high

[7] An excellent overview of studies that utilized the cost-function approach can be found in Celebi (2007). Celebi found that the estimated effects from cost-function studies, while positive and significant, were uniformly smaller than those estimated using the production function approach.

number of coefficients to be estimated would substantially reduce the degrees of freedom in the estimation.[8] Finally, the cost function approach would fail to capture any potential positive externalities that might arise from investment in road infrastructure.

Given the difficulties of the cost function approach, this paper will estimate the effects of road infrastructure utilizing an aggregate production function approach. The explanatory variables for the aggregate production function include private capital (K_i), labor (L_i), land (Z_i) and a measure of road capital input (R_i). The general form of this aggregate production function is given by Equation (1):

$$Y_i = AF(K_i, L_i, Z_i, R_i) \tag{1}$$

The aggregate production function singular advantage is the ease in which the coefficients can be estimated and interpreted. The main disadvantage of using the production function approach is the problem of reverse causality. Despite this limitation, the production function approach appears to be the most direct way to estimate the effect of investment in road infrastructure on aggregate output. Within the production function approach, the Cobb-Douglas specification and the translog specification are the two most common methods used to estimate the output elasticity of public capital.

3.2 Cobb-Douglas Specification

Many of the studies within the public capital literature have utilized the Cobb-Douglas specification. For simplicity it is assumed the Cobb-Douglas production function exhibits constant returns to scale. The underlying production function is assumed to have the following functional form:

$$Y_i = A_i K_i^{\alpha_1} L_i^{\alpha_2} Z_i^{\alpha_3} R_i^{\alpha_4} \tag{2}$$

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[8] Celebi (2007), p. 10.

The Cobb-Douglas production function can also be expressed in per-worker terms. Equation (3) illustrates the per-worker Cobb-Douglas production function:

$$y_i = A_i k_i^{\alpha_1} z_i^{\alpha_3} r_i^{\alpha_4} \qquad (3)$$

By taking the log of both sides of the production function, the per-worker production function can easily be estimated using OLS:

$$\ln y_i = \ln A_i + \alpha_1 \ln k_i + \alpha_3 \ln z_i + \alpha_4 \ln r_i \qquad (4)$$

The Cobb-Douglas specification is attractive because of the clear interpretation of the coefficients. Since both sides of the equation are expressed in logs, the estimated coefficients are simply the output elasticity with respect to the corresponding input. For example, α_4 in Equation (4) represent the elasticity of aggregate output with respect to road infrastructure. The coefficient measures the percentage change in aggregate output if the existing road stock is increased by one percent. One issue with using the Cobb-Douglas approach is that the production function has the property of diminishing marginal productivity of input. As a result, regions with low levels of public capital per worker will necessarily have higher rates of return due to the higher marginal productivity of the road input. Another problem with utilizing a Cobb-Douglas functional form is that the production function assumes that the output elasticity is constant across all states in a region. To allow for the possibility of variation of output elasticity across states within a region, the translog specification will be used.

3.3 Translog Specification

The second specification commonly used in estimating the effect of road investment is the translog production function. The translog production function is the generalized version of the Cobb-Douglas production function. Using the translog specification over the Cobb- Douglas approach has the advantage in that it allows for the estimation of the relationship between inputs (whether the inputs are complements or substitutes with each other) in the aggregate production function. In addition, the specification allows for the possibility that the output elasticity with respect to infrastructure investment may differ across states. Given the additional flexibility offered by the translog specification, the generalized production function will be used in this study. The variant of the translog production function, expressed in per worker terms, to be estimated is as follows:

$$\ln y_i = \ln A_i + \alpha_1 \ln k_i + \alpha_2 \ln z_i + \alpha_3 \ln r_i + \alpha_4 (\ln k_i)^2 + \alpha_5 (\ln z_i)^2 + \alpha_6 (\ln r_i)^2 + \alpha_7 (\ln k_i \ln z_i) + \alpha_8 (\ln k_i \ln r_i) + \alpha_9 (\ln z_i \ln r_i) + \varepsilon_i \quad (5)$$

The coefficients on the input variables (α_1, α_2, α_3) in Equation (5) do not have any direct interpretation. However, the coefficients on the higher power terms (α_4, α_5, α_6) measure the scale effect of the inputs. The squared input terms measure the effectiveness of an additional unit of input given the current input levels. For example, if α_6 is positive, this implies that adding an additional mile of paved road will have greater effectiveness in a region that already has a dense road network. The interaction terms also carry some economic intuition as the coefficients on the interaction variables (α_7, α_8, α_9) measure the degree of substitutability among inputs. If the coefficient is positive then the inputs are considered complementary, while if negative, then the inputs are substitutes.

To calculate the responsiveness of aggregate output to a one percent change in the road capital input, we simply differentiate Equation (5) with respect to road capital to get the following equation for output elasticity with respect to the road input:

$$\varepsilon_i = \frac{\partial \ln y_i}{\partial \ln r_i} = \alpha_3 + 2\alpha_6 \ln r_i + \alpha_8 \ln k_i + \alpha_9 \ln z_i \tag{6}$$

The output elasticities for the other inputs are estimated in a similar manner. Using the level of labor, private capital, land and road inputs in 1904, the output elasticity for roads can be estimated for each state.

4. Data

A cross-sectional county-level data set is utilized covering all states and the territories of Arizona, New Mexico and Oklahoma in the year 1904. The total sample includes 2,697 county-level observations. The translog specification is applied to a pooled sample of states divided into regions as opposed to applying the translog specification state by state.[9] The states and territories are divided into four regions: (1) North Atlantic region; (2) North Central region; (3) South region; and (4) West region.[10]

County level data on income per capita was not available in this period. In order to measure the level of economic activity at the county level, I used the amount of total manufacturing output plus the total level of agricultural output to proxy for aggregate output. County-level data on the total value of production from all manufacturing establishments in 1900 were found in the *Twelfth Census of the United States*. The *Census of Agriculture* for 1900 is used to gather data for agricultural output. Total

[9] Several states had only a handful of counties which would have led to degrees-of-freedom limitations.
[10] The states included in the North Atlantic region are CT, DE, ME, MD, MA, NH, NJ, NY, PA, RI, VT. The North Central region is comprised of the following states: IL, IN, IA, KS, MI, MN, MO, NE, ND, OH, SD, WI. The South region is AL, AR, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, VA, WV. The West region include AZ, CA, CO, ID, MT, NV, NM, OR, UT, WA, WY.

agricultural production is calculated as the sum of the total value of cropland production, dairy production, poultry, slaughtered livestock, orchard production and miscellaneous crop production.

Data on the levels of land and capital utilized in manufacturing and agriculture were also found using the *Twelfth Census of the United States* and the *Census of Agriculture.* Land input in manufacturing was measured by the total amount of capital invested in land used in the manufacturing process as reported by the Census. The land input in agriculture was measured as the total value of farmland. Data on private capital in manufacturing were found by calculating the total amount of manufacturing capital in cash, buildings, machinery, tools and implements. Private capital in agriculture was measured by the total value of farm buildings, fertilizer, livestock and machinery. The total private capital in a county is estimated to be the sum of the private capital in manufacturing and agriculture. The number of males aged 16 and over employed in manufacturing is used as the measure of total labor employed in the manufacturing sector. The number of laborers employed in the agricultural sector is estimated using the IPUMS 5 percent sample for the year 1900. Output, capital, land and road input measures are divided by the population employed in manufacturing and agriculture to get per worker variables.

The key variable of interest is the measure of road infrastructure stock. The total amount of road expenditures per capita is used as the proxy for road quality in a county.[11]

[11] As a check, the percentage of improved roads was also used as a measure of road infrastructure stock.

As mentioned earlier in the paper, the amount of road expenditures is directly proportional to the quality of the road network as higher quality roads require greater maintenance cost. Expenditure data for roads at the county level were collected by the Office of Public Roads in 1904. The Office of Public Roads, an agency within the Department of Agriculture, collected data on the roads located outside incorporated areas. The first road survey was conducted in 1904 with subsequent surveys conducted in 1909, 1914 and 1921.[12] Expenditure data was gathered from local and state road officials. For southern states, the amount of road expenditures also included any road taxes that were paid in labor by taxpayers.[13]

5. Results

5.1 Parameter Estimates of the Trans-log Production Function

The estimated OLS coefficients from Equation (5) are presented in Table 1.3. In each of the four regressions, state fixed effects are included to control for any unobservable or omitted state characteristics. The four columns of Table 1.3 report the parameter estimates for the production function by region. Column 1 reports the results for the North Atlantic region, column 2 for the North Central region, column 3 for the South region and column 4 for the West region. As mentioned earlier, the coefficients on the input terms (log capital per worker, log land per worker and log roads per worker)

The general conclusions do not change using the alternative measure.

[12] In the first three surveys, road statistics were reported at the county level. In the 1921 survey, the data was aggregated to the state level. After 1921, the Department of Agriculture began to publish annual reports of state road data.

[13] These types of taxes were known as statute labor taxes. Under this system of road taxes, the taxpayer generally had a choice of paying the road tax in cash or could “work the roads” by helping to repair the local roads on a designated day. The Office of Public Roads estimated the labor cost of the taxpayers who chose to work the roads.

have no direct economic intuition. The coefficients for the higher order input terms tend to be negative, although the results are not statistically significant across regions. A negative coefficient on the higher order road term, α_6 in Equation (5), suggest that roads have diminishing returns and that the effectiveness of roads decreased as additional miles were constructed. The OLS results do show that the higher order road coefficient is negative for three out of the four regions, but in none of the regressions is the result statistically significant. The results do imply, however, that areas with a high stock of road capital would be unlikely to see much benefit from additional road expenditures.

While the parameter estimates suggest that land and private capital are complements, the relationship between roads and other inputs in the production process is unclear. For the North Central and South regions, the relationship between capital and roads appear to be complementary. The coefficients on the private capital-roads interaction term are strongly positive suggesting that high levels of private capital stock were accompanied by higher levels of road capital in those regions. However, the coefficients on the interaction term between private capital and roads are slightly negative in the North Atlantic and West regions suggesting that the two inputs were substitutable. However, the results are not statistically significant for either region. The sign of the interaction term between land and road capital also varied across regions. In the North Atlantic and West regions the signs of the coefficients were positive while in the North Central and South regions the results suggest that road and land inputs were substitutes for each other.

To check whether utilizing the more flexible functional form of the translog production function is appropriate, a test was performed to see if the cross-term coefficients are zero. If the test fails to reject the null hypothesis that the cross-term coefficients are zero, then the Cobb-Douglas specification would be the appropriate functional form. However, the F-test statistic strongly rejects the hypothesis that the cross-term coefficients are zero for the North Central, South and West regions implying that the translog production model is the preferred specification. In these regions, there is some confidence that the appropriate specification was chosen. However, for the North Atlantic region, the low F-test statistic suggests that the null hypothesis cannot be rejected. It is possible that the Cobb-Douglas could be the appropriate functional form for the region.[14]

5.2 Estimating Output Elasticity

The elasticity of output with respect to roads will necessarily vary with the initial amounts of inputs. Thus, the elasticity of output for each input will differ across states. Table 1.4 calculates the output elasticity for labor, private capital, land and road inputs for the states in each of the four geographical regions. In order to estimate the output elasticity of labor directly, an added assumption is made that the translog production function realizes constant returns to scale. Input data at the state level in 1900 is used for the labor, private capital and land inputs, while state road expenditures for 1904 are utilized for the measure of road capital. The estimated output elasticity estimates in Table 1.4 show that the effect of roads on aggregate output varied dramatically across regions and across states within regions. In the North Atlantic region, the output elasticities of road infrastructure were uniformly negative, with the exception of

[14] Although not reported, I also ran the regressions using the Cobb-Douglas specification for each region. For the North Atlantic region it was estimated that roads had an average output elasticity of -0.016. The result is somewhat larger than the regional average using translog specification of -0.038. However, the Cobb-Douglas estimate was not statistically significant at the 10 percent level of significance.

Delaware and Maryland.[15] Massachusetts and Rhode Island had the lowest reported elasticity at -0.069. The estimated negative output elasticity suggests that investment in road infrastructure would have been better spent on a more productive input such as private capital. The estimated negative elasticities for roads in the North Atlantic region could imply that road infrastructure in the region had already reached its optimal level. As Figure 1.1 had shown, the states in the North Atlantic region were among the leaders in terms of the percentage of total roads that were surfaced. In particular, Massachusetts ranked first in the nation with 45.8 percent of its roads improved, with Rhode Island in second at 43.3 percent. The negative elasticities in those states suggest that road capital had diminishing returns. Given the relative high level of road capital stock, any additional investment on roads by the states in the North Atlantic region may have slowed economic growth.[16]

The results from the North Central region were mixed. While several states had negative output elasticities with respect to roads, other states had positive elasticities. These differences in elasticities within the North Central region reflect the variation in the quality of road networks across states in the region. Indiana and Ohio, ranked third and fourth in the nation respectively in terms of the percentage of total roads improved in 1904. Both of these states were estimated to have had negative output elasticities. At the other end of the spectrum, Kansas, Nebraska and South Dakota all had less than 1 percent of their total road networks improved in 1904. According to Table 1.4, these states also

[15] Although the Census categorized Delaware and Maryland in the South Atlantic region, these states were different than other states in the South Atlantic region. Both states were progressive in pushing road reform laws and were among the first states to pass state-aid road laws. The structures of local road administration in the two states were more similar to the laws of the North Atlantic states. For these reasons, I decided to include Delaware and Maryland in the North Atlantic region.

[16] It should be emphasized that a negative output elasticity does not imply that additional road expenditures physically reduced aggregate output. It only implies that investments in other capital inputs would have yielded higher returns than road input.

were estimated to have the highest output elasticities in the region. In general, states in the North Central region that initially had relatively poor road networks saw a greater effect on aggregate output from additional investments in road capital than states with higher quality road networks.[17]

Based on the analysis thus far, the absence of good roads in the South would suggest that southern states should have had some of the highest reported output elasticities with respect to investment in road capital. Table 1.4 does confirm that the average output elasticity with respect to road investment in the South region was positive. With the exception of Florida, the estimated effect of roads on aggregate output was positive for every state in the South region. Mississippi, Oklahoma, Tennessee and Texas were all estimated to have output elasticities with respect to roads above 0.10. The results from the southern states suggest that road expenditures had a greater efficacy on aggregate output in regions that were poor and/or had little road infrastructure. The effect of roads in the West region somewhat mirrors that of the South. The average output elasticity with respect to road investment is significantly positive for the region. However, there are a few outliers. California, a state with a good road network and a high level of output per capita, is estimated to have a relatively high output elasticity with respect to roads. But the output elasticity for roads in New Mexico, the poorest area in the region, is reported to be close to zero.

Table 1.5 reports the same results as in Table 1.4, but with the states arranged

[17] North Dakota appears to be an outlier to this generalization. Despite having only 0.36 percent of its roads improved, the estimated output elasticity of roads in the state was -0.04. One reason could be the high return to public capital estimated for the state. The estimated elasticity to private capital for North Dakota was 0.61 which was the highest among the states in the North Central region. The negative road elasticity suggests that resources allocated to roads may have been better spent invested in highly productive private capital.

according to income per capita. One reason to classify states by income is to check whether any pattern between economic development, as measured by income per capita, and the relative effect of road investment is discernible. Income per worker for each state is estimated by taking the sum of the total level of agricultural and manufacturing output and dividing it by total population. In 1900, New Mexico had the lowest income per worker in the nation at $81.25, while the state with highest income per worker was Rhode Island at $447.90. Three income categories are utilized to group the states. High income states are defined as states with income per capita in the top quartile, middle income states are states between the 25th and 75th percentile, while the low income category comprise states in the bottom quartile. Not surprisingly, almost all of the states in the bottom quartile in terms of income are from the South region. However, from Table 1.5, one can observe a clear pattern between output per capita and the effect of road investment. As economic development increased, the relative contribution of the road capital input declines. Table 1.5 would seem to confirm the earlier observation that at initial stages of development, additional road expenditures had a small but positive effect on aggregate output.

Based on the analysis of Tables 1.4 and 1.5, states with relatively high values of estimated output elasticity with respect to road infrastructure in 1904 should have increased their road expenditures to increase aggregate output. On the other hand, states with relatively low values of estimated output elasticities of road input should have limited the growth rate of their expenditures on public roads. Figure 1.3 presents a diagram showing the estimated output elasticity in 1904 versus the annualized growth rate in total road expenditures between 1904 and 1921.[18] The scatter plot diagram does

[18] The expenditure data are measured in real terms to account for inflation. All dollar amounts were

seem to show a positive relationship between output elasticity in 1904 and the annualized growth rate in road spending. States with relatively low levels of output elasticity, such as Massachusetts or New Hampshire, tended to have slower growth rates in road spending. The growth rates of road expenditures were highest in states with relatively high levels of output elasticity with respect to roads in 1904. While there were exceptions to this general conclusion, it does appear that most states allocated public funds efficiently in the first two decades of the 20th century.

6. Endogeneity Strategy

6.1 Problem of Endogeneity

Using the production function approach to explain observed output presents several econometric difficulties. Foremost among these difficulties is that the direction of causality between road infrastructure and aggregate output is unclear. The model in this paper assumes that causation runs from road capital to aggregate output. However, as Holtz-Eakin (1994) points out, "It is tempting to infer a causal relationship from public sector capital to productivity, but the evidence does not justify this step. It is just as easy to image the reverse scenario…. because more prosperous states are likely to spend more on public sector capital." If it is true that counties that had higher levels of output per worker were also the counties that spent more on road capital, then the estimated returns to road capital will be upwardly biased.

The literature widely acknowledges the potential problem of reverse causality from output to public capital but few studies have addressed the issue effectively. This paper will tackle the endogeneity issue headlong by looking at post office expenditures as a possible instrument. There is a growing literature that argues that infrastructure

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measured in constant 1910 dollars.

investment decisions are made by large special interest groups or incumbent politicians trying to maximize their own objective function rather than social welfare.[19] If the decisions on where to improve roads were also influenced by similar motivations in the early 20th century, then an IV approach using politically influenced variables would provide a better measure of the elasticity of output to road capital.

While there is no clear evidence that road investment decisions were directly linked to political motives in the early 20th century, there is evidence that political influence was used in the decision making process on where to extend postal service. The establishment of post-offices and rural free delivery routes was a highly political process. However, once such services were obtained, localities often experienced an improvement in the local roads. Thus, the extent of postal services in each county could serve as a potential instrument for rural roads.

6.2 Presidential Post-Offices and Rural Free Delivery

The instruments that will be utilized for road improvement is the total county expenditures for free delivery and total county expenditures for all postal services in the year 1900. The data for postal expenditures are limited to spending made by Presidential post-offices. Presidential post-offices were clearly political in nature since the postmasters of such offices were appointed to a four year term by the President, subject to Senate approval. These post-offices were likely to be established in localities that were strong supporters of the party that controlled the executive branch. From 1897-1913, the Republican Party controlled the Presidency and thus had complete control over political appointments.

A new service that was becoming increasingly popular during the period was a

[19] In particular see Cadot, Roller and Stephan (2006).

program known as Rural Free Delivery (R.F.D.). Before the establishment of R.F.D. in the 1890s, rural residents would have to travel great distances to the nearest post-office to pick up their mails. With the adoption of R.F.D., the postal service would be able to deliver mail directly to farm families. Naturally, R.F.D. service was dependent on the location of the local post-office. If the decision on where to locate rural post offices was itself politically driven, then R.F.D. service would tend to be established in areas that were predominately Republican. A paper by Kernell and McDonald (1999) provide strong evidence that Republican areas were more likely to be assigned a R.F.D. route than Democratic areas.

Postal Service statistics shown in Table 1.6 show significant differences in the number of Presidential post-offices and R.F.D. routes established across the states. Generally, southern states had far fewer post-offices and R.F.D. routes than other regions. Additionally, southern states were more likely to have their R.F.D. applications rejected by the U.S. Postal Service. For example, in 1900, the Post Office rejected 87.5 percent of rural delivery route petitions from North Carolina and 92 percent of the petitions made by local officials in Mississippi. Many southern politicians attributed their lack of success in obtaining postal services as a result of their near universal Democratic congressional delegation. The case between Iowa and Missouri would seem to bolster their claim. Despite the fact that Missouri had approximately a million more residents than Iowa, it had 100 fewer Presidential post-offices and only half the number of R.F.D. routes than its northern neighbor. Democrats claimed that the difference in postal services between the neighboring states was due to the fact that Iowa was a solidly Republican state while Missouri tended to vote Democratic at the state and federal level. The evidence would seem to suggest that the assignment of Presidential post-offices and R.F.D. routes was not random.

To serve as a valid instrument for road capital, it must also be shown that there was a strong correlation between the level of R.F.D. service and investment in road infrastructure. Evidence from the period provides support that this was likely the case. As a condition for receiving R.F.D. service, the Post Office wanted to ensure that any roads which would be traveled upon by postal workers were in good condition. Good roads were essential in ensuring continuous year round operation of rural delivery. In areas with questionable roads, local officials were required to sign a pledge promising the upkeep of the roads before approval for R.F.D. service could be granted.[20] Areas which were unable to guarantee the quality of the roads would be denied R.F.D. service. One reason for the low acceptance rate of R.F.D. petitions from southern states, according to the Postal Service, was due to the poor conditions of the local roads.[21] After a route had been approved and assigned, postal inspectors would make periodic trips along the route to check on the condition of the road. If the quality of the road was found wanting, local road officials would receive a warning from the Postal Service threatening the withdrawal of delivery service unless immediate improvements were made.[22] The great popularity of

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[20] The good roads pledge read as follows: "I have been informed that you are about to recommend the establishment of rural free delivery mails in my section, but that you hesitate to do so on account of the bad roads. I assure you that I will do all that I can to improve the roads over which you recommend the establishment of rural free delivery." United States Post Office Department (1901), *Annual Report of the Postmaster General*, p. 125.

[21] This argument is somewhat suspect considering that Kansas had 8 times the number of R.F.D. routes than Alabama despite it having a poorer road network, as measured by the total percentage of roads improved.

[22] Local road officials would receive the following warning by the Postal Service: "An investigation by this office discloses the fact that the roads traveled by the rural carrier from _______ post office are not being attended to as post roads should be. They are in bad condition. The postmaster at ________ has this day been notified to inform the patrons of route _________ that the lack of care given to the roads covered by it will, if continued, endanger the permanency of the service there." United States Post Office Department (1901), *Annual Report of the Postmaster General*, p. 125.

free delivery service among the rural residents was enough to stir local communities into action concerning the roads. In summarizing the relationship between good roads and rural free delivery, the Postmaster General wrote that:

> **"All, I think, will agree that rural free delivery is becoming a potent factor in the construction of good roads and their proper maintenance. While good roads commissions and other organization have been working for years to bring about these conditions and propaganda is still being carried forward with that end in view, it is quite apparent that the solution of the good-roads question lies largely in the rapid and systematic extension of the rural free delivery service. A good rural service means good roads, and as the people insist upon the former they must eventually obtain the latter."** [23]

Thus the expenditures on road capital should be positively correlated with the expenditures on postal delivery service.

6.3 IV Results

The expenditures on road per capita are instrumented using the total expenditures on delivery service and the total expenditures of all postal services made by Presidential post-offices. The data for postal expenditures are found using *The Annual Report of the Postmaster General* for the year 1901. The two stage least square results for the parameter estimates are reported in Table 1.7. In general, the results from IV estimations across the four regions are similar to the OLS estimates. As with the estimates in Table 1.3, the negative coefficients on the squared roads term imply that road capital has the property of diminishing returns across all regions; however the results are not statistically significant. Similar to the OLS results, the relationship between capital and land remains complementary. However, while the OLS estimation suggested a complementary relationship between capital and roads in the North Central and South region, the IV results suggest that the inputs may have been substitutes across all regions. Finally, Table 1.7 suggests that the land and road inputs may have been complements, but the

[23] United States Post Office Department (1901), *Annual Report of the Postmaster General*, p. 128.

result is only statistically significant for the West region.

Since the coefficients for the translog parameters are different between the IV and OLS estimations, we would naturally expect that the estimated output elasticities would differ in magnitude as well. Table 1.8 reports the estimated output elasticities of individual states (grouped by region) using the estimated IV coefficients. The magnitude of the output elasticities using IV estimates are significantly larger than the results reported in Table 1.4 in the North Atlantic region. As with the OLS estimation, the states in the North Atlantic region have negative output elasticities when using the IV estimated parameter. Whereas the output elasticities with respect to road infrastructure in the North Atlantic region ranged between -0.069 to 0.011 using the OLS estimates, the output elasticity of roads range from a high of -0.022 in Maryland to a low of -0.152 in Rhode Island using IV. Despite the difference in magnitudes of the elasticities, the overall conclusion that states with more developed road networks tended to have lower output elasticities with respect to roads is still supported.

The estimated effect of roads on aggregate output in the North Central region (column 2) appears to be somewhat higher using the IV results. While in Table 1.4, seven states in the North Central region had negative output elasticities with respect to roads, using the IV parameter estimates resulted in only Michigan, Ohio and Wisconsin having estimated negative output elasticities. The average output elasticity of roads for the region is only slightly positive at 0.011. The IV estimated output elasticities for the South and West regions are similar to the OLS estimates. Roads appear to have a positive effect on aggregate output in those regions. However, the magnitude of the positive effect is much larger in Table 1.8 then the reported estimates in Table 1.4. For example, the estimated output elasticity of roads in Oklahoma was 0.209 using OLS estimates, but increased to 0.471 using the IV estimates. Other states in the two regions had similar increases in output elasticity.

In order to examine whether the OLS results are biased due to endogeneity, two additional test statistics are reported at the bottom of each column in Table 1.7. The Sargan-test statistic tests whether the instruments used are appropriate for the regression equation. The null hypothesis that the proposed instruments do not belong in the regression is rejected if the p-value of the Sargan-test statistic is above a critical level. Here 10 percent is used as the critical level of significance. As was established in Section 6.2, the total expenditures on free delivery and overall postal services should be valid instruments due to the low correlation with output per capita but having a likely high correlation with respect to road expenditures. As expected, the Sargan-test statistic fails to reject the validity of these two instruments in all the regressions at the 10 percent level of significance.

The second test statistic reported in Table 1.7 is the Durbin-Wu-Hausman (DWH) test statistic which tests for the problem of endogeneity. If the p-value for the DWH test statistic is above the level of significance then the variable in question, the measure of road capital, is an exogenous variable. However, the reported p-values of the Durbin-Wu-Hausman test statistic for the North Atlantic, North Central and West regions are below the 10 percent level of significance. The implication is that treating road capital in those regions as an exogenous variable would produce inconsistent and therefore faulty estimates if endogeneity is not corrected. For these regions, the IV estimates may be preferred. The reported p-value of DWH test statistic for the South region, however, is above the critical level of significance. The test statistic fails to reject the null hypothesis that road capital is exogenous and thus the OLS estimates for the South region appears to be valid.

7. Conclusion

Overall, investments in roads appear to have a small, but positive impact on the aggregate output level across most areas in the United States in the early 20^{th} century. In developed states with a relatively good network of roads, additional expenditures on roads tended to have little impact (or even a negative effect) on aggregate output. Specifically, states in the North Atlantic region had negative output elasticities with respect to roads. The result suggests that further expenditures on roads may have lowered aggregate output by taking resources away from more productive inputs in that region. However, in developing states with a relatively poor network of rural roads, increases in road expenditures appear to have had a positive effect on aggregate output. The estimated elasticities of output with respect to road input are similar in magnitude to estimates produced in other studies that have looked at the effect of public capital investment in developing countries. Although the results lose some significance when controlling for endogeneity, the general conclusion of the positive effect of roads hold for the North Central, South and West regions.

The conclusion that marginal investments in road infrastructure have diminishing returns on aggregate output in developed states might give policymakers in developed countries some pause about the efficacy of infrastructure investment in spurring economic development. While constructing an initial network of good roads might lead to increases in productivity, construction of a secondary or tertiary road network might not be as effective in generating economic growth. Current proposals in the United States to spend billions on infrastructure investment should therefore be subject to careful scrutiny. On the other hand, poor regions that have a paucity of good roads may experience a one-time gain in productivity as they develop their road networks. Thus, road construction may serve as an effective policy tool in these developing regions. The narrowing of the income gap between the South and the rest of the nation in the post-bellum period is a subject of considerable interest among economic historians. The results from this paper find that it was the Southern states that increased their expenditures on infrastructure investment at a faster rate than other regions. It is possible that the investment on the rural roads may have been an important driver in explaining the observed economic growth in the South in the early 20th century.

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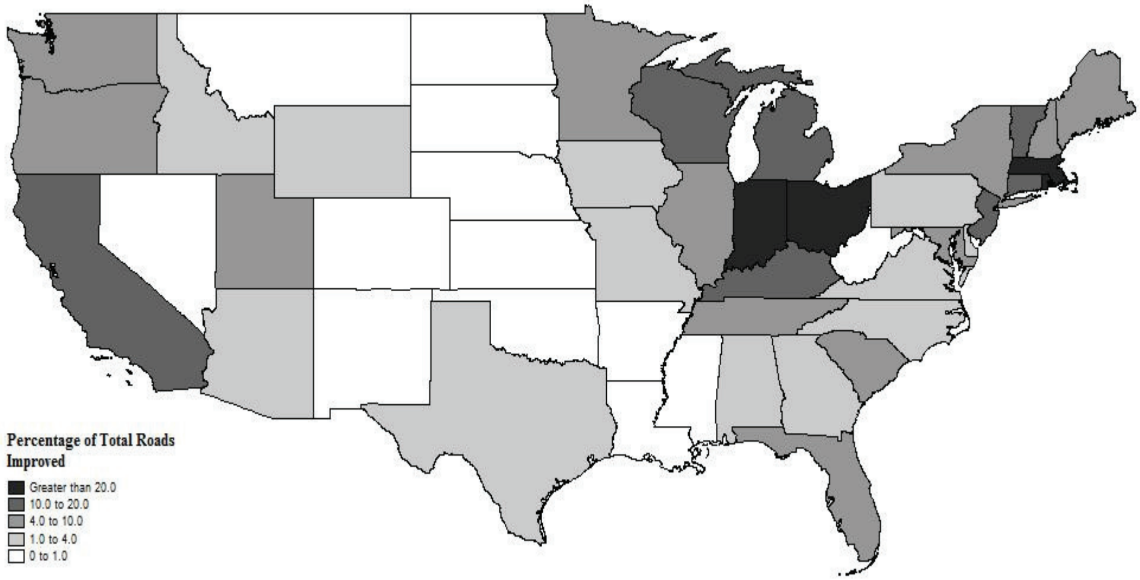
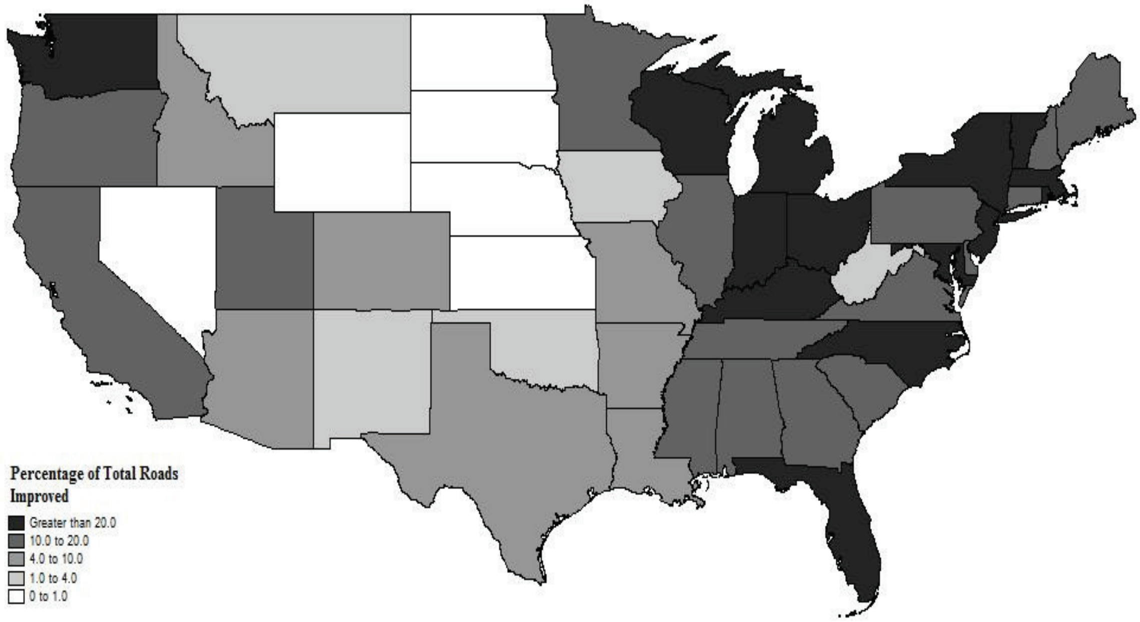
FIGURE 1.1
PERCENTAGE OF TOTAL ROADS IMPROVED (1904)



Source: U.S. Department of Agriculture (1907), *Public Road Mileage, Revenues, and Expenditures in the United States in 1904.*

FIGURE 1.2
PERCENTAGE OF TOTAL ROADS IMPROVED (1921)



Source: U.S. Department of Commerce (1923), *Statistical Abstract of the United States: 1922.*

TABLE 1.1
ROAD EXPENDITURES, BY STATE (1904-1921)

State	1904	1914	1921
Alabama	$8.04	$48.82	$67.14
Arizona	$12.03	$19.07	$47.30
Arkansas	$19.93	$28.46	$84.88
California	$49.27	$136.79	$307.37
Colorado	$22.40	$44.44	$86.50
Connecticut	$90.38	$195.14	$549.43
Delaware	$32.25	$132.07	$510.89
Florida	$26.81	$23.01	$134.40
Georgia	$16.67	$120.18	$77.10
Idaho	$11.83	$86.45	$225.80
Illinois	$43.51	$86.61	$264.52
Indiana	$53.63	$123.77	$268.76
Iowa	$24.38	$11.99	$86.04
Kansas	$7.29	$21.22	$54.82
Kentucky	$21.65	$40.52	$95.24
Louisiana	$14.78	$68.63	$167.52
Maine	$61.45	$68.15	$285.84
Maryland	$55.48	$73.56	$193.13
Massachusetts	$178.97	$107.59	$143.83
Michigan	$27.93	$118.40	$369.88
Minnesota	$21.59	$33.12	$26.68
Mississippi	$9.35	$67.55	$177.77
Missouri	$15.48	$65.50	$53.45
Montana	$14.67	$42.92	$39.65
Nebraska	$6.64	$54.44	$163.18
Nevada	$3.97	$77.19	$28.23
New Hampshire	$61.50	$82.28	$80.94
New Jersey	$235.07	$461.38	$1251.85
New Mexico	$2.46	$53.32	$75.68
New York	$56.85	$107.99	$843.06
North Carolina	$13.37	$57.28	$46.61
North Dakota	$8.19	$47.35	$87.41
Ohio	$73.28	$157.43	$299.56
Oklahoma	$10.94	$18.57	$41.00
Oregon	$20.21	$177.59	$196.44
Pennsylvania	$52.18	$277.50	$1015.44
Rhode Island	$170.03	$245.58	$2180.66
South Carolina	$8.51	$43.36	$265.73
South Dakota	$4.83	$92.84	$159.27
Tennessee	$13.68	$82.05	$105.70
Texas	$22.32	$72.95	$171.33
Utah	$23.78	$46.19	$30.14
Vermont	$41.63	$309.27	$443.15
Virginia	$14.14	$97.45	$178.96
Washington	$44.78	$297.89	$183.58
West Virginia	$23.92	$345.73	$185.29
Wisconsin	$32.23	$184.05	$330.88
Wyoming	$7.60	$69.87	$107.00

Notes: Dollar figures are measured in constant 1910 dollars.
Source: U.S. Department of Agriculture (Various Years), *State Highway Mileage and Expenditures*.

TABLE 1.2
CROSS-COUNTRY COMPARISON OF ROAD INFRASTRUCTURE

County	Year	Percentage of Total Roads Paved	County	Year	Percentage of Total Roads Paved
Columbia	1999	14.4	Cameroon	2004	10.0
Peru	2004	14.4	**United States**	**1914**	**9.9**
Samoa	2001	14.2	Guinea	2003	9.8
Laos	2003	14.1	Benin	2004	9.5
Kenya	2004	14.1	Bangladesh	2003	9.5
United States	**1921**	**13.1**	**United States**	**1909**	**8.7**
Namibia	2002	12.8	Tanzania	2003	8.6
Djibouti	1999	12.6	Ivory Coast	2004	8.1
Somalia	1999	11.8	Sierra Leone	2002	8.0
Madagascar	1999	11.6	Guyana	1999	7.4
Nicaragua	2002	11.4	**United States**	**1904**	**7.1**
Mauritania	1999	11.3	Bolivia	2004	7.0
Burundi	2004	10.4	North Korea	1999	6.4
Angola	2001	10.4	Cambodia	2004	6.4
Gabon	2004	10.2			

Sources: World Development Indicators Database (International Data); U.S. Department of Agriculture (Various Years), *State Highway Mileage and Expenditures*.

TABLE 1.3
PARAMETER ESTIMATES OF THE TRANS-LOG
PRODUCTION FUNCTION (OLS)

Variable	(1)	(2)	(3)	(4)
Log Capital per Worker	0.585	1.468***	1.948***	0.073
	(0.706)	(0.135)	(0.346)	(0.205)
Log Land per Worker	-0.086	-0.497***	-0.081	0.164
	(0.305)	(0.071)	(0.204)	(0.107)
Log Roads per Worker	-0.072	-0.294***	-0.426***	-0.091
	(0.125)	(0.064)	(0.145)	(0.080)
[Log Capital per Worker]^2	-0.080	-0.193***	-0.293***	0.021
	(0.200)	(0.025)	(0.089)	(0.041)
[Log Land per Worker]^2	-0.098**	0.014	-0.063*	0.031*
	(0.049)	(0.015)	(0.039)	(0.016)
[Log Roads per Worker]^2	-0.009	-0.005	-0.015	0.004
	(0.007)	(0.006)	(0.012)	(0.043)
[Log capital per worker] x [Log land per worker]	0.223	0.157***	0.190**	0.033
	(0.176)	(0.035)	(0.104)	(0.043)
[Log capital per worker] x [Log road per worker]	-0.035	0.165***	0.205***	-0.012
	(0.064)	(0.022)	(0.050)	(0.030)
[Log land per worker] x [Log road per worker]	0.059	-0.043***	-0.009	0.093***
	(0.040)	(0.014)	(0.036)	(0.023)
F-Stat for Test of Functional Form H_o: cross-term coefficients = 0	2.06	55.97	30.01	11.58
State Fixed Effects Included	Y	Y	Y	Y
Number of Counties	238	990	1177	292
R^2	0.788	0.865	0.799	0.611

Notes: Dependent Variable: ln(Output per Worker)
Column (1) reports the parameter estimates for the North Atlantic Region; Column (2) the parameter estimates for the North Central region; Column (3) the parameter estimates for the South region and Column (4) the parameter estimates for the West Region.
Robust standard errors are reported in parentheses.
*denotes statistical significance at the 90 percent confidence level; **at 95 percent, and *** at 99 percent.

TABLE 1.4
ESTIMATED OUTPUT ELASTICITY (OLS)
STATES ARRANGED BY REGION (1904)

	Labor	Private Capital	Land	Roads
North Atlantic:				
Connecticut	0.574	0.457	0.026	-0.058
Delaware	0.467	0.695	-0.173	0.011
Maine	0.480	0.554	0.006	-0.040
Maryland	0.454	0.699	-0.160	0.007
Massachusetts	0.603	0.412	0.053	-0.069
New Hampshire	0.513	0.543	-0.015	-0.040
New Jersey	0.536	0.482	0.039	-0.056
New York	0.509	0.590	-0.077	-0.022
Pennsylvania	0.486	0.615	-0.088	-0.014
Rhode Island	0.596	0.400	0.072	-0.069
Vermont	0.432	0.657	-0.079	-0.009
North Central:				
Illinois	0.591	0.448	0.008	-0.047
Indiana	0.452	0.599	-0.008	-0.043
Iowa	0.301	0.496	0.154	0.050
Kansas	0.417	0.389	0.142	0.052
Michigan	0.551	0.465	-0.001	-0.031
Minnesota	0.476	0.525	0.030	-0.015
Missouri	0.508	0.455	0.047	-0.010
Nebraska	0.388	0.366	0.176	0.070
North Dakota	0.388	0.609	0.040	-0.037
Ohio	0.583	0.483	-0.027	-0.038
South Dakota	0.362	0.427	0.158	0.054
Wisconsin	0.544	0.393	0.055	0.009
South:				
Alabama	0.274	0.556	0.113	0.056
Arkansas	0.225	0.606	0.090	0.080
Florida	0.293	0.652	0.084	-0.029
Georgia	0.260	0.622	0.091	0.027
Kentucky	0.300	0.520	0.081	0.099
Louisiana	0.419	0.352	0.147	0.082
Mississippi	0.208	0.597	0.092	0.103
North Carolina	0.306	0.509	0.100	0.085
Oklahoma	0.170	0.553	0.068	0.209
South Carolina	0.359	0.460	0.104	0.076
Tennessee	0.340	0.460	0.092	0.108
Texas	0.291	0.475	0.074	0.160
Virginia	0.466	0.355	0.091	0.087
West Virginia	0.311	0.548	0.066	0.074

West:				
Arizona	0.756	0.233	0.040	-0.028
California	0.651	0.256	0.026	0.066
Colorado	0.728	0.248	0.016	0.009
Idaho	0.449	0.282	0.181	0.088
Montana	0.791	0.244	-0.011	-0.025
Nevada	0.661	0.277	0.026	0.039
New Mexico	0.653	0.267	0.070	0.010
Oregon	0.569	0.261	0.103	0.066
Utah	0.616	0.275	0.061	0.048
Washington	0.737	0.214	0.039	0.009
Wyoming	0.597	0.263	0.126	0.024

Notes: Output elasticities are calculated using OLS parameter estimates from Table 3.
State level input data for labor, private capital and land from1900 are utilized. State level road expenditure data in 1904 are used as road inputs.

TABLE 1.5
ESTIMATED OUTPUT ELASTICITY (OLS)
STATES ARRANGED BY INCOME LEVEL (1904)

	Labor	Private Capital	Land	Roads
High Income States:				
Rhode Island	0.596	0.400	0.072	-0.069
Connecticut	0.574	0.457	0.026	-0.058
Massachusetts	0.603	0.412	0.053	-0.069
New Jersey	0.536	0.482	0.039	-0.056
New Hampshire	0.513	0.543	-0.015	-0.040
Montana	0.791	0.244	-0.011	-0.025
New York	0.509	0.590	-0.077	-0.022
Illinois	0.591	0.448	0.008	-0.047
Pennsylvania	0.486	0.615	-0.088	-0.014
California	0.651	0.256	0.026	0.066
Delaware	0.467	0.695	-0.173	0.011
Nebraska	0.388	0.366	0.176	0.070
Middle Income States:				
Vermont	0.432	0.657	-0.079	-0.009
Ohio	0.583	0.483	-0.027	-0.038
Colorado	0.728	0.248	0.016	0.009
Wisconsin	0.544	0.393	0.055	0.009
Kansas	0.417	0.389	0.142	0.052
Maryland	0.454	0.699	-0.160	0.007
Maine	0.480	0.554	0.006	-0.040
Minnesota	0.476	0.525	0.030	-0.015
Washington	0.737	0.214	0.039	0.009
Arizona	0.756	0.233	0.040	-0.028
Indiana	0.452	0.599	-0.008	-0.043
North Dakota	0.388	0.609	0.040	-0.037
Iowa	0.301	0.496	0.154	0.050
Michigan	0.551	0.465	-0.001	-0.031
Oregon	0.569	0.261	0.103	0.066
Missouri	0.508	0.455	0.047	-0.010
South Dakota	0.362	0.427	0.158	0.054
Nevada	0.661	0.277	0.026	0.039
Wyoming	0.597	0.263	0.126	0.024
Louisiana	0.419	0.352	0.147	0.082
Utah	0.616	0.275	0.061	0.048
Kentucky	0.300	0.520	0.081	0.099
Idaho	0.449	0.282	0.181	0.088
West Virginia	0.311	0.548	0.066	0.074

Low Income States:				
Virginia	0.466	0.355	0.091	0.087
Texas	0.291	0.475	0.074	0.160
Oklahoma	0.170	0.553	0.068	0.209
Tennessee	0.340	0.460	0.092	0.108
Florida	0.293	0.652	0.084	-0.029
North Carolina	0.306	0.509	0.100	0.085
Alabama	0.274	0.556	0.113	0.056
Arkansas	0.225	0.606	0.090	0.080
Georgia	0.260	0.622	0.091	0.027
South Carolina	0.359	0.460	0.104	0.076
Mississippi	0.208	0.597	0.092	0.103
New Mexico	0.653	0.267	0.070	0.010

Notes: Output elasticities are calculated using OLS parameter estimates from Table 3.
Income is defined as output per capita where output is the sum of total manufacturing and farm output as defined in text. High Income states are states in the top quartile, Middle Income states are those states in the between the 25^{th} and 75^{th} percentile and Low Income states are states in the bottom quartile. Within income groups states are arranged from highest income to lowest income.

FIGURE 1.3
ESTIMATED OUTPUT ELASTICTIY VS GROWTH RATE OF ROAD EXPENDITURES
(1904-1921)

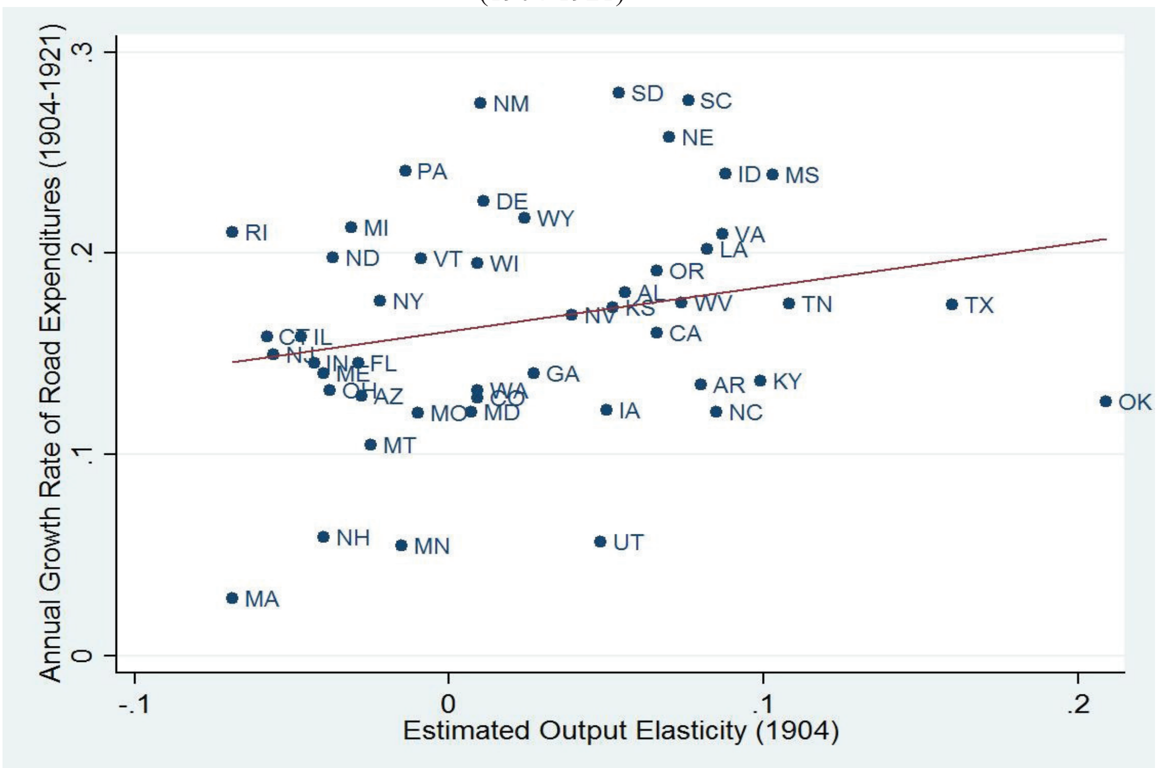


TABLE 1.6
POSTAL STATISTICS (1900)

State	Number of Presidential Post Offices	Population per Post Office (in thousands)	Total Number of R.F.D. Routes Established	% of R.F.D. Applications Approved
Alabama	43	42.5	43	36
Arizona	17	7.2	2	66
Arkansas	46	28.5	14	48
California	122	12.2	84	74
Colorado	49	11.0	34	55
Connecticut	84	10.8	101	88
Delaware	13	14.2	20	64
Florida	36	14.7	1	33.3
Georgia	55	40.3	143	30
Idaho	18	9.0	12	52
Illinois	278	17.3	517	42.5
Indiana	162	15.5	454	54
Iowa	240	9.3	581	50
Kansas	134	11.0	343	46
Kentucky	67	32.0	13	22
Louisiana	31	44.6	5	83.5
Maine	68	10.2	72	55
Maryland	30	39.6	172	95
Massachusetts	172	16.3	61	49
Michigan	194	12.5	340	40
Minnesota	136	12.9	177	40
Mississippi	48	32.3	2	8
Missouri	155	20.0	265	43
Montana	25	9.7	0	0
Nebraska	108	9.8	139	35
Nevada	9	4.7	0	0
New Hampshire	48	8.6	68	75
New Jersey	114	16.5	50	70
New Mexico	14	14.0	0	0
New York	350	20.7	387	56
North Carolina	53	35.7	31	12.5
North Dakota	36	8.8	8	33.3
Ohio	224	18.6	561	45
Oklahoma	24	32.9	9	26
Oregon	29	14.3	28	44
Pennsylvania	309	20.4	383	84
Rhode Island	20	21.4	14	73
South Carolina	32	41.9	103	49
South Dakota	47	8.5	42	43
Tennessee	57	35.4	170	54
Texas	158	19.3	126	56
Utah	12	23.1	7	41
Vermont	44	7.8	58	80
Virginia	63	29.4	41	35
Washington	43	12.0	15	44
West Virginia	39	24.6	41	65
Wisconsin	142	14.6	280	49
Wyoming	10	9.3	4	50

Source: United States Post Office Department (1901), *Annual Report of the Postmaster General*, pp. 110 and 900.

TABLE 1.7
PARAMETER ESTIMATES OF THE TRANSLOG
PRODUCTION FUNCTION (2SLS)

Variable	(1)	(2)	(3)	(4)
Log Capital per Worker	-0.318	0.561	0.946	0.310
	(1.594)	(0.477)	(2.845)	(0.657)
Log Land per Worker	0.291	-0.187	2.108	0.130
	(0.504)	(0.334)	(2.898)	(0.310)
Log Roads per Worker	0.119	-0.081	-1.357	-0.367
	(0.630)	(0.217)	(0.942)	(0.457)
$[\text{Log Capital per Worker}]^2$	-0.046	-0.160***	-0.292***	-0.024
	(0.255)	(0.035)	(0.113)	(0.075)
$[\text{Log Land per Worker}]^2$	-0.204***	-0.029	-0.365	0.035
	(0.078)	(0.031)	(0.522)	(0.024)
$[\text{Log Roads per Worker}]^2$	-0.011	-0.006	-0.093	-0.048
	(0.028)	(0.028)	(0.106)	(0.047)
[Log capital per worker] x	0.365*	0.234***	0.357	0.135
[Log land per worker]	(0.222)	(0.045)	(0.609)	(0.089)
[Log capital per worker] x	-0.208	-0.029	-0.003	-0.017
[Log road per worker]	(0.265)	(0.093)	(0.665)	(0.143)
[Log land per worker] x	0.176	0.047	0.452	0.136*
[Log road per worker]	(0.116)	(0.085)	(0.714)	(0.079)
Sargan Test Statistic	0.901	1.179	3.334	7.785
	[0.924]	[0.882]	[0.504]	[0.100]
DWH Chi-Square Statistic	11.986	10.120	3.898	17.310
	[0.017]	[0.038]	[0.420]	[0.002]
State Fixed Effects Included	Y	Y	Y	Y
Number of Counties	238	986	1177	292
R^2	0.993	0.994	0.985	0.970

Notes: Dependent Variable: ln(Output per Worker). Column (1) are parameter estimates for the North Atlantic Region; Column (2) are parameter estimates for the North Central region; Column (3) are parameter estimates for the South region and Column (4) are parameter estimates for the West Region. Standard errors are reported in parentheses for each variable. For the test statistics the p-value is reported in brackets. *denotes statistical significance at the 90 percent confidence level; **at 95 percent, and *** at 99 percent

TABLE 1.8
ESTIMATED OUTPUT ELASTICITY (2SLS)
STATES ARRANGED BY REGION (1904)

	Labor	Private Capital	Land	Roads
North Atlantic:				
Connecticut	0.338	0.368	0.408	-0.114
Delaware	0.183	0.870	-0.030	-0.023
Maine	0.385	0.410	0.321	-0.115
Maryland	0.247	0.781	-0.006	-0.022
Massachusetts	0.351	0.297	0.476	-0.124
New Hampshire	0.369	0.422	0.301	-0.092
New Jersey	0.383	0.330	0.413	-0.126
New York	0.285	0.599	0.179	-0.063
Pennsylvania	0.254	0.674	0.141	-0.069
Rhode Island	0.311	0.342	0.500	-0.152
Vermont	0.313	0.635	0.130	-0.078
North Central:				
Illinois	0.487	0.575	-0.071	0.009
Indiana	0.450	0.547	0.001	0.002
Iowa	0.278	0.538	0.154	0.030
Kansas	0.369	0.489	0.124	0.018
Michigan	0.551	0.445	0.019	-0.015
Minnesota	0.419	0.575	-0.008	0.013
Missouri	0.452	0.525	0.015	0.008
Nebraska	0.329	0.495	0.151	0.026
North Dakota	0.341	0.628	0.006	0.025
Ohio	0.566	0.476	-0.027	-0.015
South Dakota	0.313	0.522	0.138	0.027
Wisconsin	0.500	0.465	0.037	-0.002
South:				
Alabama	0.300	0.371	0.441	-0.112
Arkansas	0.211	0.418	0.350	0.021
Florida	0.362	0.492	0.384	-0.239
Georgia	0.287	0.444	0.386	-0.118
Kentucky	0.328	0.456	0.038	0.178
Louisiana	0.527	0.298	0.230	-0.056
Mississippi	0.174	0.399	0.355	0.072
North Carolina	0.343	0.406	0.194	0.057
Oklahoma	0.077	0.422	0.031	0.471
South Carolina	0.433	0.411	0.099	0.057
Tennessee	0.391	0.431	-0.014	0.193
Texas	0.293	0.450	-0.127	0.384
Virginia	0.607	0.470	-0.305	0.227
West Virginia	0.357	0.512	-0.044	0.174

West:				
Arizona	0.444	0.421	0.102	0.032
California	0.142	0.591	0.024	0.244
Colorado	0.319	0.493	0.048	0.140
Idaho	-0.020	0.564	0.313	0.143
Montana	0.424	0.443	0.029	0.104
Nevada	0.171	0.537	0.076	0.217
New Mexico	0.257	0.468	0.172	0.103
Oregon	0.109	0.560	0.166	0.165
Utah	0.139	0.539	0.131	0.191
Washington	0.384	0.495	0.036	0.085
Wyoming	0.212	0.472	0.251	0.065

Notes: Output elasticities calculated using parameter estimates from the 2SLS regressions from Table 7. State level input data for labor, private capital and land from1900 are utilized. State level road expenditure data in 1904 are used as road inputs.

CHAPTER 2

The Political Economy of the Rural Roads in the Early 20^{th} Century

1. Introduction

Beginning in the last decade of the 19th century, roads began to take an increasingly important role in the transportation network of the United States. A movement to improve the rural road network called the Good Roads Movement sprang from the urban centers in the Northeast, and expenditures on roads and bridges by state and local governments accelerated. Table 2.1 shows that in 1890, total expenditures on roads and bridges were only half of the amount spent on education. By 1920, total expenditures on roads had increased more than fourteen-fold and rivaled public education spending.

This study seeks to document and explain this initial period of growth in rural-road expenditures. Why did local funding for roads suddenly increase starting in the 1890s? Why did investment in roads vary so dramatically across states and across counties within states? Which groups opposed and which supported the Good Roads Movement? In this paper, I use a panel of county-level road expenditure data covering the years 1904 and 1914 to find the determinants of rural road demand in the United States in the early 20th century.

The observed increase in public highway expenditures during this period should not be surprising. The Good Roads Movement was not rooted in political ideology. All the major political parties of the period embraced the principles behind the Good Roads Movement.[24] The investment in the rural roads was designed to address a fundamental

[24] The universality of support for good roads is most evident in the national party platforms of the period. The Republican Party Platform of 1908 stated that "We recognize the social and economic advantages of good country roads, maintained more and more largely at public expense, and less and less at the expense of the abutting owner. In this work, we commend the growing practice of state-aid, and we approve the efforts of the National Agricultural Department by experiments and otherwise, to make clear to the public the best methods of road construction." Similar sentiments were found in the party platforms of the

problem with infrastructure, and it drew the support from a diverse cross-section of the population. Urban dwellers hoped improved rural roads would mean cheaper goods and better roads for their bicycles and automobiles. Rural residents hoped to gain access to markets to sell their products, and safer and more reliable access to schoolhouses. Lastly, rail and canal companies would profit from an increased volume of agricultural goods reaching shipping points.

Despite the support by the national political parties and broad based local support for better roads, there was opposition. A summary of various statewide elections concerning roads between 1906 and 1924 is shown in Table 2.2. Out of sixty-nine statewide road ballot measures, thirty were rejected. In some elections, the votes were 4-to-1 against the road improvement proposals. A number of other local road tax and bond measures, not reported in Table 2.2, were also defeated in municipal elections during this period. The defeat of road measures suggests that there were perceived redistributive effects associated with road spending, and some groups feared that they would be negatively affected if road expenditures increased. An investigation into the determinants of demand on road expenditures will yield insights on which groups were leading the opposition.

Though there is a large body of literature on the determinants of public expenditures, few studies have looked at the determinants of local highway expenditures. The few road expenditure studies that have been conducted have focused primarily on the

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Democratic and Progressive Parties. The Progressive Party Platform of 1908 stated that "We recognize the vital importance of good roads, and we pledge our party to foster their extension in every popular way, and we favor early construction of national highways."
Sources: Iowa Secretary of State (1909), *The Iowa Official Register*, *Vol. 23* (Des Moines: State Printer), p.332. Iowa Secretary of State (1913), *The Iowa Official Register*, *Vol. 26* (Des Moines: State Printer), p.353.

effect that intergovernmental aid programs have had on local highway expenditure decisions. Using state highway expenditures for the period 1976 to 1982, Meyers (1987) found a substitution rate of approximately 63 percent between federal highway grants and state highway spending. Given this relatively large substitution effect, the study concluded that federal road aid had little stimulative effect on state road spending. Deller and Walzer (1993) examined the combined effect of state and federal aid on levels of highway spending by county governments. They found that in the late 1980s, the presence of federal highway aid had a positive effect on county road expenditures, but state highway aid had little effect on local highway spending. Gamkhar (2000) mirrored the earlier studies in finding that increases in federal highway aid had negligible effects on current state and local government highway spending, although it may have had a lagged effect.

The broader question on the factors that affect local road demand has remained largely unexplored. There are, however, several studies that have looked at the political economy of highway expenditures. Bennett and Congleton (1995) use various public choice models to account for the variation in state highway expenditures in the 1980s. The authors estimated reduced form models of median voter demand, special interest group model, and a combined model. The study found that federal highway aid grants did have a positive effect on state highway expenditures. In addition, factors that affect the decision of the median voter such as average income or population have some statistical significance. Lastly, the empirical results suggest that the presence of lobbying groups could account for a significant share of the variation in state road expenditures.

A study of the political economy of road construction in Spain is also relevant.

Curto-Grau, Herranz-Loncán, and Solé-Ollé (2009) attempted to identify the factors that could explain variation in road investment across Spanish provinces between 1874 and 1923. The paper sought to determine whether the distribution of transport infrastructure in Spain was solely determined by economic variables, such as population density and road construction costs. The authors found that the ruling government used road funds as a means to dole out political favors. Provinces with large shares of minority party deputies received less road investment than areas that supported the government. The paper's central conclusion was that economic factors alone could not explain the variation in public road expenditures. Other explanatory factors such as political considerations were important in explaining the observed variation.

This paper complements the existing literature by utilizing a little known data set on the level of county road expenditures to study road spending during a key period in the development of the transportation infrastructure in the United States. Like Bennett and Congleton (1995), I will use a combined public choice model with elements of the median voter and special interest group models to estimate the demand for rural roads. The results deliver support to the notion that political influence, especially by farmers, appears to have been a key factor in explaining the variation in road expenditures across counties. Characteristics that affect the behavior of the median voter, such as wealth, also appear to have had a strong effect on levels of road expenditure. I also find that increases in intergovernmental state-aid did not have as much of a stimulative effect on local road expenditures as some might have expected.

2. Institutional Framework

2.1 A Brief History of Rural Roads in the United States

In the early years of the nation, the overland road network in the early America was hardly more than dirt paths covered in layers of deep dust when dry which became impassable muddy quagmires during inclement weather. During this early period, there was some movement towards the privatization of the public roads with the establishment of turnpike companies. These private companies were granted rights in constructing roads and had the ability to charge tolls. By 1811, 317 turnpikes had been chartered, primarily in New York and New England, with a combined network of roads of around 4,500 miles.[25] Although the turnpike companies were principally funded by private interests, they were also the recipients of public aid. This aid took the form of liberal charters, land grants, tax exemptions and even direct payments. Despite the expansion of the turnpike system in the early 19th century, these private turnpike companies still managed only a small percentage of the American road network.

At around the same time as the construction of the turnpikes, there was a spirited debate over the role of the federal government in the funding of internal improvement projects. The admission of Ohio into the United States in 1803 led some lawmakers to believe that the federal government should assume some fiscal responsibility in the provision of internal improvements. These politicians saw a national road network as critical towards cementing the commercial ties between the Atlantic seaboard and the newly formed interior states. In 1816, Congress passed a bill authorizing appropriations for the construction of national roads. However, President Monroe vetoed the 1816 bill

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[25] Chatburn (1921), p. 342.

on the grounds that the bill was unconstitutional.[26]

In addition to constitutional questions, sectionalism began to play an increasing role in the debate over federal financing of internal improvements. States in the New England and Mid-Atlantic regions already had a system of good roads relative to the rest of the nation, and thus were less likely to benefit from a federally financed road network. Furthermore, these regions were not eager to fund the construction of roads that might threaten their trade position or exacerbate an out-migration.[27] Over time, the opposition to federal funding of a national road system eventually won the debate. In 1834, the maintenance of the Cumberland National Road was turned over to the states along its route while other national roads were similarly transferred from federal to state control.[28]

The absence of federal involvement in road management affairs placed the burden of maintaining the roads on the shoulders of state and local governments. Initially, state governments showed some interest in providing a system of good roads. In the 1830s, state governments borrowed approximately $150 million to finance internal improvement projects, though the vast majority of these funds were directed towards canal projects.[29] The subsequent tight credit markets following the Panics of 1837 and 1839 left many states unable to pay bondholders and several states defaulted. States that were heavily indebted saw passage of constitutional spending limits which curbed the amount of debt that could be issued by state governments. After 1840, state governments were no longer

[26] Monroe, a strict constructionist, believed that the Constitution did not give Congress the explicit authority to fund road construction.
[27] Additionally, southern lawmakers were also opposed to federal financing of roads. Southerners were concerned that federal funding of road projects would increase the need for revenue and would thus be used by northerners as an excuse to raise tariffs. Additionally, they feared that federal involvement in roads would lead to federal involvement in other issues including slavery.
[28] In 1834, there were about a dozen other minor national roads that were maintained by the Federal government.
[29] Mason (1957), p. 20.

in a financial position to undertake internal improvement projects including rural road construction. By the mid 19th century, state governments transferred the responsibility of construction, improvement and maintenance of the roads to the municipal governments.

The years between 1840 and 1890 saw a marked decline in the condition of the rural road network. The main culprit was the road management system employed by local governments. During this period, each county (or township in some states) had complete jurisdiction over all roads within their boundaries. Many counties and townships relied extensively on the old feudal system where road taxes were paid principally in the form of labor. These statute labor laws required that every able-bodied male of voting age was to work a prescribed number of days per year on the roads. Although this labor road tax could be paid in cash, most taxpayers chose to pay the tax in labor. While statute labor laws could be found across all regions, they were most widely employed in the Southern states. Contemporary observers and road reformers noted the obvious failings of this road tax system. Local road supervisors were often untrained in the basic principles of road engineering and the laborers had little incentive to overexert themselves in the payment of their road taxes. Anecdotal evidence suggest that days spent paying the road tax were seen more as an opportunity to catch up with neighbors or hold community picnics than to improve the local roads.[30]

As urban centers became more developed in the post-bellum period, paved streets became increasingly common within city limits. Urban and rural residents began to take

[30] One contemporary observer provided the following first-hand description of how statute labor laws usually operated. "Arriving on the ground long after the usual time of beginning work, the road-makers proceed to discuss the general question of road-making and other matters of public concern, until slow-acting conscience convinces them that they should be about their task…. An hour or two is consumed a noon-day lunch and a further discussion of public and private affairs. A little work is done in the afternoon, and at the end of the day the road-making is abandoned until the next year." *Scribner's Magazine* (1889), p. 477.

note of the jarring contrast between the paved surfaces found in the cities and the rough dirt roads found just outside the city limits. Starting around 1890, there were calls for a return of state and federal aid to improve and maintain the rural road network. This Good Roads Movement quickly became a potent political force in the agitation for the improvement of the nation's roads.

There were two important developments in the 1890s that help explain the timing of the Good Roads Movement. The first development was the mass adoption of bicycles by urban residents. The early bicyclists faced miles and miles of treacherous roads as they traveled outside the cities. Bicyclists became one of the early proponents of good roads as they sought to create road surfaces which they could utilize. Leading bicycling groups such as the League of American Wheelmen became powerful advocates for road improvement. The second major development in the 1890s was the establishment of the Rural Free Delivery (R.F.D.) program by the Postal Service in 1893. R.F.D. service meant that rural customers would never have to travel more than ½ a mile to collect their mails. In order to maintain their rural free delivery routes, the Postal Service required local communities to maintain a system of good roads. Given the popularity of R.F.D. in rural communities, many local governments undertook road improvement projects with earnest. It was estimated that local governments spent $70 million on roads between 1900 and 1908, much of it driven by the desire to retain these coveted postal routes.[31]

These developments led state governments, especially in the urban states of the Northeast, to pass laws permitting state assistance in road improvement. In 1891, New Jersey passed a state highway law that allowed the state to pay up to a third of the cost of construction of improved roads undertaken by the local governments. Massachusetts

[31] Fuller (1955), p. 71.

soon followed in 1893 with its own good roads bill which established a state highway commission. The Massachusetts law went further than New Jersey in that the state would pay up to 75 percent of the cost of road improvement on petition by local authorities.[32] The success of the state-aid program in New Jersey and Massachusetts to stimulate the construction of good roads led other states (primarily in the Northeast) to adopt similar laws. Figure 2.1 show that 13 states had some form of state-aid laws by 1904. The states with state-aid laws were located exclusively in the North Atlantic and Mountain/Pacific regions. However, within ten years a wave of state-aid legislation was passed in other states. As shown in Figure 2.2, all states outside of the Deep South (with the exception of Indiana) had some type of state-aid road law. The new era of state financing of the local roads was here.

2.2 Rural Road Expenditures and Revenue Sources in the Early 20th Century

Figure 2.3 illustrates the rapid increase in the amount of total road expenditures per road mile across all regions between 1904-1921.[33] Aggregate public spending on rural roads in the United States was $80 million in 1904 or approximately $27 per mile of existing roads. The states in the North Atlantic region were clear leaders in terms of road expenditures. States in that region expended approximately $75 per mile of road which was nearly three times the national average. The breakdown of road expenditures by state in 1904 is shown in Figure 2.5. The top three states in terms of road expenditures, with road expenditures per mile exceeding over $100, were Massachusetts, New Jersey and Rhode Island. The high level of expenditures in these states could be explained by the fact that the region had already established a relatively high quality road network by

[32] Most of the initial roads that received state-aid funds eventually became designated state highways and formed the backbone of the state highway network in many of the states.
[33] All dollar amounts are adjusted to constant 1910 dollars.

1904. Almost 20 percent of roads in the North Atlantic region were surfaced (either with brick, concrete or macadamized surfaces) compared to only 7 percent of roads surfaced nationally. These types of paved roads had higher maintenance costs than simple earth roads. Another possible explanation is the prevalence of state-aid laws in the North Atlantic region. These laws helped defray the cost of road construction for communities, decreasing the effective price of roads and thus may have increased local spending on roads. At the other end of the spectrum, states in the South Central region had the lowest expenditures per mile of road in 1904. States in this region spent only $16 per mile of road.[34] Figure 2.5 show that in addition to the states in the Deep South, the Dakotas, Nebraska, Kansas, Wyoming, New Mexico and Nevada also had low levels of road expenditures. One reason for the low level of expenditures was the heavy reliance on statute labor laws to maintain and construct roads. In the states with statute labor laws, all road taxes (including property taxes) could be worked out through labor which would have resulted in low levels of cash expenditures on the roads.

With the exception of a fall in road spending during World War I, road expenditures increased rapidly between 1904 and 1921 across all regions. Figure 2.6 shows the dramatic increase in the number of states that spent over $100 per mile of road by 1914. The states that expended heavily on roads were no longer confined to the North Atlantic region but now included states in the Upper Midwest and Pacific Coast. Surprisingly, Florida and North Carolina were also leading states in terms of road spending. Overall, the North Atlantic region maintained its leadership position in road

[34] South Central region includes the states of AL, AR, KY, LA, MS, OK, TN, and TX.

expenditures spending on average over $300 per mile of road.[35] The North Central region spent $167 per road mile followed by the West region. The South Central region lagged once again. However, its total road expenditures of $112 per mile of road in 1921 represented a seven-fold increase compared to the total amount spent by the region in 1904.

At the beginning of the 20th century, four major funding categories were used to raise revenues for local road expenditures. These sources were local property and poll taxes, statute labor, bond issues and state-aid. In 1904, property and poll taxes represented the largest single source of local road revenues at 67.5 percent, followed by labor road taxes or statute labor at 24.8 percent, state and local road bonds 4.4 percent and state-aid 3.3 percent.[36] Over time, the composition of funding for rural roads altered significantly. The key development was the centralization of road management, as evidenced by the increase in the share of total expenditures from state sources. The total amount of state-aid amounted to only $2.4 million in 1904, but by 1922 the total amount of state-aid for roads and bridges had risen to $466 million expended annually.[37]

Table 2.3 shows the increasing contribution by states to fund local road projects. In 1904, state-aid accounted for only 4.5 percent of total road expenditures and modestly increased to10.2 percent of overall expenditures by 1914. By 1921, the share of state-aid grew to nearly half of total expenditures on roads. Regionally, state governments in the

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[35] Data for the North Atlantic region excludes New York for 1921. During 1920-1921 the state of New York spent a significant amount of funds, raised primarily through state bond measures, on road projects. It is estimated that New York alone accounted for a quarter of the total amount expended on roads nationally. Including New York, the average expenditure per road mile in the North Atlantic region would increase to over $1100 per mile of road, nearly 10 times greater than any other region.

[36] U.S. Department of Agriculture. Office of Public Roads (1907), *Bulletin No. 32*, pp.8-9. The value of labor taxes was estimated by the Office of Public Roads. They imputed by the value by multiplying the total aggregate number of days worked on the roads by the average daily wage for a laborer.

[37] U.S. Department of Agriculture (1925), *Department Bulletin No. 1279: Rural Highway Mileage, Income, and Expenditures, 1921 and 1922.*

North Atlantic region funded a greater share of road expenditures than states in other regions. A major source of state-aid came from the issuance of state bonds, especially in the North Atlantic region. In 1921, there were approximately $346 million of state bonds outstanding, with all but $3 million issued since 1904.[38] As automobiles became more widely adopted, the share of state road revenues generated from motor vehicle licenses, gasoline taxes and other user taxes increased. By 1921, motor vehicle license and gasoline taxes accounted for about 7 percent of total road revenues.[39]

While state funding increased, local road expenditures funded through property taxes also saw a significant increase during the period. As shown in Figure 2.4, the growth of expenditures per mile of road raised through local property taxes mirrored the growth of the overall road spending. In 1904, approximately $19 per road mile was raised through local property taxes or poll taxes paid in cash. By 1921, that figure approached $96 per mile of road.[40] While aggregate spending per mile of road from property taxes increased during the period, its share of total expenditures declined as state-aid grew at a faster rate.

3. A Model of Road Demand

In this section, a simple model is developed which estimates the demand for local road expenditures by the decisive voter. The initial model of demand for roads will depend on traditional economic factors such as income, the price of roads and intergovernmental aid. The model will then be expanded to see to what extent did the

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[38] U.S. Department of Agriculture (1925), *Bulletin No. 1279*, p.80.
[39] U.S. Department of Agriculture (1925), *Bulletin No. 1279,* p. 11-13.
[40] A partial explanation for this increase in local expenditures is the abolition of statute labor laws in many states during this period. In 1904, 33 states and the territories of Arizona, New Mexico and Oklahoma enforced some type of statute labor laws. By 1914, only 16 states had such laws with all but 5 of these states located in the South. The states that abolished the statute labor laws replaced the labor tax with property taxes payable in cash only.

political power of interest groups affected the level of road provision. To begin, the model assumes that the median voter is a utility maximizing individual who chooses between two goods: a bundle of private goods consumed (X_i) and public roads (R_i). Both X_i and R_i are measured as a flow of services per year. The utility-maximizing voter will choose between X and R to maximize the following utility function:

$$\max_{X,R} U = U(X_i, R_i) \qquad (1)$$

To account for the possibility that the supply of public roads is not a pure public good, this paper borrows from Bergstrom and Goodman (1973) in incorporating population (N) into the median voter model. Let R* represent the total amount of roads supplied at the county level and let N represent the population in a county. The individual demand for local roads could be expressed as follows:

$$R_i = N^{-\theta} R^* \qquad (2)$$

If public roads are a pure public good with the usual properties of non-rivalry and non-excludability, then the parameter θ will equal 0. As a result, the amount of road expenditures demanded by the individual in a given year will equal the amount of road expenditures spent by the local government. On the other hand if the parameter θ is equal to 1, then roads are a private good that are rival in consumption. The amount of roads an individual will consume will be inversely proportional to the population in the county. If θ is between 0 and 1 then roads are considered a quasi-public good.

The budget constraint for the median voter is the following:

$$Y_i = P_x X_i + \tau_i P_R R^* \qquad (3)$$

Substituting for R* using Equation (2) the following budget constraint can be derived:

$$Y_i = P_x X_i + \tau_i P_R N^{\theta} R_i \tag{4}$$

In Equations (3) and (4), the variable Y_i represent the income/wealth of the voter. P_x is the price of the bundle of private goods consumed by the individual. For simplicity the price of the bundle of private goods is normalized to 1. τ_i is the tax share for the mean voter. The tax share variable is the share of road taxes that is paid by the voter with mean income. It is assumed that each individual voter must pay a fraction of the total cost of road expenditures. Lastly, P_R is the net price per unit of road. The net price per unit of road (P_R) is equal to the total price per unit of road net any intergovernmental aid. Let variable C represent the total price of a mile of road. The total price of a mile of road (C) will be determined by the cost of inputs (labor, capital and materials) and also by the level of technology.[41] Here it assumed that the price per unit of road also depends on the level of intergovernmental aid received. Let G represent the amount of state-aid received by the municipal or county governments. As the amount of state-aid received increases, the net price (P_R) of constructing an additional mile of road will decrease. Thus the net price of constructing a mile of road can be represented as follows:

$$P_R = C - G \tag{5}$$

The individual voter's demand for public roads can thus be obtained by maximizing Equation (1) with respect to the budget constraint stated in Equation (4). Solving the first

[41] One of the neglected factors in the growth of road-building in the early 20th century was the mechanization of road construction. While road construction was primarily a labor intensive process, new innovations were being developed such as mechanized road drags and graders. In addition, the road building process was becoming more professionalized with civil engineers in charge of road projects instead of local officials. These factors lowered the cost of road construction in the early 20th century.

order conditions, the demand function for R_i can be expressed as:

$$R_i = f(Y_i, C, G, \tau_i, N) \quad (6)$$

Assuming a constant elasticity demand function yields the following expression:

$$R_i = A[\tau_i (C - G) N^{\theta}]^{\lambda} Y_i^{\varphi} \quad (7)$$

Let φ represent income elasticity and λ represent price elasticity with respect to roads.

Taking logs on both sides we get the following estimation equation:

$$\ln R_i = a_0 + \ln A + \lambda \ln \tau_i + \lambda \ln[C - G] + \lambda\theta \ln N + \varphi \ln \mathrm{Y}_i + \varepsilon_i \quad (8)$$

Equation (8) states that the median voter's demand for a road network is a function of several factors. The assumptions are that the demand for roads increases as voter wealth increases, as population increases, as the amount of state-aid increases and as the cost of road construction falls. In addition the demand for roads will also depend on a set of variables that shift voter preferences. This set of variables is represented by A in Equation (8). These other variables include the share of the county population residing in a rural area, the share of farms operated by tenant farmers and the percentage of farms under ten acres.

In the public choice literature, a common alternative to the mean voter model is the special interest group model outlined by Becker (1983). Becker's main insight was that individual voters belong to various groups with varying degrees of political power. Special interest groups give rise to demand for the provision of public goods. These special interest groups are defined by religion, culture, occupation, age, geography or other characteristics. Becker assumed that each of these groups use their political influence to maximize the well being of their members. The special interest group model predicts that the government provision of public goods will be in response to pressure exerted by these interest groups.

Attempts to directly measure the political influence of interest groups in the literature has been methodologically problematic. Some papers have tried to tie political influence by the amount of campaign expenditures spent by interest groups. Others have argued that the political influence of each group is an increasing function of membership size. Given the constraints of the available data, this study will look at the number of members in each group as a proxy for political influence. Thus, the special interest group model would argue that the quality of the road network will depend on the membership levels of special interest groups. It should be noted that this measure of political influence has its limitations. As evidenced by modern politics, interest groups may be large in membership size, but could be ineffectual in influencing policy. Conversely, special interest groups could be relatively small, yet they still might yield outsized influence in the political process.[42] The special interest model using membership size to measure political influence is expressed in Equation (9):

$$r = f(m_1, m_2, m_3, ..., m_k) \quad (9)$$

Equation (9) states that the demand for roads is a function of the political pressure exerted by the membership, m_k, of each special interest group k. Special interest groups that expect to receive large benefits from the construction of an improved road network will prefer high levels of road expenditures while groups who believe that the costs of

[42] In this category, groups such as the National Rifle Association, farming groups and unions come into mind.

roads outweigh the benefits will demand a low level of road expenditures. Thus according to the special interest model, the amount of road expenditures will increase as membership in a pro-road special interest groups rises, while expenditures will decrease as membership in an anti-road special interest groups rises.

A recent trend in the literature has been to use a combined model that includes features of both the traditional median voter model and the special interest model. Under the combined model, the demand for the quality of the road network, R, can be expressed by the following equation:

$$\ln R_i = \lambda \ln \tau_i + \lambda \ln[C - G] + \lambda\theta \ln N + \varphi \ln Y_i + \sum_{i=1}^{k} \beta_i A_i + \sum_{j=1}^{j} \psi_j m + \varepsilon_i \quad (10)$$

The main estimating equation will be Equation (10) where R is the level of local road expenditures demanded by the median voter. Y and τ are the respective income and tax share of the voter. The term [C – G] is the net price of a unit of road, while A is a vector of other characteristics that will affect the median voter's demand for roads. Finally, m is the vector of variables that represent the membership levels of the various special interests groups for and against roads.

4. Data

I collect county-level data from several sources on local highway road expenditures, economic and demographical characteristics. The data cover all counties in the North Atlantic, North Central and Mountain/Pacific regions. The southern states had a different institutional structure for the provision of local road services. Property taxes, payable in cash were rare as most southern municipalities utilized labor road taxes. The region also made extensive use of convict labor to construct and repair roads. Local road expenditure data for the South comingled these other sources of road provision making it difficult to separate the amount of expenditures paid in cash on the roads. As a result, the counties from the South Atlantic and South Central regions were not included in this study.[43]

Local highway expenditure data are taken from surveys published by the Office of Public Roads, an agency within the U.S. Department of Agriculture. The agency, first established in 1893, was charged with investigating systems of road management and methods of road making across the country. These duties were eventually broadened to include the collection of data to show the national progress in road construction and maintenance. The Office of Public Roads conducted several road surveys in unincorporated areas in 1904, 1909, 1914 and 1921.[44] In addition to mileage and road type, some of the surveys included information on costs, appropriations, expenditures and relevant road laws. In the surveys conducted in 1904 and 1914 data on road expenditures by county were collected by the Office. The surveys for those years also categorized road expenditures by revenue sources showing the amount of expenditures raised by property taxes, bond revenue and state-aid.[45] Expenditures that were funded through property taxes are used in this study as the measure of local road spending.

The U.S. decennial censuses for population, 1900-1910 provide county-level data on characteristics that could potentially affect road demand for the median voter. The

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[43] Delaware and Maryland categorized as South Atlantic by the Census had abolished statute labor by 1904 and is thus included in this study. For the purposes of this paper, they are included in the North Atlantic region.

[44] The first three surveys were conducted at the county level. The fourth survey in 1921 reported road data only at the state level. A fifth survey was also conducted in 1926, but only state road mileage data was released.

[45] In the 1904 road survey, the Office of Public Roads also included road taxes that were paid by labor in states with poll tax or statute labor laws. For these states, the Office of Public Roads estimated the value of labor by multiplying the aggregate number of days worked on the roads by the average daily wage for a laborer. This value is reported separately from the amount raised by local taxation (property taxes).

data include county size, county population and other demographic variables. A key variable in the model is the income or wealth of the mean voter. The Census did not report individual income data for this period, so alternative measures of wealth/income of the mean voter will be used. The average value of farmland per farm will be one measure of mean voter wealth. Average farmland values are obtained from the decennial *Census of Agriculture*, 1900-1910. The *Census of Agriculture* was also used to obtain data on agricultural production, the average size of farms and the number of tenant operated farms. Using average land values as a measure of wealth is somewhat restrictive since it would exclude any wealth not held in farmland. As an alternative proxy for the wealth of the mean voter, the assessed valuation of taxable property per capita is obtained. The assessed valuation data were obtained from the *Census of Wealth, Debt, and Taxation* for the years 1902 and 1912, again at the county level.

Membership in special interest groups is estimated using IPUMS census data. Data on the number of individuals employed as farmers and in the railroad industry are estimated using the IPUMS one percent sample for the 1900 and 1910 population censuses.[46] There is a potential issue with the comparability of occupational coding between the 1900 and 1910 census. There were fewer occupational categories within the agricultural sector in the 1900 survey than in the 1910 survey. Since the occupational category was self-reporting, an individual may have identified himself as a farmer or farm laborer in 1900, but could have identified himself in a different occupational category in the 1910 census. To deal with this potential problem, I categorized all

[46]Political organizations did exist for farmers such as the Farmer's Alliance and the National Grange. The preferred measure of political power of the farmers would have been membership in these politically active groups. Unfortunately, such membership data at the county-level do not exist.

individuals who reported an occupation within the agricultural sector as a farmer.[47] Another potential special interest group for roads is voters with schoolchildren. To measure the political influence that voters with school-age children might have had on road expenditures, I use the share of the county population between the ages of 5 and 18 as estimated through IPUMS census data.

Unlike the other variables described above, there is no direct measure of the share of taxes paid by the average voter. To estimate a measure of tax burden faced by the individual voter, the assessed valuation of taxable real property per capita is obtained from the *Census of Wealth, Debt and Taxation.*[48] The road tax levy per $100 of valuation is obtained from the county-level surveys conducted by the Office of Public Roads. The total amount of taxes paid by the average voter is obtained by multiplying the road tax levy by the assessed valuation per capita.[49] This figure is then divided by total road revenue generated from property taxes to estimate the share of real property taxes paid by the voter with average wealth.

Table 2.4 shows the summary county-level statistics for the years 1904 and 1914. There is significant variation in the variables across regions and periods. The amount of county road expenditures is represented by two different measures. The first measure, total road expenditures per mile of existing road stock, is a proxy for road quality. A higher dollar value implies higher maintenance costs per mile of road which are typically

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[47] Although not reported, I also ran the regressions using a common occupational coding from IPUMS which recoded the data from earlier censuses using the 1950 occupational classification. The results were not significantly altered.
[48] In regions outside the South, over half of local road revenues were generated through property taxes during the early 20th century. These property taxes were raised largely from taxes on real property (primarily land and structures). Only a small fraction of taxes were collected from personal property taxes (cash holdings, stocks and bonds).
[49] Since the road tax levy is expressed in per $100 of valuation, the per capita assessed valuation amount is divided by $100.

associated with high quality roads. The second measure of road expenditures is total road expenditures per square mile. This second variable measures the spatial extent of the road network. A high value suggests that roads were being built throughout the county, although the quality of the road network may or may not be of high quality. Table 2.4 shows that the North Atlantic region was the initial leader in terms of the quantity and quality of local rural roads. The region expended twice the amount per mile of road than the next closest region. In addition, the high level of road expenditure per square area suggests an expansive road network in the North Atlantic region, while the low amount expended on roads per square mile in the Western regions suggest a fragmented road network. All regions experienced an increase in local road expenditures, but the increase was more pronounced in the North Central and Mountain/Pacific regions. By 1914, expenditures per mile of road were nearly equal between the North Atlantic and the Mountain/Pacific regions.[50] Likewise the size of the road network, as measured by expenditures per square area, increased dramatically in the North Central and Mountain/Pacific regions.

The wealth of the average voter appears to be highest among the states in the Mountain/Pacific region. The wealth in the Western states is evidenced by the higher value of farmland per farm and by the higher assessed valuation of taxable property per capita. The share of the population engaged in farming was highest in the North Central region. However, farms in the West were more likely to be owner-operated, whereas approximately a quarter of farms in the North Atlantic and North Central region were operated by tenant farmers. Farms were also generally larger in counties in the

[50] Much of the improvement in the quality of roads in the Mountain/Pacific region was due to infrastructure investment in California and Washington during this period.

Mountain/Pacific region. In terms of agricultural production, dairy production accounted for a higher share of total agricultural output in the North Atlantic region than in any other region of the country. Interestingly, the total share of agricultural production from poultry and egg production declined precipitously across all regions between the years 1904 and 1914.[51]

The North Atlantic region had the highest percentage of counties reporting some form of state-aid for the local roads. Approximately 88 percent of the counties in the region received state-aid in 1904, although the percentage dropped to 37 percent by 1914.[52] The North Central region lagged behind the West and North Atlantic states in passing state-aid laws, but by 1914 approximately a third of the counties in the North Central region were recipients of state-aid for local road expenditures. Of the counties receiving state-aid in the North Atlantic region, the average aid amount exceeded the regional average of local road expenditures.[53] Although, the amount of state-aid received by counties in the other regions was modest, it accounted for a growing share of total road expenditures.

5. Empirical Strategy

5.1 Estimating the Demand for Roads

The demand for roads, R_i, is represented by two measures. The log of total road expenditures made by local governments divided by the total existing road mileage in a

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[51] Examining production and price data from the U.S. Department of Agriculture yearbooks reveals no decline in either price or production in the poultry/egg sector to account for the observed decline in share of production. The fall in output share was most likely the result of an increase in relative prices to other agricultural products.

[52] State-aid revenues in the North Atlantic region were generated principally from state road bond sales. The amount of bonds issued varied from year to year, which may explain the drop in the number of counties receiving state-aid.

[53] The high average amount of state-aid in the North Atlantic region is driven by expenditures by New York state. In 1912, New York passed a $50 million state bond measure that resulted in generous amounts of aid being transferred to local jurisdictions in 1913-14.

county measures the demand for high quality roads. The other measure will be the log of total expenditures divided by county area in square miles. This variable is a proximate measure for the demand for an expansive road network. Expenditures are limited to outlays made by municipal and county governments.

The assessed valuation of taxable property per capita and the value of farmland per farm are separately used to proxy for the wealth of the mean voter. The assumption is that roads are a normal good and as wealth increases, the demand for a high quality road network will also increase. Additionally, greater wealth increases the demand for goods that are sold in the market and we would expect wealthier individuals to demand better road networks to improve market access.

We would also expect to see a positive relationship between population and the demand for higher quality roads. An increase in population implies a greater use of the existing road network. This is commonly referred to in the literature as "congestion in consumption".[54] As the road network is used on an increased scale, additional expenditures will be required to maintain the quality of the road network. To check to see whether the size of the county may proxy for the average travel distance to reach markets, the population measure is divided by the county area to get population density. A positive coefficient on the logged population density variable would be expected.

Increases in intergovernmental aid should also affect the demand for roads. As mentioned earlier, an increase in state-aid to fund local road projects would decrease the net price of providing local roads. The reduction in the price of road construction due to

[54] See Hayes (1986).

state-aid should increase the demand for roads, holding all other factors constant.[55] In states where state-aid is distributed, higher levels of state-aid received by a particular county should be accompanied by an increase in local road expenditures. Another factor that should affect demand according to the median voter model is the input cost of road improvement and changes in road building technology over time. Unfortunately, data on the wages of road laborers and road capital costs are not available at the county-level during this period. Consequently, input prices for roads are not included in the analysis and any effects they may have had will be captured by the intercept term. Likewise, technological changes in road construction will be indirectly captured through a time intercept term.

The estimation strategy next turns to the influence of special interest groups. The share of the total population employed as farmers is used to measure the political influence of farming interests. In the late 19th and early 20th century, farmers held significant sway in domestic politics especially in the North Central region. It would seem likely that farmers would be natural supporters of good roads. Indeed, many proponents of the Good Roads Movement argued that farmers and others in the rural community would be the primary beneficiaries of an improved rural road network. Improved roads would reduce transport costs, making markets more accessible, and would result in increased farm profits. In addition to the economic benefits, rural communities would have improved access to governmental services such as postal, health

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[55] The model presented assumes that state-aid is exogenously determined. However, this assumption may be unrealistic. In many states, state road revenues were raised through state taxes assessed on real property. The distribution of state-aid to the county and local governments also differed across states. Several states applied a straightforward formula where the amount of state-aid received was proportional to the amount of state taxes raised in the county. In other states, however, the distribution of state-aid was dependent on the willingness of individual counties to undertake road projects. Thus counties that demanded higher quality rural roads and were willing to spend resources to obtain them were more likely to receive state-aid funding in these states.

and educational services. However, anecdotal evidence appears to show that farm groups used their political influence to limit the size of road expenditures. In their annual convention in 1892, the Farmers' Alliance resolved that it was "unalterably opposed to, and would condemn any method proposing the bonding of state, county, or district for road building."[56] The Michigan Grange went on record to state its opposition to state and county road systems because "the farmers must bear the expense, while bicyclists and pleasure-riding citizens will reap the larger benefits."[57]

In another example of the opposition to good roads by farmers, the Pennsylvania State Grange took out a newspaper advertisement in 1913 to state its opposition to a $50 million bond measure in an upcoming statewide special election. Their main argument was that farmers would pay the bulk of the cost of the improved roads, through an increase in property taxes while the true beneficiaries of an improved road network, corporations and urban residents, would not bear a proportionate burden of the tax.[58] This line of attack against good roads was a common argument made by farmers. Although farming groups readily acknowledged that they would benefit from improved rural roads, the perception was held by a large number of farmers that the high cost associated with the construction of a network of hard-surfaced rural roads would increase property taxes.[59] In addition, there was fear that state-aid funding of roads would result

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[56] Mason (1957), p. 90.
[57] Ibid.
[58] "Twelve Reasons Why Pennsylvania State Grange Opposes $50 Million Loan For Road Purposes." Beaver County Times. [Beaver, Pennsylvania] 24 October 1913.
[59] In a hearing before a Congressional panel, a Mr. Burke, offered the following testimony about the defeat of a road bill in Illinois, "A bill was introduced that road improvements should be carried forward upon something like this basis: 50 percent to be paid by the state, 35 percent to be paid by the county in which the improvement is made, and 15 percent to be laid by the individual whose farm abutted the improvement…. But the farmers defeated that measure, upon the ground that the 50 percent and 35 percent very largely came out of their pockets also, and that while they would be paying 15 percent absolutely as individuals, they were generally paying a very large proportion of the whole 100 percent, showing that they

in a loss of local control of highway administration to state officials. The combined fear of increased taxes and loss of local control outweighed the expected benefits of roads for some farmers. Thus the higher the share of the county population that was engaged in farming, the lower would be the expected amount of road expenditures.

The tax share variable, τ_i, attempts to capture the net burden to farmers from road construction. If the tax share of the voter is large, then additional expenditures on roads will become increasingly expensive. Although the tax share variable is an imperfect measure of the true burden of road provision for an individual, it is a useful tool in describing the behavior of the average voter. A main assumption is that voters are aware that by voting for increases in road expenditures they are also voting to increase their property tax rates. If the voter knows the assessed valuation of his property, then he will be able to determine his current tax burden and the additional costs of roads in the form of higher taxes. Thus, if the average voter is shouldering a high share of the road tax burden, then it would be expected that the voter would be less likely to support additional road expenditures.

The model also tests to see whether there are differences within the farming sector in the demand for roads. Some agricultural products stood to benefit from quicker access to markets. While grains such as wheat and corn could be stored for a significant period of time, the absence of reliable access to markets made products such as dairy and eggs difficult to produce in many localities. In an economic survey conducted in Dinwiddie County, Virginia, the Office of Public Roads estimated that the dairy industry was profitable only within a radius of 3 miles of Petersburg, the principal market town. After

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realize how unjustly they are being treated in the matter of taxation." 57th Congress, 1st Session (1901), *Report on Agriculture and Agricultural History, Vol. X. House Document No. 179,* p.197.

improvement of the local roads, it became profitable to produce and transport dairy products within a 7 mile radius of Petersburg.[60] Contemporary observers argued that dairy farmers would be one of the primary beneficiaries of good roads.[61] There is also a possibility that non-dairy farmers may also support good roads as the improvement of rural roads would have expanded the area of commercial dairy production. Farmers who initially had lived outside the zone of profitability would have the option of entering dairy production. Thus individuals who potentially wish to become dairy farmers would also support increased expenditures to improve the rural roads.[62] However, measuring potential dairy farmers would be difficult given the data available. To measure the extent that dairy production may have affected improved roads, the share of agricultural output from dairy products is included in the model. Similarly, the share of agricultural output from poultry and egg production is used to measure that industry's importance on road demand.

Changes in farming characteristics may also have affected the demand for roads in rural counties. Approximately a quarter of the farms in the North Central and North Atlantic regions were operated by tenant farmers. Some felt that the rise in tenancy would slow the construction of rural roads since both owners and tenants lacked the economic incentives to pay for such improvements. Although roads may have increased the value of the farm, the primary beneficiary would have been the owner of the land and

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[60] U.S. Department of Agriculture (1916), *Bulletin No. 393*, pp.33-34.

[61] William D. Hoard, a former Wisconsin governor wrote, "In my relation to farmers as a creamery man I have very clear opportunity of seeing how valuable to them would be a much better state of road…. There are in Wisconsin about 2,500 cheese factories and creameries. To each one of these every morning there comes an average of, say, forty farmers with their milk. This milk must go to the creamery or factory without fail every morning in the year, rain or shine, good or bad roads. Now that number of factories or creameries represent 100,000 farmers, who certainly ought to be interested in the improvement of roads from a business standpoint." League of American Wheelmen (1904), *Good Roads*, p. 16.

[62] Given this line of reasoning, existing dairy farmers may have voted against roads since improved roads would extend the area of production drawing additional competition.

not the tenant farmer. While it is true that tenant farmers may have benefited from improved roads through higher farm prices, there was no guarantee that they would be around long enough to recoup any investments made towards infrastructure improvements. The absentee farm owner also lacked incentives to pay for rural improvements since they no longer resided in the community.[63] A high percentage of tenant farmers in a county could have led to a decrease in local road expenditures. However, some economists within the public choice literature have argued that renters might be more likely to support public spending since they perceive their tax shares to be lower than those paid by owner occupied properties. If renters believed that they would not have to pay the entire increase in property taxes through higher rents, then it might be expected that they would be more likely to vote for public roads than land owners.

Another marked change in the agricultural sector was an increase in average farm size. The average size of a farm grew steadily starting around the late 19th century. As farms become larger and focused towards market production, improved market access would become increasingly important. Small farms that produced primarily for household consumption would see less need for improved roads since they would not realize the full benefits of improved market access. Therefore, the structure of land ownership may also have played a key role in explaining the demand for roads. Counties

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[63] The chair of the Good Roads Committee of the Chicago Automobile Club, Burley B. Ayers summarized the effect of tenant farmers on good roads when he wrote, "The reason why such great states as Michigan and Illinois do not have good roads may be traced to the tenant-farmer system…. The owner expects the farm to yield all possible for the tenant and himself, and hence the least expenditure upon buildings, fences, roads and such improvements…. In the midst of great prosperity, with great crops growing everywhere, farmhouses and barns and roads and fences are dilapidated…. There will be no good roads until the ratio of profit between the owner and tenant is so arranged that there will be a comfortable margin to draw on for the roads. While the fight is still on between the owner and tenant for necessary improvements on the farm itself, the owning farmers will beat any bill in the legislature looking toward road improvements. And when one looks back on the history of these movements---notably the Michigan good roads movement that recently came to defeat in the legislature---the cause is to be traced to just this source." *Automotive Industries, Vol. 21* (1909), p. 507.

that were dominated by small farms should have lower road expenditures, while counties that are dominated by larger farms should have higher road expenditures.

Two possible pro-road groups are the railroad industry and families with school age children. The political influence of the railroad industry is assumed to be proportional to the number of individuals employed in the railroad industry. It might seem surprising to consider railroad interests to be in favor of good roads, as roads are generally seen as a competitive threat to the rail network. However, in the early years of the Good Roads Movement, much of the agitation to improve the roads was focused on local farm-to-market roads and not on inter-county or inter-state road networks. Improvement of local farming roads would facilitate an increase in the amount of agricultural products that reached local railheads for shipment to distant markets. Railroad companies were thus enthusiastic early supporters of the Good Roads movement and would most likely prefer large expenditures to improve and maintain local roads.[64] Over time, however, railroad companies would become increasingly concerned over the emergence of trucking. Trucks were seen as a dangerous competitor for the transport of freight, especially over long distances.[65]

Another group which may have favored improved roads could have been voters

[64] Many railroad companies took an active role in promoting good roads. The Office of Public Roads described the efforts of one such company, the Illinois Central Railway Company which funded a "Good Roads Train" in 1901 to tour Louisiana, Mississippi, Tennessee, Kentucky, and Illinois. The special train contained nine cars loaded with modern road making equipment as well as road engineers and road experts. The train would stop in communities along the way and built demonstration roads showing the advantages of good roads. The governor of Mississippi stated, "By their [Illinois Central Railway Company] work, demonstrating what could be done by the methods they employed, and by their agitation of the question, the people have become aroused as they never were before…. Mississippi is today starting out on a higher plane than ever before." U.S. Department of Agriculture (1903), *Report of the Office of Public Road Inquiries for 1903,* pp.335-336.

[65] Charles Dearing wrote of the changing views of the railroad industry concerning rural roads: "It is difficult to determine the precise date at which railroad leaders grew uneasy about the potential competition of the automobile interests, but not until 1910 were they sufficiently concerned over demands of automobilists for through roads to launch a counter drive for farm-to-market roads. Only in 1916 did railroads begin to regard the motor vehicle as a really serious competitor. Dearing (1942), p. 228.

with school age children. Many contemporary observers noted a relationship between good roads and school attendance. In some communities, especially in the North Central states, the number of days that schools were held in session was entirely dependent on the condition of the local roads. Schools could be closed months at a time during the winter because of impassable roads.[66] Road improvement would allow for school transport, improved school attendance and an increase in the number of days schools are held in session. Voters with school age children would likely support large expenditures on roads as a means towards improving educational outcomes. To gauge the support of voters with school-age children, the share of the county population between the ages of 5 and 18 is used.

5.2 Empirical Results

The main regression results, shown in Tables 2.5 and 2.6, include all the regions in the sample. The log value of county and township road expenditures per road mile is used as the dependent variable in Table 2.5 while the log value of local road expenditures per square mile is used as the dependent variable in Table 2.6. Columns 1 through 3 in both tables use farmland value per farm as the wealth measure for the mean voter, while columns 4 through 6 use the assessed valuation of taxable property per capita as the broader measure of wealth. Columns 1 and 4 provide estimates of the base specification of the combined median voter and special interest model, while Columns 2 and 5 include the composition of agricultural production and the share of the population of school-age children. Columns 3 and 6 restrict the analysis of road demand to counties that received state-aid. State and year fixed effects are included in all specifications to control for unobserved heterogeneity at the state level and across years.

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[66] Dewey (1919), pp. 44-46.

The OLS results are broadly in line with the expectations of the model described in Section 3. An advantage of transforming the demand function into log form as presented in Equation (10) is that the coefficients of the variables can be interpreted as elasticities. The coefficient measuring the wealth of the mean voter (the income elasticity) is statistically significant and positive in both Tables 2.5 and 2.6. The positive coefficient holds whether farmland value per farm or assessed valuation of taxable property per capita is used as the proxy for wealth. The estimated income elasticity estimates range from 0.20 to 0.84, implying that roads are a normal good since demand for road expenditures rises with income.

It appears that population size and population density both have a positive effect on the demand for roads. For most of the specifications, the population variables are statistically significant. As expected, the average voter's tax share elasticity is negative and statistically significant. An exception is the subset of counties that received state-aid where the negative coefficient on the tax share variable is not statistically significant. The negative result states that as the tax share increases, the demand for increased road expenditures falls. This negative coefficient is consistent with the results found in previous literature.

Farmers appear to be a significant force in the opposition of improved roads in Table 2.5. The coefficient for the share of the population employed as farmers is negative and statistically significant at the one percent level in all regressions. Increasing the share of the county population who are employed as farmers by one percentage point decreases the amount of road expenditure per mile by 1.7 percent (column 2, Table 2.5). The coefficient on the farmer variable is approximately of the same magnitude in all specifications. The coefficient suggests that farmers were highly effective in using their political clout to limit local road expenditures on high quality roads. However, when the dependent variable used is the total road expenditure per square mile, the negative coefficient of the farmer variable is no longer statistically significant. In several of the specifications, the estimated coefficients shown in Table 2.6 are positive. This result suggests that the opposition of farmers towards road expenditures may have been limited towards the construction of costly hard surfaced roads. The weak results of the farmer coefficient found in Table 2.6 opens the possibility that farmers wanted to increase the size of the road network but preferred the construction of cheaper road types as opposed to high quality roads.[67] Another special interest group, the share of the population employed in the railroad sector, does not appear to have had much of an effect on road expenditures. The coefficient is not statistically significant in any of the specifications. The share of agricultural production in dairy products has the expected sign and is statistically significant for the broader sample of counties, but is not statistically significant when the sample is restricted to counties that received state-aid. Likewise, the share of agricultural production in poultry and eggs appears to have had a positive effect on the demand for roads, but the result is statistically significant in only one of the specifications.

The share of the population between the ages of 5 and 18 has a mostly negative effect of road expenditures although the result is not statistically significant. One possible reason is that road expenditures and school expenditures were substitutable

[67] The difference between constructing a mile of macadam road and a mile of improved earth road was not trivial. Based on cost data found in the 1909 road survey conducted by the Office of Public Roads, the cost of constructing a mile of high quality macadamized road average between $2000 and $4000, while a mile of improved earth road cost $250-$400.

public goods. Counties that expended relatively large amounts on schools may not have had sufficient resources to make large expenditures on road infrastructure.[68]

The coefficient for small farm size has the predicted negative sign in four out of the six specifications in Table 2.5. The variable is also negative and statistically significant in Table 2.6. The results in Table 2.6 suggest that owners of small farms did not want an expansive road network built, since they would be least likely to benefit from such a network as they had a limited amount of products to sell. It was expected that the coefficient for farm tenancy would be negative, given the anecdotal evidence, but the resulting coefficients were ambiguous and statistically weak. Interestingly, the sign on the coefficient for the fraction of the population living in rural areas is positive in both Tables 2.5 and 2.6, despite the statistically significant negative coefficient for the farmer variable. This suggests that while farmers may have opposed high quality roads, rural voters employed in sectors outside of farming were more supportive of improved rural roads. These non-farmers generally resided in small villages or country towns which were centers of small artisanal manufacturing. The rural voters who resided in the villages owned less land than farmers, and would have been less affected by increases in property taxes to pay for the roads. Given the social benefits of improved roads including access to better schools, better health services, mail order delivery and access to opportunities offered in larger towns and regional cities, non-farmers in rural areas appear to have been enthusiastic supporters of good roads.

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[68] Another possible explanation is that counties with higher distribution of young people must by necessity have fewer older voters. It has been argued that older voters may have a higher demand for public goods than younger voters. According to the theory, the life cycle hypothesis would suggest that older voters would tend to spend a larger portion of current income on current consumption (including consumption on public goods) than a younger voter with similar income and tax share. Thus the effect of the age variable on demand for public goods should be positive. See Bergstrom and Goodman (1973).

In the sample of counties that received state-aid, the coefficient on the amount of state-aid received, as measured by the log of the total amount of state-aid per mile, is positive. Although the result is statistically significant, the estimated effect is small. The reported coefficient in column 3 in Table 2.5 suggests that an increase of state-aid by one percent would increase local road expenditures by only 0.07 percent. To put it in dollar terms, an additional dollar of state-aid was expected to increase local road expenditures by 30 cents. The rise in state-aid could explain approximately a quarter of the observed rise in local road expenditures per mile of road during this period. However, in Table 2.6, the effect of state-aid on the level of road expenditures per square mile is negligible. This result suggests that state-aid had a greater stimulative effect in improving the quality roads rather than in the expansion of the overall size of the road network.

5.3 Empirical Results by Region

I also chose to run separate regressions across regions to see if the results in Tables 2.5 and 2.6 held on a regional level. The regressions for the North Atlantic, North Central and Mountain/Pacific regions using road expenditures per existing road mile is shown in Tables 2.7, 2.8, and 2.9 respectively. The general results from Table 2.5 appear to hold for the various regions. The income/wealth elasticity is positive and statistically significant across all regions. Population and population density coefficients are also positive. However, the population coefficient is not statistically significant for the North Atlantic region. The share of the population employed in farming is strongly negative across the North Central, and Mountain/Pacific regions, but only weakly negative in the North Atlantic region. In none of the specifications for the sample of counties in the

North Atlantic region is the farmer coefficient statistically significant. The weak negative results for the farmer variable in the North Atlantic region suggest that there may have been regional differences in the political clout of farmers. Farmers in the North Central and Mountain/Pacific regions may have been more effective in voicing opposition to road expenditures to costly high quality roads. The share of the population in rural areas, the share of tenant farmers and the share of small farms do not appear to be a significant explanatory factor in the demand for high quality roads in any of the regions.

Table 2.9 shows that the coefficient on state-aid is positive and statistically significant for the Mountain/ Pacific region. Column 3 in Table 2.9 indicates that a one percent increase in state-aid increased road expenditures by 0.37 percent. The estimated state-aid coefficient in the West region is approximately 8 times larger than the estimated coefficients in the other regions. Tables 2.7 and 2.8 show that while the state-aid coefficient is positive, it is not statistically significant from zero. The small and statistically insignificant state-aid coefficient suggests that increases in state-aid had little effect on local road expenditures in the North Atlantic and the North Central regions. A possible explanation for this regional difference in the efficacy of state-aid may have resulted from how local voters viewed the permanence of state road funding. If voters viewed state-aid as a permanent source of future road revenues, then they would likely have viewed state road spending as a substitute for local road expenditures. On the other hand, if state-aid was viewed as transitory (such as a one-time grant), then local road expenditures may have increased in the short run in order to invest in expensive road equipment or to fund a road project. Also if state-aid funds required a local match, then a positive relationship between state-aid and local road expenditures would be expected.

Another regional difference in state-aid financing was that state road revenues were primarily funded by state bonds in the North Atlantic and Mountain/Pacific regions, while North Central states funded state-aid through more diverse sources including state bonds, state taxes and motor-vehicle fees.[69] In states where state-aid was funded through bonds, local governments had no assurance of annual funding by the state. If states wished to increase the level of state-aid, new bond measures would have to be approved by voters. In states where state-aid was funded primarily by state taxes and motor-vehicle fees, state road revenues had a steady stream of income. Local governments could then plan state-aid into their road budgets. Thus, if voters across regions had different views over the permanence of state-aid funding then it might explain the difference in the stimulative effect of state-aid in the Mountain/Pacific region versus the relatively weak effect of state-aid in the North Atlantic and North Central regions.

Tables 2.10, 2.11 and 2.12 look at the regressions at the regional level when road expenditures per square mile of area are used as the dependent variables. While most of the signs of the coefficients estimated in the regional tables are consistent with Table 2.6, the coefficients on farmer share are now positive for both the North Atlantic and Mountain/Pacific regions, although the results are not statistically significant. In the North Central region, the coefficient on the farmer variable remains statistically negative in all of the specifications. This unexpected result suggests that farmers in the North Atlantic and Mountain/Pacific regions were not universally opposed to all road expenditures. Farmers in these regions appear to be willing to spend funds on the expansion of the road network, but not if the network would be comprised of many miles

[69] In 1915, California and New York alone accounted for 72 percent of the total amount of state bonds outstanding nationally.

of expensive hard surfaced roads.

The share of the population living in rural areas and the share of tenant farmers appear to be significant factors in explaining the demand for local road networks in the North Central and Mountain/Pacific regions. The positive coefficients on the tenant farmer variable suggest that tenant farmers may not have believed that they would pay the entire increase in property taxes that would have resulted from an increase in road expenditures. If this was the case, then tenant farmers would have tended to vote for more public expenditures than farm-owners. The results show little evidence that tenant farming held back improvements to local infrastructure projects as had been claimed by contemporary commentators.

5.4 Instrumenting for Wealth

A potential problem that arises in using the median voter model is that the estimation strategy may fail to properly identify the true effect of voter wealth on road demand. One potential reason is that the causal relationship may be misidentified. Instead of the average wealth of the voter unilaterally determining the level of road expenditures in a county, it could also be that the variation in road expenditures across counties may affect the level of average wealth. Economic surveys, conducted during this period, suggested just such a causal feedback from improved roads to land values. In one survey, the Office of Public Roads used records of land sales in eight counties and examined the change in assessed value after road improvement. They found that the sale price of land increased dramatically after the local roads were improved.[70]

[70] In one survey for Dinwiddie County, Virginia the Office of Public Roads found that the average value of 43 farms sold or offered for sale prior to road improvement ranged in value from $8.38 to $43.74 per acre in 1909. After the roads were built, the same farms ranged in value between $24.70 to $73.80 per acre.

In order to ensure the identification of the true effect of wealth on demand for roads, I will utilize the lagged values of assessed valuation of taxable property and the average farmland value per farm. In particular, I will utilize the assessed valuation of taxable property found in the *Census of Debt, Wealth and Taxation of 1890* as the instrument for assessed valuation used in the study. Similarly, the lagged value of farmland per farm in 1890 will be used as an instrument for the average value of farmland per farm. The land value data was gathered from the *Census of Agriculture* for 1890. Since these lagged variables for wealth occurred in the past, it would be safe to assume that road expenditures in 1904 or 1914 would not have affected wealth in 1890. The lagged variables thus being uncorrelated with the error term should be valid candidates as instruments.

The results of the 2SLS regressions are presented in Tables 2.13 and 2.14. Columns 1 to 3 uses the lagged value of assessed valuation of property per capita as an instrument for current assessed valuation per capita. Columns 4 to 6 uses the lagged value of land per farm as an instrument for current farmland value per farm. The results are similar with the OLS results shown in Table 2.5. The first-stage F-statistic is large for both instruments across all specifications. The coefficients on the assessed valuation variable are slightly larger than those found using OLS, with the expected increase in the standard errors. Using the lagged values of wealth as instruments result in a doubling of the coefficients in columns 4 and 5, but the results still shows that wealth had a positive effect on the demand for roads. Also included in Tables 2.13 and 2.14 are the p-values of the Durbin-Wu-Hausman test statistic. A p-value below the 10 percent level of

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The conclusion was that the rise in assessed value was a direct result of easier access of farms to markets through improved roads. U.S. Department of Agriculture (1916), *Bulletin No. 393,* p.33.

significance would suggest that endogeneity may be a potential problem. In Table 2.13, the p-values of the test statistic are all above the 10 percent level of significance, thus implying that the OLS estimates are valid. In Table 2.14, when the dependent variable is the total expenditures per square mile, the reported p-values are below the critical level of significance suggesting that the IV estimates may be preferred. However, using the IV estimates in Table 2.14 does not change the basic conclusions drawn from the OLS estimates presented earlier.

6. Conclusion

The early 20th century saw dynamic changes in the provision of quality roads and in the administration of local public roads. One of the key reforms that resulted from the movement was the re-emergence of the state governments in the funding of public roads through state-aid programs. Starting with New Jersey and other states in the Northeast, 42 states had adopted some form of state-aid legislation by 1914. The dramatic rise in state-aid funding was expected to have a significant impact on the quantity and quality of the rural road network. However, the results of this paper offer a mixed bag concerning the effectiveness of state-aid in funding local road projects. While the state-aid coefficient is generally positive, as expected by the model, it appears that the effectiveness of intergovernmental aid varied by region. In states in which state-aid was viewed as transitory, as in the Western states, state-aid appeared to have acted as leverage for increasing local road expenditures. In states where state-aid was seen as a permanent source of funding, such as in the North Central region, it appears that local governments viewed the intergovernmental aid as a substitute for local funding.

At a time when state-aid financing of the roads was increasing at an exponential rate, some in the Good Roads Movement questioned the ability to construct a high quality road network solely though state-aid. These skeptics believed that only through national-aid could local governments secure the necessary finances to build good roads.[71] Thus another factor to consider for future research is the effectiveness of federal-aid dollars on local road expenditures. By the 1920s, federal financing of the roads was becoming an increasingly important source of funding of local roads.[72]

The results of this paper also suggest that rent seeking behavior by special interest groups was a significant explanatory factor in the demand for rural roads. There appears to be a strong negative relationship between farmers and the demand for high quality roads. Advocates of the Good Roads Movement often expressed frustration with the farming class for their opposition to road reform and their apparent inability to recognize the benefits of improved roads. An example of the contempt directed towards farmers is found in a pamphlet titled *The Gospel of Good Roads*. The pamphlet, written as a letter to farmers, blamed them for the deplorable conditions of the nation's roads. In one passage, the pamphlet's author wrote, "In all kindness let me remind you that in other years you [the farmers] and your good neighbors have opposed many great improvements which were intended for our common benefit, and which the lapse of time has placed in the highest niches of human advancement…. I might almost say there is no great invention of commercial or agricultural value which was cheered at its birth by the

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[71] Hoyt (1966), p. 268.

[72] Before 1916, federal financing of the roads was non-existent. Although the Good Roads Movement had strong support among both parties in Congress, road bills routinely failed to get out of Congressional committees. At issue was whether federal aid should be directed towards local farm-to-market roads as advocated by farmers or whether it should be aimed towards cross-country interstate routes as lobbied by auto clubs and manufacturers. In 1916 the federal government, for the first time in a hundred years, appropriated funds towards road construction with the passage of the Federal-Aid Act (Bankhead-Shackleford Bill). Although, there would be some objections to continued federal financing of road projects throughout the 1920s, the federal financing of the American roads took on an increasingly important role

warmth of your approval."[73]

This criticism levied towards farmers by Good Roads advocates is unfair. The farming class was never against the general concept of better roads. Farmers accepted that improved rural roads were necessary and widely acknowledged the economic benefits associated with roads. Where they disagreed vigorously with the Good Roads Movement was on what type of roads should be built and who should pay for such roads. Farmers believed that the construction of expensive hard surfaced roads, such as macadam roads, would lead to increased property taxes. The principal fear of farmers was that they would bear a disproportionate share of the tax burden as a result of the construction of high quality roads. It is therefore not surprising that farmers were strongly opposed to increased road expenditures for high quality roads across all regions. However, when examining the demand for a general road network, the results find that the farmer opposition became less strident. This suggests that farmer opposition towards road expenditures was not universal. An area for future research would be to examine whether farmer opposition towards roads varied with the economic conditions in the agricultural sector. Were farmers more likely to support local road expenditures during booming economic times in the agricultural sector? A positive answer to this question may explain a significant portion of the observed rise in local road spending in the early 20th century.

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[73] Potter (1891), *The Gospel of Good Roads: A Letter to the American Farmer*, p. 6.

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TABLE 2.1
TOTAL EXPENDITURES ON SCHOOLS AND HIGHWAYS (1890-1921)

	Total Expenditures on Schools	Total Expenditures on Roads and Bridges
1890	$145,583,115	$72,262,023
1904	$273,216,227	$79,771,418
1914	$605,460,785	$239,663,785
1921	$1,039,385,055	$1,036,587,772

Notes: Figures are expenditures from all levels of government.
Sources: Report of the Commissioner of Education (Various Years); U.S. Department of Agriculture (Various Years), *State Highway Mileage and Expenditures.*

TABLE 2.2
STATEWIDE VOTES ON ROAD RELATED MEASURES (1906-1924)

State	Year	Ballot Abstract	Result
Missouri	1906	Permit counties to incur indebtedness by 2/3 vote for road purposes.	Adopted
Alabama	1908	Permit use of convict labor on roads.	Adopted
Missouri	1908	Authorize counties to levy a special road tax.	Adopted
Missouri	1908	Authorize a state tax for permanent road fund.	Rejected
California	1910	Authorize $18 million road bond measure.	Adopted
Louisiana	1910	Levy ¼ of one mill tax to create road fund.	Adopted
Missouri	1910	Authorize a state tax for permanent road fund.	Rejected
Oregon	1910	Permit counties to vote bonds for road improvement.	Adopted
Colorado	1912	Establishment of state highway commission.	Rejected
Colorado	1912	Increase county debt limitation for road purposes.	Rejected
Colorado	1912	Authorize bond measure for improvement of highways.	Rejected
Louisiana	1912	Authorize tax for construction of public roads.	Adopted
Maine	1912	Authorize $2 million road bond measure.	Adopted
Minnesota	1912	Levy state tax for improving roads.	Adopted
New York	1912	Authorize $50 million road bond measure.	Adopted
Ohio	1912	Authorize $50 million road bond measure.	Rejected
Oregon	1912	Permit state to issue bonds for road purposes.	Adopted
Oregon	1912	Limit county and state road indebtedness.	Adopted
Oregon	1912	Permit counties to issue bonds for roads by majority vote.	Rejected
Oregon	1912	County bonding and road construction act.	Rejected
Oregon	1912	State road bonding act.	Rejected
Kentucky	1913	Permit employment of convict labor upon public roads.	Adopted
Pennsylvania	1913	Authorize $500 million road bond measure.	Rejected
Texas	1913	Authorize the issuance of bonds for public improvement.	Rejected
Arizona	1914	Authorize $5 million road bond measure.	Rejected
Colorado	1914	Levy state road tax one-half mill.	Adopted
Michigan	1914	Authorize road bond measure for public roads.	Rejected
Missouri	1914	Levy state road tax.	Rejected

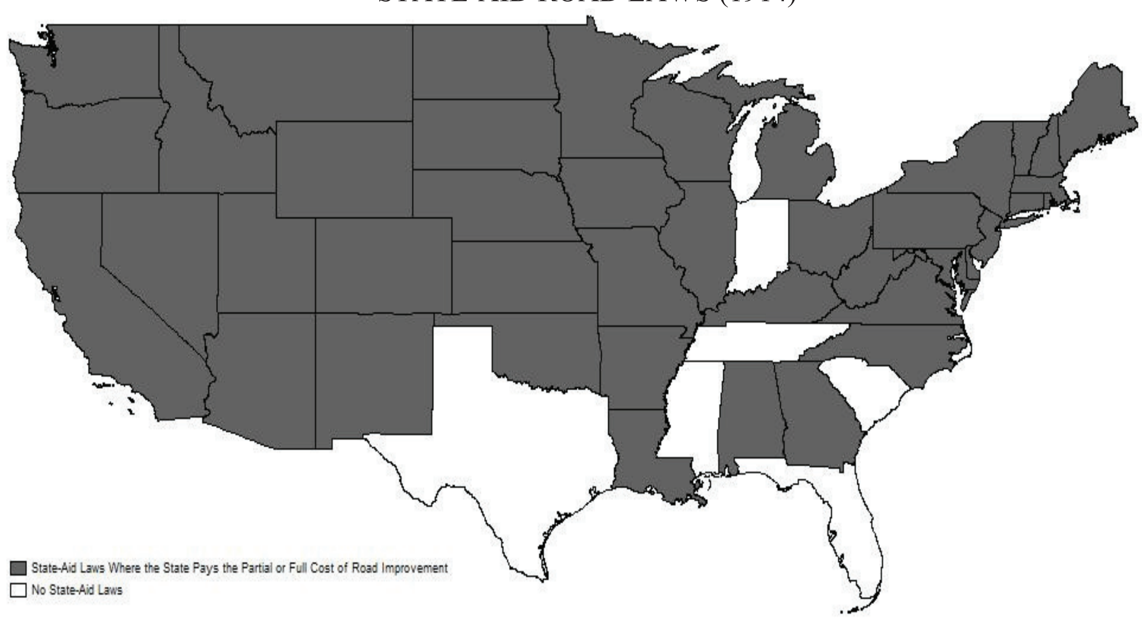
Missouri	1914	Authorize road districts to increase rate of taxation by majority vote.	Rejected
Missouri	1914	Authorize $25 million road bond measure.	Rejected
Missouri	1914	Authorize levy and collection of special road taxes.	Rejected
Wyoming	1914	Empowering state to issue bonds and levy taxes for public road construction.	Adopted
California	1915	Authorize $15 million road bond measure.	Adopted
Kentucky	1915	Permit employment of convict labor upon public roads	Adopted
Texas	1915	Authorize the issuance of bonds for public improvement.	Rejected
Texas	1915	Authorize the levy of a special road tax in any county which is approved by a majority.	Rejected
Arkansas	1916	Permit counties to levy taxes for the construction of roads.	Adopted
New Jersey	1916	Adoption of Egan Road Act	Adopted
South Dakota	1916	Authorize the state to engage in the construction and maintenance of roads.	Adopted
Michigan	1917	Empowering the state the right to construct and improve highways.	Adopted
Oregon	1917	Authorize $6 million road bond measure.	Adopted
Missouri	1918	Levy state road tax.	Rejected
Missouri	1918	Permit cities to incur additional indebtedness for highway improvement.	Rejected
Missouri	1918	Authorize levy and collection of special road taxes.	Rejected
North Dakota	1918	Authorize state and its subdivisions to make internal improvements.	Adopted
Pennsylvania	1918	Authorize $500 million road bond measure.	Adopted
California	1919	Authorize $10 million road bond measure.	Adopted
Alabama	1920	Special road tax.	Rejected
Arizona	1920	Creation of state highway department.	Rejected
Colorado	1920	Authorize road bond measure.	Adopted
Idaho	1920	Authorize road bond measure.	Adopted
Kansas	1920	Good Roads Amendment.	Adopted
Michigan	1920	Authorize $50 million road bond measure.	Adopted
Minnesota	1920	Creation of a state highway system; authorize taxation of motor vehicles.	Adopted
Missouri	1920	Authorize a special tax levy.	Adopted
Missouri	1920	Authorize $60 million road bond measure.	Adopted
Montana	1920	Authorize road bond measure.	Rejected
Washington	1920	Authorize $30 million road bond measure.	Rejected
Washington	1920	Permit employment of convict labor on public roads.	Rejected
West Virginia	1922	Authorize $50 million road bond measure.	Adopted
Alabama	1922	Authorize $25 million road bond measure.	Adopted
Arizona	1922	Authorize road bond measure.	Rejected
Colorado	1922	Authorize $60 million road bond measure.	Adopted
Maine	1922	Creation of a State Highway Commission.	Rejected
New Jersey	1922	Authorize $40 million road bond measure.	Adopted
Alabama	1924	Permit Mobile County to levy special road tax.	Adopted
Illinois	1924	Authorize $100 million road bond measure.	Adopted
Kentucky	1924	Authorize $75 million road bond measure.	Rejected
Missouri	1924	Fund state highway system by means of a tax on gasoline.	Adopted

Source: Various state reports.

FIGURE 2.1
STATE-AID ROAD LAWS (1904)

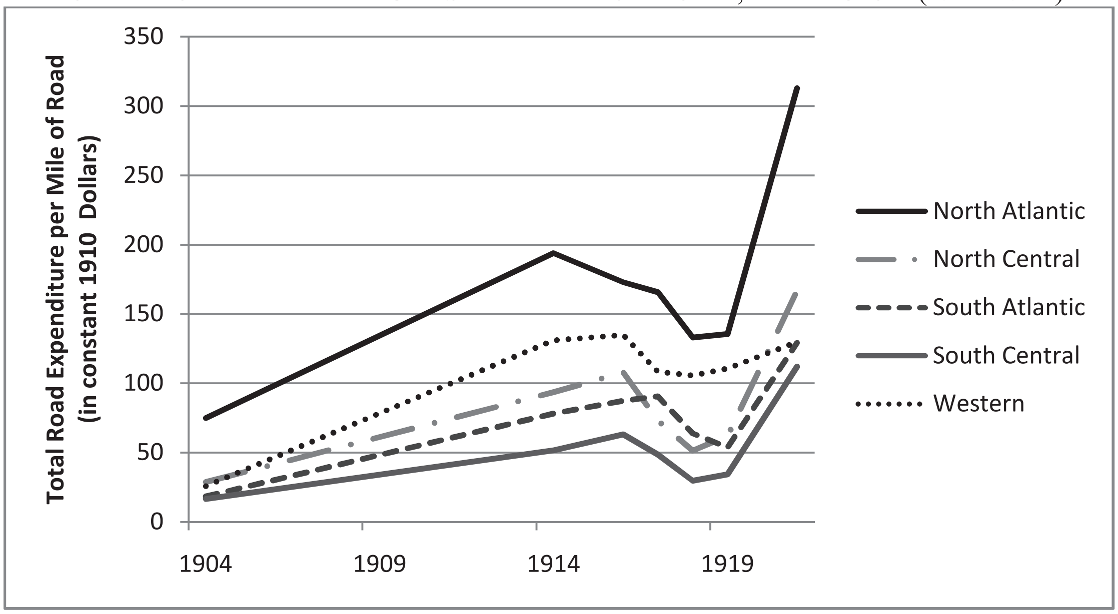
Source: Office of Public Roads (1907), *Bulletin No.32*.

FIGURE 2.2
STATE-AID ROAD LAWS (1914)



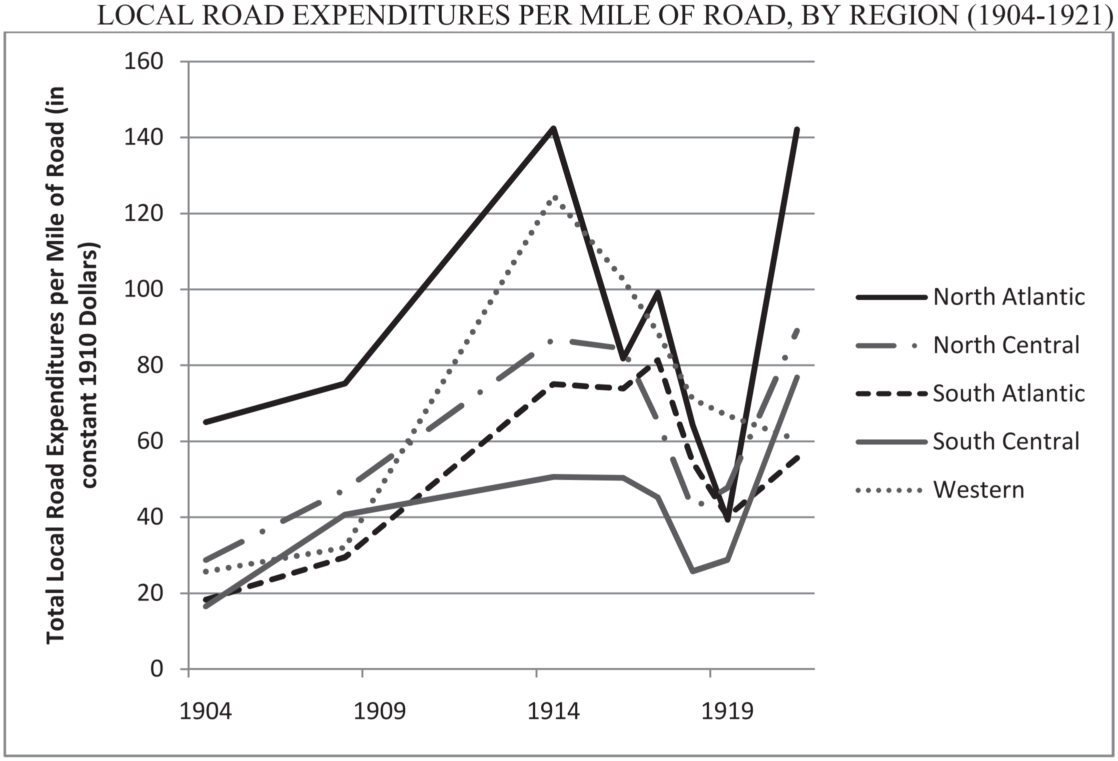
Source: U.S. Department of Commerce (1922), *Statistical Abstract of the United States*, Table No. 216.

FIGURE 2.3
TOTAL ROAD EXPENDITURES PER MILE OF ROAD, BY REGION (1904-1921)



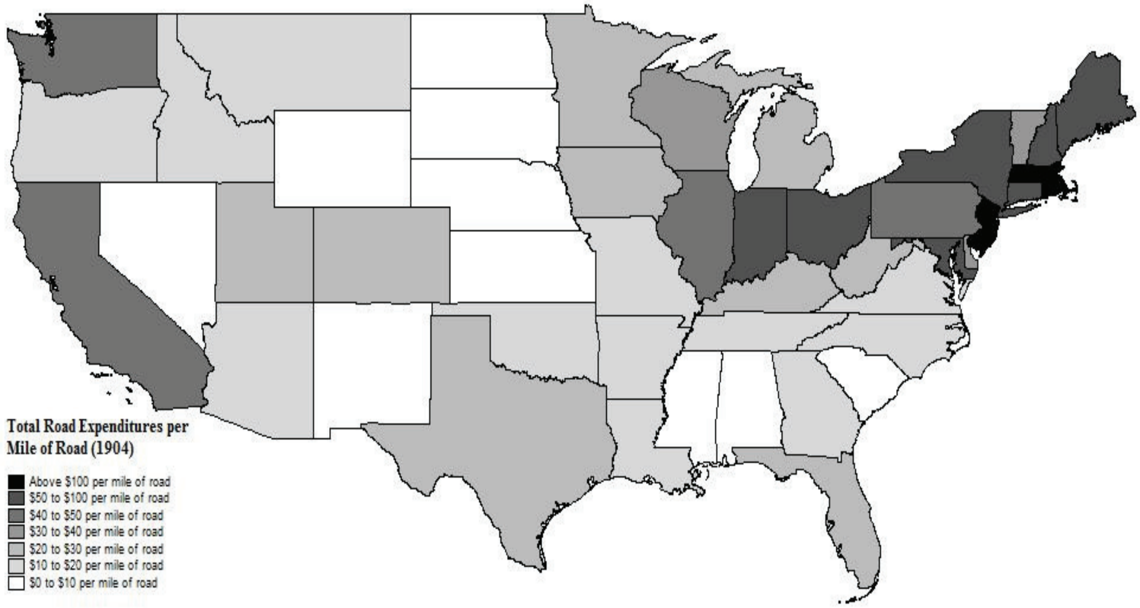
Source: U.S. Department of Agriculture (Various Years), *State Highway Mileage and Expenditures.*

FIGURE 2.4
LOCAL ROAD EXPENDITURES PER MILE OF ROAD, BY REGION (1904-1921)



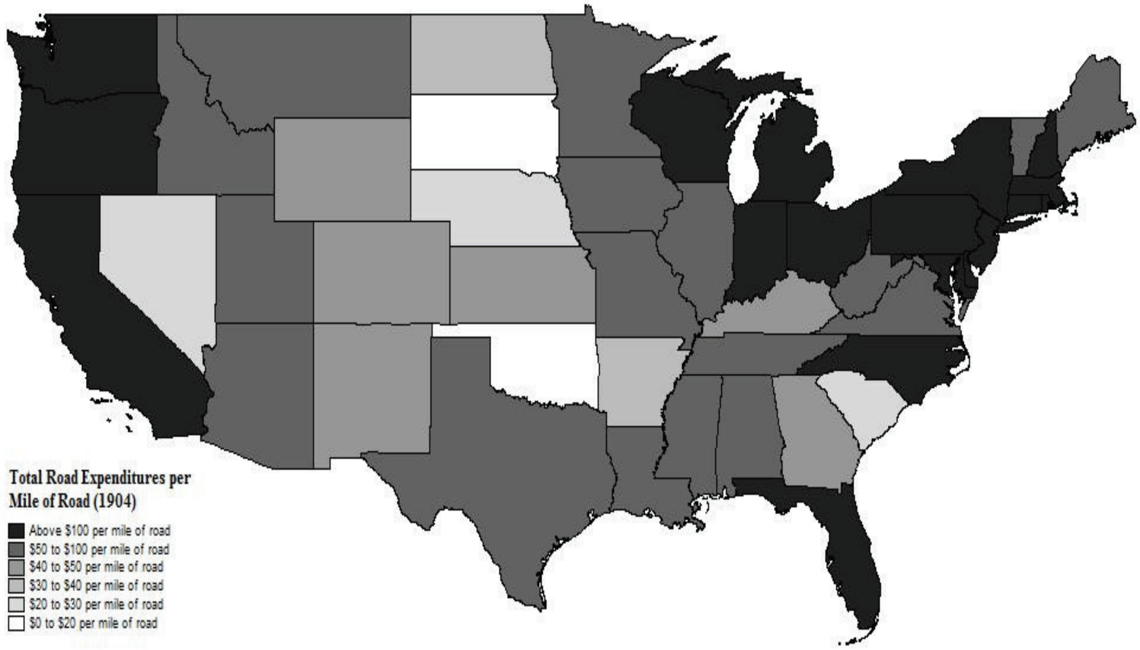
Notes: Dollar amounts are expressed in constant 1910 dollars. Source: U.S. Department of Agriculture (Various Years), *State Highway Mileage and Expenditures.*

FIGURE 2.5
TOTAL ROAD EXPENDITURES PER MILE OF ROAD (1904)



Source: U.S. Department of Agriculture, Office of Public Roads (1907), *Public Road Mileage, Revenues, and Expenditures in the United States in 1904.*

FIGURE 2.6
TOTAL ROAD EXPENDITURES PER MILE OF ROAD (1914)



Source: Bureau of Public Roads (1917), *Bulletins No.386-389.*

TABLE 2.3
SHARE OF TOTAL ROAD EXPENDITURES FUNDED BY STATE-AID[1], by Region
(IN PERCENT)

Region	1904	1914	1916	1917	1918	1919	1921
North Atlantic	15.4	26.6	52.6	40.2	51.6	71.0	54.6
North Central	0	7.0	21.7	10.5	17.7	22.9	46.5
South Atlantic	0.3	3.8	15.3	9.9	14.6	24.9	56.9
South Central	0	1.7	20.1	7.0	13.3	16.0	34.1
Western	0.2	4.8	23.9	18.1	32.6	39.6	53.4
U.S.	4.5	10.2	27.3	18.3	28.5	37.3	48.7

Notes: [1]State-Aid includes any revenues generated from state taxes, state bond issues, motor vehicle license fees and gasoline taxes.
Source: U.S. Department of Agriculture (Various Years), *State Highway Mileage and Expenditures.*

Table 2.4
DESCRIPTIVE COUNTY STATISTICS

Variable	North Atlantic 1904	North Central 1904	Mountain/ Pacific 1904	North Atlantic 1914	North Central 1914	Mountain/ Pacific 1914
Total Local Road Expenditures/Mile of Road	$71.31 ($81.98)	$24.24 ($34.79)	$36.20 ($71.10)	$102.78 ($326.69)	$55.89 ($93.00)	$101.21 ($216.84)
Total Local Road Expenditures/Sq. Area	$167.38 ($281.33)	$40.26 ($70.70)	$13.23 ($27.36)	$193.34 ($576.02)	$84.67 ($135.05)	$55.26 ($157.24)
Average Value of Farmland per Farm	$2,851 ($3,768)	$3,620 ($2,155)	$4,070 ($3,432)	$3,649 ($6,031)	$7,653 ($4,926)	$8,073 ($5,312)
Assessed Valuation per capita	$531.95 ($249.86)	$400.33 ($227.83)	$622.21 ($408.40)	$599.52 ($292.50)	$693.89 ($485.18)	$819.35 ($580.67)
State-Aid/Mile of Road	$11.96 ($19.80)	N/A	$3.68 ($6.23)	$115.29 ($156.12)	$12.26 ($30.82)	$10.41 ($12.35)
Population	92,261 (191,085)	25,720 (66,774)	12,970 26,397	112,618 (251,662)	28,486 (86,314)	20,313 (45,546)
Fraction of County Population in Rural Areas	0.609 (0.331)	0.826 (0.214)	0.840 (0.242)	0.574 (0.295)	0.813 (0.226)	0.818 (0.239)
Fraction of Farms Operate by Tenant Farmers	0.228 (0.122)	0.258 (0.132)	0.142 (0.091)	0.200 (0.118)	0.279 (0.142)	0.133 (0.090)
Average Farm Size (in Acres)	98.64 (32.09)	193.16 (188.84)	490.18 (667.67)	96.47 (31.45)	199.35 (169.73)	391.47 (439.51)
Share of Population Between Ages 5-18	0.268 (0.036)	0.315 (0.042)	0.279 (0.060)	0.261 (0.040)	0.295 (0.054)	0.268 (0.070)
Fraction of Population Employed as Farmers	0.062 (0.038)	0.107 (0.056)	0.084 (0.063)	0.095 (0.061)	0.159 (0.084)	0.158 (0.100)
Fraction of Population Employed in Railroads	0.011 (0.015)	0.006 (0.033)	0.012 (0.027)	0.019 (0.014)	0.015 (0.026)	0.027 (0.036)
Share of Total Agricultural Production in Dairy Products	0.152 (0.059)	0.070 (0.039)	0.085 (0.065)	0.190 (0.098)	0.083 (0.065)	0.095 (0.094)
Share of Total Agricultural Production in Poultry/Eggs	0.240 (0.071)	0.269 (0.076)	0.150 (0.082)	0.098 (0.039)	0.078 (0.034)	0.060 (0.038)
# of Counties Reporting State-Aid	214	0	89	90	346	62
Total Number of Counties	244	1057	325	244	1057	366

Notes: Dollar amounts are adjusted to constant 1910 dollars using the CPI from *Historical Statistics of the United States Millennial Edition Online*. Table Cc1-2.

TABLE 2.5
DETERMINANTS OF PUBLIC DEMAND FOR ROADS IN ALL REGIONS

Variable	(1)	(2)	(3)
Farmland Value per Farm	0.334***	0.387***	0.198*
	(0.044)	(0.045)	(0.119)
Assessed Valuation per Capita			
Population	0.903	0.787***	0.410
	(0.223)	(0.247)	(0.352)
Population per Square Mile	0.263***	0.222***	0.266***
	(0.035)	(0.037)	(0.081)
Tax Share	-0.978***	-0.868***	-0.544
	(0.226)	(0.248)	(0.356)
Share of Population in Rural Areas	0.022	0.056	0.043
	(0.116)	(0.117)	(0.189)
Share of Farms Operated by Tenants	0.002	0.055	-0.790
	(0.242)	(0.244)	(0.527)
Share of Farms Under 10 Acres	0.598	0.683	-1.234
	(0.446)	(0.436)	(1.205)
Share of Population Employed as Farmers	-1.738***	-1.743***	-2.518***
	(0.360)	(0.362)	(0.703)
Share of Population Employed in RR Sector	-0.289	-0.219	-0.836
	(0.711)	(0.697)	(1.796)
Share of Population Between Ages 5-18		-0.149	-0.797
		(0.457)	(0.691)
Share of Total Agricultural Production in Dairy Products		1.553***	-0.066
		(0.364)	(0.633)
Share of Total Agricultural Production in Poultry and Eggs		0.372	0.212
		(0.336)	(0.911)
State-Aid Received/Mile of Road			0.072**
			(0.031)
Number of Counties	3045	3037	681
R^2	0.539	0.545	0.566

Notes: Dependent variable is ln(Road Expenditures/Mile of Road). Robust standard errors are reported in parentheses. All regressions include state and year fixed effects. *denotes statistical significance at the 90 percent confidence level; ** at 95 percent, and *** at 99 percent.

TABLE 2.5 (CONTINUED)
DETERMINANTS OF PUBLIC DEMAND FOR ROADS IN ALL REGIONS

Variable	(4)	(5)	(6)
Farmland Value per Farm			
Assessed Valuation per Capita	0.489***	0.502***	0.562***
	(0.046)	(0.048)	(0.107)
Population	0.597***	0.562**	0.075
	(0.213)	(0.236)	(0.297)
Population per Square Mile	0.332***	0.311***	0.290***
	(0.034)	(0.036)	(0.076)
Tax Share	-0.710***	-0.681***	-0.249
	(0.215)	(0.237)	(0.300)
Share of Population in Rural Areas	0.115	0.134	0.148
	(0.114)	(0.115)	(0.194)
Share of Farms Operated by Tenants	0.307	0.414*	-1.014**
	(0.206)	(0.216)	(0.436)
Share of Farms Under 10 Acres	-0.065	-0.052	-1.488
	(0.418)	(0.416)	(1.102)
Share of Population Employed as Farmers	-1.446***	-1.418***	-2.143***
	(0.353)	(0.357)	(0.629)
Share of Population Employed in RR Sector	-0.601	-0.538	-0.574
	(0.686)	(0.680)	(1.720)
Share of Population Between Ages 5-18		0.047	-0.264
		(0.450)	(0.655)
Share of Total Agricultural Production in Dairy Products		0.948***	-0.189
		(0.343)	(0.654)
Share of Total Agricultural Production in Poultry and Eggs		0.201	0.163
		(0.315)	(0.883)
State-Aid Received/Mile of Road			0.070**
			(0.031)
Number of Counties	3045	3037	681
R^2	0.548	0.553	0.582

Notes: Dependent variable is ln(Road Expenditures/Mile of Road). Robust standard errors are reported in parentheses. All regressions include state and year fixed effects. *denotes statistical significance at the 90 percent confidence level; ** at 95 percent, and *** at 99 percent.

TABLE 2.6
DETERMINANTS OF PUBLIC DEMAND FOR ROADS IN ALL REGIONS

Variable	(1)	(2)	(3)
Farmland Value per Farm	0.420***	0.467***	0.238**
	(0.040)	(0.042)	(0.111)
Assessed Valuation per Capita			
Population	0.934***	0.884***	0.384
	(0.196)	(0.225)	(0.283)
Population per Square Mile	0.849***	0.811***	0.825***
	(0.034)	(0.036)	(0.073)
Tax Share	-0.880***	-0.834***	-0.325
	(0.197)	(0.225)	(0.283)
Share of Population in Rural Areas	0.491***	0.495***	0.273
	(0.111)	(0.110)	(0.185)
Share of Farms Operated by Tenants	0.443**	0.504**	0.190
	(0.213)	(0.217)	(0.462)
Share of Farms Under 10 Acres	-0.829*	-0.679	-1.553
	(0.480)	(0.469)	(1.092)
Share of Population Employed as Farmers	-0.021	-0.098	-0.697
	(0.341)	(0.347)	(0.682)
Share of Population Employed in RR Sector	-0.149	-0.177	-0.697
	(0.556)	(0.558)	(1.873)
Share of Population Between Ages 5-18		-0.075	-0.485
		(0.415)	(0.619)
Share of Total Agricultural Production in Dairy Products		0.888***	0.447
		(0.319)	(0.569)
Share of Total Agricultural Production in Poultry and Eggs		0.746**	1.086
		(0.337)	(0.854)
State-Aid Received/Mile of Road			-0.00004
			(0.025)
Number of Counties	3046	3038	681
R^2	0.770	0.773	0.827

Notes: Dependent variable is ln(Road Expenditures/Square Mile). Robust standard errors are reported in parentheses. All regressions include state and year fixed effects. *denotes statistical significance at the 90 percent confidence level; ** at 95 percent, and *** at 99 percent.

TABLE 2.6 (CONTINUED)
DETERMINANTS OF PUBLIC DEMAND FOR ROADS IN ALL REGIONS

Variable	(4)	(5)	(6)
Farmland Value per Farm			
Assessed Valuation per Capita	0.534***	0.552***	0.564***
	(0.045)	(0.046)	(0.102)
Population	0.631***	0.655***	0.044
	(0.182)	(0.212)	(0.224)
Population per Square Mile	0.929***	0.916***	0.857***
	(0.032)	(0.033)	(0.068)
Tax Share	-0.624***	-0.651***	-0.027
	(0.183)	(0.212)	(0.220)
Share of Population in Rural Areas	0.593***	0.584***	0.383**
	(0.107)	(0.107)	(0.181)
Share of Farms Operated by Tenants	0.937***	0.994***	0.055
	(0.184)	(0.193)	(0.392)
Share of Farms Under 10 Acres	-1.601***	-1.537***	-1.853*
	(0.402)	(0.395)	(0.992)
Share of Population Employed as Farmers	0.351	0.299	-0.290
	(0.341)	(0.350)	(0.620)
Share of Population Employed in RR Sector	-0.434	-0.493	-0.467
	(0.520)	(0.523)	(1.624)
Share of Population Between Ages 5-18		0.119	0.036
		(0.400)	(0.590)
Share of Total Agricultural Production in Dairy Products		0.143	0.254
		(0.296)	(0.582)
Share of Total Agricultural Production in Poultry and Eggs		0.458	0.940
		(0.308)	(0.811)
State-Aid Received/Mile of Road			-0.002
			(0.025)
Number of Counties	3046	3038	681
R^2	0.774	0.776	0.834

Notes: Dependent variable is ln(Road Expenditures/Square Mile). Robust standard errors are reported in parentheses. All regressions include state and year fixed effects. *denotes statistical significance at the 90 percent confidence level; ** at 95 percent, and *** at 99 percent.

TABLE 2.7
DETERMINANTS OF PUBLIC DEMAND FOR ROADS IN NORTH ATLANTIC REGION

Variable	(1)	(2)	(3)
Farmland Value per Farm	0.591***	0.713***	0.053
	(0.191)	(0.197)	(0.293)
Assessed Valuation per Capita			
Population	0.115	0.003	0.267
	(0.321)	(0.298)	(0.271)
Population per Square Mile	0.254***	0.145	0.252**
	(0.090)	(0.098)	(0.098)
Tax Share	-0.150	-0.074	-0.254
	(0.336)	(0.308)	(0.287)
Share of Population in Rural Areas	-0.326	-0.400	-0.132
	(0.273)	(0.272)	(0.243)
Share of Farms Operated by Tenants	-0.865	-0.823	-0.255
	(0.635)	(0.617)	(0.853)
Share of Farms Under 10 Acres	-0.446	0.246	-0.174
	(1.309)	(1.185)	(1.136)
Share of Population Employed as Farmers	-0.615	-0.738	-3.925**
	(1.678)	(1.655)	(1.955)
Share of Population Employed in RR Sector	-4.081	-3.841	-3.860
	(2.640)	(2.485)	(3.197)
Share of Population Between Ages 5-18		-1.837	0.561
		(1.778)	(1.837)
Share of Total Agricultural Production in Dairy Products		1.298*	0.184
		(0.776)	(1.084)
Share of Total Agricultural Production in Poultry and Eggs		3.015***	0.324
		(0.871)	(0.963)
State-Aid Received/Mile of Road			0.043
			(0.034)
Number of Counties	458	458	236
R^2	0.627	0.639	0.636

Notes: Dependent variable is ln(Road Expenditures/Mile of Road). Robust standard errors are reported in parentheses. All regressions include state and year fixed effects. *denotes statistical significance at the 90 percent confidence level; ** at 95 percent, and *** at 99 percent.

TABLE 2.7 (CONTINUED)
DETERMINANTS OF PUBLIC DEMAND FOR ROADS IN NORTH ATLANTIC REGION

Variable	(4)	(5)	(6)
Farmland Value per Farm			
Assessed Valuation per Capita	0.804***	0.842***	0.177
	(0.137)	(0.137)	(0.179)
Population	0.115	0.090	0.285
	(0.314)	(0.315)	(0.267)
Population per Square Mile	0.320***	0.306***	0.265***
	(0.094)	(0.099)	(0.101)
Tax Share	0.025	0.007	0.267
	(0.326)	(0.319)	(0.283)
Share of Population in Rural Areas	0.014	0.017	-0.084
	(0.283)	(0.274)	(0.323)
Share of Farms Operated by Tenants	-0.752	-0.599	-0.377
	(0.625)	(0.626)	(0.876)
Share of Farms Under 10 Acres	-0.148	0.175	-0.474
	(1.185)	(1.186)	(1.404)
Share of Population Employed as Farmers	-0.681	-0.619	-3.749*
	(1.678)	(1.655)	(2.096)
Share of Population Employed in RR Sector	-2.081	-1.810	-3.401
	(2.546)	(2.468)	(3.482)
Share of Population Between Ages 5-18		1.718	1.345
		(1.815)	(2.131)
Share of Total Agricultural Production in Dairy Products		1.288*	0.294
		(0.772)	(1.140)
Share of Total Agricultural Production in Poultry and Eggs		0.989	0.259
		(0.824)	(1.140)
State-Aid Received/Mile of Road			0.048
			(0.035)
Number of Counties	458	458	236
R^2	0.640	0.643	0.637

Notes: Dependent variable is ln(Road Expenditures/Mile of Road). Robust standard errors are reported in parentheses. All regressions include state and year fixed effects. *denotes statistical significance at the 90 percent confidence level; ** at 95 percent, and *** at 99 percent.

TABLE 2.8
DETERMINANTS OF PUBLIC DEMAND FOR ROADS IN NORTH CENTRAL REGION

Variable	(1)	(2)	(3)
Farmland Value per Farm	0.229***	0.243***	-0.014
	(0.050)	(0.054)	(0.143)
Assessed Valuation per Capita			
Population	1.172***	1.415***	1.650***
	(0.338)	(0.377)	(0.570)
Population per Square Mile	0.171***	0.174***	0.198
	(0.053)	(0.056)	(0.123)
Tax Share	-1.310***	-1.551***	-1.771***
	(0.339)	(0.375)	(0.546)
Share of Population in Rural Areas	0.213	0.258*	0.738**
	(0.153)	(0.155)	(0.321)
Share of Farms Operated by Tenants	0.241	0.211	-0.018
	(0.265)	(0.269)	(0.727)
Share of Farms Under 10 Acres	1.504	1.281	4.132
	(1.165)	(1.174)	(2.698)
Share of Population Employed as Farmers	-2.917***	-2.890***	-3.928***
	(0.528)	(0.523)	(0.906)
Share of Population Employed in RR Sector	-0.355	-0.225	-0.970
	(0.817)	(0.805)	(2.742)
Share of Population Between Ages 5-18		0.973*	0.079
		(0.565)	(0.769)
Share of Total Agricultural Production in Dairy Products		0.902**	0.652
		(0.406)	(0.693)
Share of Total Agricultural Production in Poultry and Eggs		-0.396	-4.904*
		(0.472)	(2.734)
State-Aid Received/Mile of Road			0.060
			(0.057)
Number of Counties	1985	1980	340
R^2	0.565	0.572	0.563

Notes: Dependent variable is ln(Road Expenditures/Mile of Road). Robust standard errors are reported in parentheses. All regressions include state and year fixed effects. *denotes statistical significance at the 90 percent confidence level; ** at 95 percent, and *** at 99 percent.

TABLE 2.8 (CONTINUED)
DETERMINANTS OF PUBLIC DEMAND FOR ROADS IN NORTH CENTRAL REGION

Variable	(4)	(5)	(6)
Farmland Value per Farm			
Assessed Valuation per Capita	0.237***	0.230***	0.411***
	(0.055)	(0.057)	(0.150)
Population	1.113***	1.357***	0.966*
	(0.351)	(0.385)	(0.579)
Population per Square Mile	0.244***	0.259***	0.185
	(0.053)	(0.054)	(0.122)
Tax Share	-1.253***	-1.493***	-1.102**
	(0.352)	(0.383)	(0.544)
Share of Population in Rural Areas	0.241	0.284*	0.601**
	(0.152)	(0.154)	(0.308)
Share of Farms Operated by Tenants	0.549**	0.468*	-0.656
	(0.228)	(0.247)	(0.637)
Share of Farms Under 10 Acres	0.464	0.275	4.444*
	(1.269)	(1.284)	(2.526)
Share of Population Employed as Farmers	-2.724***	-2.660***	-3.538***
	(0.516)	(0.514)	(0.804)
Share of Population Employed in RR Sector	-0.621	-0.498	-0.941
	(0.841)	(0.832)	(2.672)
Share of Population Between Ages 5-18		0.939*	0.238
		(0.570)	(0.765)
Share of Total Agricultural Production in Dairy Products		0.440	0.569
		(0.396)	(0.705)
Share of Total Agricultural Production in Poultry and Eggs		-0.722	-3.357
		(0.452)	(2.608)
State-Aid Received/Mile of Road			0.057
			(0.56)
Number of Counties	1985	1980	340
R^2	0.564	0.570	0.571

Notes: Dependent variable is ln(Road Expenditures/Mile of Road). Robust standard errors are reported in parentheses. All regressions include state and year fixed effects. *denotes statistical significance at the 90 percent confidence level; ** at 95 percent, and *** at 99 percent.

TABLE 2.9
DETERMINANTS OF PUBLIC DEMAND FOR ROADS IN MOUNTAIN/PACIFIC REGION

Variable	(1)	(2)	(3)
Farmland Value per Farm	0.059	0.194**	0.415**
	(0.083)	(0.082)	(0.192)
Assessed Valuation per Capita			
Population	1.171***	0.736**	2.664***
	(0.284)	(0.318)	(0.695)
Population per Square Mile	0.378***	0.296***	0.551***
	(0.052)	(0.054)	(0.146)
Tax Share	-1.172***	-0.790**	-2.983***
	(0.298)	(0.326)	(0.724)
Share of Population in Rural Areas	0.147	0.279	0.515
	(0.242)	(0.246)	(0.450)
Share of Farms Operated by Tenants	1.033*	0.613	-1.112
	(0.636)	(0.649)	(1.320)
Share of Farms Under 10 Acres	0.790	0.896*	-0.890
	(0.552)	(0.528)	(1.456)
Share of Population Employed as Farmers	-1.140***	-0.930**	0.269
	(0.446)	(0.452)	(0.903)
Share of Population Employed in RR Sector	-0.099	0.397	0.390
	(1.209)	(1.192)	(1.791)
Share of Population Between Ages 5-18		-0.523	2.294
		(0.734)	(1.454)
Share of Total Agricultural Production in Dairy Products		2.693***	2.753*
		(0.554)	(1.585)
Share of Total Agricultural Production in Poultry and Eggs		0.371	-0.080
		(0.632)	(2.514)
State-Aid Received/Mile of Road			0.371***
			(0.101)
Number of Counties	602	599	105
R^2	0.596	0.617	0.684

Notes: Dependent variable is ln(Road Expenditures/Mile of Road). Robust standard errors are reported in parentheses. All regressions include state and year fixed effects. *denotes statistical significance at the 90 percent confidence level; ** at 95 percent, and *** at 99 percent.

TABLE 2.9 (CONTINUED)
DETERMINANTS OF PUBLIC DEMAND FOR ROADS IN MOUNTAIN/PACIFIC REGION

Variable	(4)	(5)	(6)
Farmland Value per Farm			
Assessed Valuation per Capita	0.558***	0.566***	1.543***
	(0.094)	(0.093)	(0.303)
Population	0.750***	0.364	-0.385
	(0.291)	(0.322)	(0.754)
Population per Square Mile	0.416***	0.337***	0.461***
	(0.049)	(0.051)	(0.136)
Tax Share	-0.795***	-0.457	-0.940
	(0.302)	(0.325)	(0.742)
Share of Population in Rural Areas	0.221	0.284	1.025**
	(0.231)	(0.325)	(0.422)
Share of Farms Operated by Tenants	0.484	0.588	-0.693
	(0.550)	(0.555)	(0.928)
Share of Farms Under 10 Acres	0.525	0.455	0.041
	(0.522)	(0.514)	(1.335)
Share of Population Employed as Farmers	-1.376***	-1.124***	-0.310
	(0.447)	(0.457)	(0.812)
Share of Population Employed in RR Sector	-1.176	-0.695	0.735
	(1.125)	(1.119)	(1.719)
Share of Population Between Ages 5-18		-0.672	1.943*
		(0.709)	(1.180)
Share of Total Agricultural Production in Dairy Products		2.240***	4.078***
		(0.492)	(1.464)
Share of Total Agricultural Production in Poultry and Eggs		0.636	0.212
		(0.581)	(2.174)
State-Aid Received/Mile of Road			0.434***
			(0.097)
Number of Counties	602	599	105
R^2	0.627	0.646	0.752

Notes: Dependent variable is ln(Road Expenditures/Mile of Road). Robust standard errors are reported in parentheses. All regressions include state and year fixed effects. *denotes statistical significance at the 90 percent confidence level; ** at 95 percent, and *** at 99 percent.

TABLE 2.10
DETERMINANTS OF PUBLIC DEMAND FOR ROADS IN NORTH ATLANTIC REGION

Variable	(1)	(2)	(3)
Farmland Value per Farm	0.473***	0.645***	0.058
	(0.163)	(0.168)	(0.248)
Assessed Valuation per Capita			
Population	0.212	0.013	0.160
	(0.280)	(0.239)	(0.169)
Population per Square Mile	0.848***	0.684***	0.822***
	(0.084)	(0.091)	(0.096)
Tax Share	-0.114	0.035	0.323*
	(0.291)	(0.247)	(0.170)
Share of Population in Rural Areas	0.030	-0.070	0.060
	(0.242)	(0.223)	(0.217)
Share of Farms Operated by Tenants	-0.348	-0.380	0.319
	(0.628)	(0.608)	(0.804)
Share of Farms Under 10 Acres	-2.216**	-1.300*	0.039
	(0.883)	(0.807)	(1.402)
Share of Population Employed as Farmers	2.406	2.127	-1.177
	(1.564)	(1.507)	(1.847)
Share of Population Employed in RR Sector	-6.660***	-6.461***	-6.132**
	(2.415)	(2.204)	(2.754)
Share of Population Between Ages 5-18		-4.429***	-2.976*
		(1.654)	(1.817)
Share of Total Agricultural Production in Dairy Products		1.253*	0.202
		(0.705)	(0.946)
Share of Total Agricultural Production in Poultry and Eggs		4.166***	0.957
		(0.802)	(0.958)
State-Aid Received/Mile of Road			0.006
			(0.031)
Number of Counties	458	458	236
R^2	0.702	0.724	0.770

Notes: Dependent variable is ln(Road Expenditures/Square Mile). Robust standard errors are reported in parentheses. All regressions include state and year fixed effects. *denotes statistical significance at the 90 percent confidence level; ** at 95 percent, and *** at 99 percent.

TABLE 2.10 (CONTINUED)
DETERMINANTS OF PUBLIC DEMAND FOR ROADS IN NORTH ATLANTIC REGION

Variable	(4)	(5)	(6)
Farmland Value per Farm			
Assessed Valuation per Capita	0.867***	0.814***	0.032
	(0.132)	(0.130)	(0.172)
Population	0.029	0.098	0.165
	(0.259)	(0.243)	(0.171)
Population per Square Mile	0.881***	0.827***	0.837***
	(0.091)	(0.095)	(0.098)
Tax Share	0.086	0.116	0.325*
	(0.267)	(0.246)	(0.171)
Share of Population in Rural Areas	0.305	0.307	0.095
	(0.251)	(0.240)	(0.306)
Share of Farms Operated by Tenants	-0.455	-0.218	0.381
	(0.597)	(0.600)	(0.827)
Share of Farms Under 10 Acres	-2.060***	-1.387*	0.092
	(0.791)	(0.793)	(1.434)
Share of Population Employed as Farmers	2.495	2.282	-1.211
	(1.561)	(1.528)	(1.927)
Share of Population Employed in RR Sector	-4.350*	-4.442**	-6.154**
	(2.416)	(2.288)	(2.977)
Share of Population Between Ages 5-18		-1.007	-2.784
		(1.670)	(2.054)
Share of Total Agricultural Production in Dairy Products		1.266*	0.183
		(0.690)	(1.001)
Share of Total Agricultural Production in Poultry and Eggs		2.300***	0.829
		(0.755)	(1.011)
State-Aid Received/Mile of Road			0.006
			(0.032)
Number of Counties	458	458	236
R^2	0.724	0.730	0.769

Notes: Dependent variable is ln(Road Expenditures/Square Mile). Robust standard errors are reported in parentheses. All regressions include state and year fixed effects. *denotes statistical significance at the 90 percent confidence level; ** at 95 percent, and *** at 99 percent.

TABLE 2.11
DETERMINANTS OF PUBLIC DEMAND FOR ROADS IN NORTH CENTRAL REGION

Variable	(1)	(2)	(3)
Farmland Value per Farm	0.332***	0.367***	0.047
	(0.043)	(0.045)	(0.125)
Assessed Valuation per Capita			
Population	1.445***	1.671***	1.141**
	(0.273)	(0.304)	(0.535)
Population per Square Mile	0.828***	0.810***	0.740***
	(0.051)	(0.053)	(0.121)
Tax Share	-1.434***	-1.660***	-1.138**
	(0.268)	(0.299)	(0.506)
Share of Population in Rural Areas	0.740***	0.766***	0.995***
	(0.141)	(0.141)	(0.284)
Share of Farms Operated by Tenants	0.523**	0.573***	0.938
	(0.219)	(0.223)	(0.601)
Share of Farms Under 10 Acres	-2.882**	-2.879***	-0.635
	(1.140)	(1.147)	(2.523)
Share of Population Employed as Farmers	-1.662***	-1.710***	-1.832**
	(0.495)	(0.490)	(0.769)
Share of Population Employed in RR Sector	-0.825	-0.691	0.141
	(0.617)	(0.628)	(2.428)
Share of Population Between Ages 5-18		0.866*	0.432
		(0.475)	(0.704)
Share of Total Agricultural Production in Dairy Products		1.068***	1.472**
		(0.378)	(0.611)
Share of Total Agricultural Production in Poultry and Eggs		0.322	-2.652
		(0.436)	(2.502)
State-Aid Received/Mile of Road			0.022
			(0.046)
Number of Counties	1986	1981	340
R^2	0.728	0.732	0.724

Notes: Dependent variable is ln(Road Expenditures/Square Mile). Robust standard errors are reported in parentheses. All regressions include state and year fixed effects. *denotes statistical significance at the 90 percent confidence level; ** at 95 percent, and *** at 99 percent.

TABLE 2.11 (CONTINUED)
DETERMINANTS OF PUBLIC DEMAND FOR ROADS IN NORTH CENTRAL REGION

Variable	(4)	(5)	(6)
Farmland Value per Farm			
Assessed Valuation per Capita	0.305***	0.308***	0.395***
	(0.051)	(0.052)	(0.136)
Population	1.427***	1.643***	0.494
	(0.285)	(0.314)	(0.513)
Population per Square Mile	0.931***	0.936***	0.741***
	(0.051)	(0.052)	(0.116)
Tax Share	-1.417***	-1.632***	-0.500
	(0.280)	(0.309)	(0.478)
Share of Population in Rural Areas	0.783***	0.809***	0.854***
	(0.140)	(0.141)	(0.273)
Share of Farms Operated by Tenants	1.016***	0.999***	0.460
	(0.199)	(0.215)	(0.533)
Share of Farms Under 10 Acres	-4.297***	-4.326***	-0.505
	(1.340)	(1.363)	(2.476)
Share of Population Employed as Farmers	-1.393***	-1.369***	-1.398**
	(0.488)	(0.488)	(0.679)
Share of Population Employed in RR Sector	-1.152**	-1.046*	0.029
	(0.590)	(0.594)	(2.317)
Share of Population Between Ages 5-18		0.802*	0.550
		(0.479)	(0.705)
Share of Total Agricultural Production in Dairy Products		0.367	1.348**
		(0.372)	(0.610)
Share of Total Agricultural Production in Poultry and Eggs		-0.237	-1.574
		(0.423)	(2.389)
State-Aid Received/Mile of Road			0.018
			(0.690)
Number of Counties	1986	1981	340
R^2	0.725	0.728	0.730

Notes: Dependent variable is ln(Road Expenditures/Square Mile). Robust standard errors are reported in parentheses. All regressions include state and year fixed effects. *denotes statistical significance at the 90 percent confidence level; ** at 95 percent, and *** at 99 percent.

TABLE 2.12
DETERMINANTS OF PUBLIC DEMAND FOR ROADS IN MOUNTAIN/PACIFIC REGION

Variable	(1)	(2)	(3)
Farmland Value per Farm	0.270***	0.312***	0.697***
	(0.073)	(0.076)	(0.197)
Assessed Valuation per Capita			
Population	1.027***	0.971***	2.838***
	(0.246)	(0.300)	(0.700)
Population per Square Mile	0.977***	0.950***	1.141***
	(0.048)	(0.051)	(0.125)
Tax Share	-0.904***	-0.877***	-2.815***
	(0.257)	(0.311)	(0.730)
Share of Population in Rural Areas	0.638***	0.691***	0.493
	(0.222)	(0.226)	(0.450)
Share of Farms Operated by Tenants	1.181**	0.972*	0.024
	(0.533)	(0.550)	(1.151)
Share of Farms Under 10 Acres	0.441	0.768*	-0.325
	(0.474)	(0.457)	(1.295)
Share of Population Employed as Farmers	0.589	1.169	0.947
	(0.433)	(0.882)	(0.899)
Share of Population Employed in RR Sector	0.960	0.289	0.175
	(0.875)	(0.701)	(2.464)
Share of Population Between Ages 5-18		0.289	1.544
		(0.701)	(1.532)
Share of Total Agricultural Production in Dairy Products		1.020**	0.945
		(0.468)	(1.559)
Share of Total Agricultural Production in Poultry and Eggs		-0.134	0.064
		(0.604)	(2.193)
State-Aid Received/Mile of Road			-0.033
			(0.082)
Number of Counties	602	599	105
R^2	0.838	0.840	0.866

Notes: Dependent variable is ln(Road Expenditures/Square Mile). Robust standard errors are reported in parentheses. All regressions include state and year fixed effects. *denotes statistical significance at the 90 percent confidence level; ** at 95 percent, and *** at 99 percent.

TABLE 2.12 (CONTINUED)
DETERMINANTS OF PUBLIC DEMAND FOR ROADS IN MOUNTAIN/PACIFIC REGION

Variable	(4)	(5)	(6)
Farmland Value per Farm			
Assessed Valuation per Capita	0.617***	0.621***	1.798***
	(0.092)	(0.098)	(0.315)
Population	0.589**	0.590**	0.148
	(0.247)	(0.306)	(0.788)
Population per Square Mile	1.007***	0.997***	1.046***
	(0.045)	(0.047)	(0.114)
Tax Share	-0.527**	-0.541*	-0.416
	(0.259)	(0.319)	(0.792)
Share of Population in Rural Areas	0.641***	0.656***	1.087***
	(0.219)	(0.222)	(0.365)
Share of Farms Operated by Tenants	1.344***	1.306***	1.282
	(0.490)	(0.489)	(0.881)
Share of Farms Under 10 Acres	-0.190	-0.210	0.432
	(0.425)	(0.416)	(1.162)
Share of Population Employed as Farmers	0.534	0.632	0.388
	(0.454)	(0.492)	(0.812)
Share of Population Employed in RR Sector	0.075	0.074	0.428
	(0.811)	(0.838)	(1.649)
Share of Population Between Ages 5-18		0.111	0.961
		(0.672)	(1.122)
Share of Total Agricultural Production in Dairy Products		0.344	2.924***
		(0.390)	(0.956)
Share of Total Agricultural Production in Poultry and Eggs		-0.020	-0.019
		(0.584)	(1.872)
State-Aid Received/Mile of Road			0.042
			(0.074)
Number of Counties	602	599	105
R^2	0.854	0.855	0.798

Notes: Dependent variable is ln(Road Expenditures/Square Mile). Robust standard errors are reported in parentheses. All regressions include state and year fixed effects. *denotes statistical significance at the 90 percent confidence level; ** at 95 percent, and *** at 99 percent.

TABLE 2.13
DETERMINANTS OF PUBLIC DEMAND FOR ROADS IN ALL REGIONS (IV)

Variable	(1)	(2)	(3)
Farmland Value per Farm	0.353***	0.359***	0.514***
	(0.065)	(0.070)	(0.165)
Population	0.863***	0.782***	0.311
	(0.167)	(0.181)	(0.238)
Population per Square Mile	0.280***	0.249***	0.226***
	(0.034)	(0.036)	(0.067)
Tax Share	-0.934***	-0.863***	-0.426*
	(0.166)	(0.180)	(0.237)
Share of Population in Rural Areas	0.042	0.082	0.019
	(0.107)	(0.108)	(0.184)
Share of Farms Operated by Tenants	-0.015	0.123	-1.492***
	(0.265)	(0.252)	(0.531)
Share of Farms Under 10 Acres	0.459	0.478	-1.154
	(0.403)	(0.407)	(0.788)
Share of Population Employed as Farmers	-1.805***	-1.750***	-2.850***
	(0.339)	(0.343)	(0.637)
Share of Population Employed in RR Sector	-0.225	-0.083	-1.541
	(0.758)	(0.756)	(1.977)
Share of Population Between Ages 5-18		-0.129	-0.434
		(0.407)	(0.637)
Share of Total Agricultural Production in Dairy Products		1.419***	0.186
		(0.334)	(0.559)
Share of Total Agricultural Production in Poultry and Eggs		0.191	1.296
		(0.368)	(0.950)
State-Aid Received/Mile of Road			0.071***
			(0.024)
Number of Counties	2921	2914	659
First State F-Stat	79.39	75.31	26.08
DWH Test State [p-value]	0.705	0.266	0.167
R^2	0.548	0.553	0.575

Notes: Dependent variable is ln(Road Expenditures/Mile of Road). Robust standard errors are reported in parentheses. All regressions include state and year fixed effects. *denotes statistical significance at the 90 percent confidence level; ** at 95 percent, and *** at 99 percent.

TABLE 2.13 (CONTINUED)
DETERMINANTS OF PUBLIC DEMAND FOR ROADS IN ALL REGIONS (IV)

Variable	(4)	(5)	(6)
Assessed Valuation per Capita	0.615***	0.644***	1.054***
	(0.087)	(0.093)	(0.188)
Population	0.465**	0.457**	0.286
	(0.183)	(0.191)	(0.258)
Population per Square Mile	0.363***	0.343***	0.290***
	(0.034)	(0.035)	(0.062)
Tax Share	-0.577***	-0.577***	0.086
	(0.181)	(0.189)	(0.253)
Share of Population in Rural Areas	0.164	0.185*	0.250
	(0.108)	(0.108)	(0.186)
Share of Farms Operated by Tenants	0.177	0.256	-1.597***
	(0.219)	(0.218)	(0.434)
Share of Farms Under 10 Acres	-0.328	-0.313	-1.348*
	(0.405)	(0.402)	(0.783)
Share of Population Employed as Farmers	-1.497***	-1.451***	-1.200***
	(0.328)	(0.331)	(0.630)
Share of Population Employed in RR Sector	-0.624	-0.516	-0.915
	(0.756)	(0.757)	(1.983)
Share of Population Between Ages 5-18		0.266	0.458
		(0.412)	(0.663)
Share of Total Agricultural Production in Dairy Products		0.946***	-0.170
		(0.312)	(0.521)
Share of Total Agricultural Production in Poultry and Eggs		0.206	0.685
		(0.347)	(0.873)
State-Aid Received/Mile of Road			0.068***
			(0.024)
Number of Counties	2921	2914	659
First State F-Stat	81.06	75.70	26.69
DWH Test State [p-value]	0.160	0.121	0.153
R^2	0.555	0.558	0.570

Notes: Dependent variable is ln(Road Expenditures/Mile of Road). Robust standard errors are reported in parentheses. All regressions include state and year fixed effects. *denotes statistical significance at the 90 percent confidence level; ** at 95 percent, and *** at 99 percent.

TABLE 2.14
DETERMINANTS OF PUBLIC DEMAND FOR ROADS IN ALL REGIONS (IV)

Variable	(1)	(2)	(3)
Farmland Value per Farm	0.565***	0.606***	0.796***
	(0.060)	(0.065)	(0.155)
Population	0.821***	0.797***	0.319
	(0.154)	(0.168)	(0.223)
Population per Square Mile	0.854***	0.806***	0.744***
	(0.031)	(0.034)	(0.063)
Tax Share	-0.757***	-0.740***	-0.224
	(0.154)	(0.167)	(0.222)
Share of Population in Rural Areas	0.506***	0.499***	0.226
	(0.099)	(0.100)	(0.172)
Share of Farms Operated by Tenants	0.059	0.218	-1.061**
	(0.244)	(0.233)	(0.497)
Share of Farms Under 10 Acres	-1.219***	-1.038***	-1.562**
	(0.373)	(0.377)	(0.738)
Share of Population Employed as Farmers	-0.183	-0.270	-1.415**
	(0.313)	(0.318)	(0.597)
Share of Population Employed in RR Sector	-0.342	-0.384	-1.370
	(0.701)	(0.701)	(1.852)
Share of Population Between Ages 5-18		-0.048	-0.054
		(0.377)	(0.597)
Share of Total Agricultural Production in Dairy Products		1.058***	0.934*
		(0.310)	(0.524)
Share of Total Agricultural Production in Poultry and Eggs		1.120***	2.789***
		(0.342)	(0.890)
State-Aid Received/Mile of Road			0.002
			(0.023)
Number of Counties	2922	2915	659
First State F-Stat	217.23	205.12	91.81
DWH Test State [p-value]	0.044	0.100	0.067
R^2	0.766	0.769	0.823

Notes: Dependent variable is ln(Road Expenditures/Square Mile). Robust standard errors are reported in parentheses. All regressions include state and year fixed effects. *denotes statistical significance at the 90 percent confidence level; ** at 95 percent, and *** at 99 percent.

TABLE 2.14 (CONTINUED)
DETERMINANTS OF PUBLIC DEMAND FOR ROADS IN ALL REGIONS (IV)

Variable	(4)	(5)	(6)
Assessed Valuation per Capita	0.758***	0.798***	1.048***
	(0.081)	(0.087)	(0.173)
Population	0.414**	0.471***	0.234
	(0.171)	(0.179)	(0.238)
Population per Square Mile	0.968***	0.950***	0.855***
	(0.032)	(0.032)	(0.057)
Tax Share	-0.414**	-0.476***	0.288
	(0.169)	(0.177)	(0.233)
Share of Population in Rural Areas	0.659***	0.640***	0.487***
	(0.100)	(0.101)	(0.171)
Share of Farms Operated by Tenants	0.668***	0.750***	-0.501
	(0.204)	(0.203)	(0.400)
Share of Farms Under 10 Acres	-2.277***	-2.184***	-1.917***
	(0.378)	(0.377)	(0.722)
Share of Population Employed as Farmers	0.344	0.288	-0.352
	(0.306)	(0.310)	(0.581)
Share of Population Employed in RR Sector	-0.691	-0.767	-0.880
	(0.706)	(0.709)	(1.828)
Share of Population Between Ages 5-18		0.339	0.729
		(0.386)	(0.611)
Share of Total Agricultural Production in Dairy Products		0.198	0.214
		(0.292)	(0.480)
Share of Total Agricultural Production in Poultry and Eggs		0.727**	1.504*
		(0.325)	(0.805)
State-Aid Received/Mile of Road			-0.004
			(0.022)
Number of Counties	2921	2915	659
First State F-Stat	217.10	203.35	94.96
DWH Test State [p-value]	0.024	0.017	0.074
R^2	0.766	0.767	0.828

Notes: Dependent variable is ln(Road Expenditures/Square Mile). Robust standard errors are reported in parentheses. All regressions include state and year fixed effects. *denotes statistical significance at the 90 percent confidence level; ** at 95 percent, and *** at 99 percent.

CHAPTER 3

Paving the Way to Educational Success: Road Improvement and School Outcomes, 1900-1920

1. Introduction

Rural school consolidation was the joining of two or more smaller schools (typically one room schoolhouses) into a centrally located multi-room school. Although the consolidation movement started as early as 1869 in Massachusetts, it was only after the turn of the 20th century that consolidated schools became increasingly widespread. For many communities in the United States one-room schoolhouses were the norm. In rural areas, especially in states in the Midwest, settlements were so widely dispersed and roads so poor that communities had to build small schools that were readily accessible to local children. These one-room schools were characterized by low attendance, short school terms and poorly paid and trained teachers.

Table 3.1 illustrates the prevalence of one-room schools by region. States in the North Central region had by far the highest number of one-room schoolhouses in the nation. For example, Illinois and Iowa each had over 10,000 one-room schoolhouses in 1920. As late as 1928, approximately 90 percent of the nation's school buildings were one-room schoolhouses.[74] The numbers underscore the importance that one-room schools and the subsequent consolidation movement would play in the education of rural children. The dawn of the new century also saw significant improvement in educational measures including increases in school attendance rates, school year length and in the average number of days attended per enrolled student. Figures 3.1 through 3.3 illustrate the growth in these educational variables in the first two decades of the 20th century.

From the figures, it is clear that the states in the North Central region were ahead of the rest of the nation in terms of educational outcomes. Goldin and Katz (2000)

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[74] Department of the Interior (1928), *Rural School Consolidation,* Table 1.

analyzed how the Midwestern states became leaders in the educational revolution in the United States. They hypothesized that the region was becoming increasingly wealthy due to rising land values. Since land wealth was relatively easy to tax, it proved to be a growing source for school revenues. Advances in farm technology and agricultural science also increased the need for an educated farming class to keep up with the latest advances in animal science, machinery, and fertilizers. In addition, Goldin and Katz argued that the Midwest became an educational leader partly due to a relative absence of Catholics, a high degree of social cohesion and a geographically mobile society.

Explaining the general rise of schooling in the United States has been an active area of research among economic historians. While much of the research has looked at the changes in the American educational system since 1930 (see Angrist and Kruger (1991)), several papers have focused on the changes in the American educational system in the late 19^{th} and early 20^{th} century. Margo and Finegan (1996) tried to explain the observed rise in the school attendance rate between 1900 and 1930. They contended that the passage and enforcement of compulsory schooling laws coupled with other progressive legislation, such as child labor laws, could have helped explain much of the rise in school attendance during the period. Goldin (2001) took a different angle in explaining the growth of the American educational system in the 20^{th} century. She attributed several demand side factors as possible explanatory factors. The emergence of big government and big business, a burgeoning retail sector and rapid advancements in science led to a rise in demand for professions which required at least a high school degree. These labor market changes in the early 20^{th} century resulted in higher returns to schooling thus increasing the relative demand for education.

Another historical fact of the American educational system was that in the late 19th century, city school systems had improved markedly while rural schools fell behind. It was not until the beginning of the 20th century that rural schools began to catch up with urban schools. This catch up effect is shown in Figures 3.1 to 3.3 for urban and rural schools in the Midwest. Rural schools were making great strides in educational performance while urban schools remained relatively stagnant during the years 1900 to 1918. As shown in Figure 3.1, attendance rates in rural schools in the North Central region had caught up to the rates found in urban schools by 1918. A large fraction of the rise of overall schooling must have come from the gains made in rural areas. Thus in order to explain the rise of education in the United States in the early 20th century, one must address the rise of rural education.

However, the current literature has not fully addressed the rise of rural education in the first two decades of the 20th century. This paper offers a possible explanation for the rise of rural education during this period by examining the effect that rural road improvement had on school consolidation and its effect on educational outcomes such as school attendance rates. The Good Roads Movement was a widespread social and political movement that started around the 1880s in response to the deteriorating condition of the nation's rural roads. The Good Roads Movement quickly was adopted by agrarian reformers as a solution to the mounting problems facing the farming community. An improved road network would not only make it easier for farmers to get their products to market, potentially raising land values, but it would also generate indirect social benefits such as improved schools. The fact that both the good roads movement and the school consolidation movement were contemporaneous strongly suggests a link between the two movements. If road improvement could explain the rise of school consolidation then it would be a significant factor in explaining the rise of educational outcomes in rural areas.

The focus of the paper will be on the effect of road improvement on school consolidation in states in the North Central region. The Midwest was chosen since the region had the largest number of one-room schoolhouses and was thus an area of particular focus for proponents of the school consolidation movement. This paper adds to the literature that has tried to measure the benefits that are associated with investment in public capital. Most studies have found that investment in road capital has a small positive effect on aggregate output. The evidence presented here provides strong evidence that investment in road capital had profound impacts on school outcomes. By quantifying the social externalities associated with road improvement in the early 20th century, this paper will show that the current estimates of the economic impact of roads have most likely been underestimated in the traditional cost-benefit studies of public capital.

2. School Consolidation in the United States

2.1 The Rise of School Consolidation in the United States

For much of the 19th century, rural families were largely satisfied with the quality of education their children received in their local schools. However, as the century progressed, vast differences arose between urban and rural school systems. Urban school districts had graded schools, specialized teachers and high schools while rural school districts were predominately one-room schools staffed with inexperienced teachers. As a result, by the turn of the century, there existed a dual system of public schooling in the nation. By any measure, town and city schools outperformed rural schools in the North Central region. In some cases the differences between rural and city schools were substantial. For example, in 1905, urban schools in the North Central region were on average kept in session for approximately 193 days. In contrast, rural schools in the region were in session for only 147 days.[75] Urban children were not only receiving more days of instruction but in many cases the quality of instruction was far superior to that received by rural schoolchildren. While rural schools could only offer basic coursework in reading, writing and arithmetic, urban schools could offer a broader curriculum, one that included natural and agricultural sciences, music, art and foreign languages. The larger school size also allowed urban schools to offer facilities such as school kitchens, libraries, indoor plumbing, centralized heating and playgrounds. According to one source, only one percent of one-room schools had running water or indoor toilets at the turn of the 20th century.[76] It was under this backdrop of a widening gap between urban and rural schools that the school consolidation movement gained momentum. Many educational reformers believed that school consolidation was the best way to democratize educational opportunities between urban and rural schoolchildren.

School consolidation was seen by many contemporaries as the cure-all solution to the problems facing rural education. Arp (1918) and Rapeer (1920) outlined many of the benefits associated with school consolidation. It was believed that larger rural schools would lead to greater efficiency, which in turn would provide a higher quality education at a lower cost. One source of this higher efficiency would be the improved quality of rural teachers. The inexperience of rural teachers was a subject of great concern among

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[75] U.S. Office of Education (1907), *Report of the Commissioner of Education. Vol. 1,* pp. 302-03.
[76] Ellsworth (1956), p. 120.

educational reformers.[77] A primary reason for the low quality of rural teachers was the low wages offered to teachers in rural areas. The average urban teacher had seven years of experience and earned $525 per year, while the average rural teacher earned $300 per year and only had two years of service. Five percent of rural teachers had not even finished the 8th grade.[78] Rural schools simply couldn't offer the wages being paid to teachers in the town and cities. As a direct result, those teachers with the highest amount of education or professional training were drawn to urban schools. Consolidation allowed for the realization of economies of scale. Larger schools would result in greater revenues which allowed for higher wages to be paid to rural teachers.

A second source of efficiency gains would be through grading and teacher specialization. Teachers in one-room schools had to provide daily instruction for multiple grades, which meant that each grade only received a fraction of the instructional day devoted to their coursework. Rural teachers were often overwhelmed by the amount of preparation necessary to instruct as many as eight grades simultaneously. The construction of larger schools with multiple rooms resulted in graded classrooms and the hiring of additional teachers. Teachers could focus on one or two grades and children would receive more instructional time devoted to their particular grade. Larger schools also allowed for the hiring of teachers in specialized subjects such as art, music and agricultural science, which meant that rural students were beginning to receive an education more comparable to that enjoyed by urban children. Finally, teachers in a

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[77] The Superintendent of Public Instruction of Wisconsin scathingly described rural teachers as "… in most cases young, immature, half-trained, ineffective, and lacking in professional ideals and ambitions. There are of two general classes-the callow apprentice class and the old stagers who have been too inefficient to get employment elsewhere." Wisconsin Department of Public Instruction (1901), *Ninth Biennial Report of the State Superintendent of the State of Wisconsin*, p.26.
[78] Arp (1918), p. 146.

consolidated school would be under the supervision of an on-site principal. The increased supervision would enhance the professional training of rural teachers, which was noticeably absent in the one-room school system.

Consolidation would also encourage increased attendance of rural schools by making schools more attractive to students and their parents. The improved curriculum would provide the agricultural training necessary to educate the next generation of farmers. In a period where there were rapid changes in agricultural knowledge, a good education was seen as an asset. The improved instruction in rural schools increased the likelihood that graduates of the common rural school would be able to attend high school, which would also lead to higher school attendance. Consolidated schools supplied amenities that could previously have only been offered in urban schools. Increased school attendance, higher teacher quality and improved curriculum were just some of the purported benefits of school consolidation. Given these benefits, to what extent could changes in school outcomes be directly attributed to the school consolidation movement?

2.2 Measuring the Benefits of School Consolidation

Several studies have attempted to quantify the benefits of school consolidation on educational outcomes. One of the first attempts was by Rogers (1915) who conducted a comparative study of Indiana school systems between 1912 and 1913. In his study, Rogers drew a random sample of 96 school districts throughout the state and gathered comprehensive statistics in each district. Consolidated school districts in the sample outperformed one-room school districts in school attendance, teacher quality and length of school year. Both enrollment rates and attendance rates were considerably higher in consolidated school districts than in the one-room school districts. Additionally, teachers in consolidated schools had more training and experience than one-room school teachers. Rogers concluded that consolidation did indeed have a significant positive impact on rural education.

MacKinnon and Minns (2009) used school level data in British Columbia between the years 1900 and 1930 and found that changes in grading and school consolidation could account for approximately 25 percent of the observed change in the provincial school attendance rate. They also estimated that the school attendance rate was 8 percent higher in graded schools than in ungraded schools. The study provided strong evidence of a positive link between consolidation and rural school improvement. A study by Go (2009) examined the effect of school district consolidation on the city school systems in the late 19th century United States. Using a sample of 224 cities, he concluded that consolidation had a large positive effect on the school attendance rate in urban school systems.

While most studies have found a positive relationship between consolidation and student outcomes, other studies have provided a contrarian view on the benefits of school consolidation. One example is Berry and West (2010) whose paper examined school district consolidation between the years 1930 and 1970. They found that children who attended smaller schools obtained higher returns to education and completed more years of schooling than those who attended consolidated school districts. The results from the Berry and West study illustrate the fact that school consolidation in the United States is still a dynamic area of research for scholars.

2.3 School Consolidation and Good Roads

The link between improved infrastructure such as good roads and school consolidation was stressed by contemporary observers. Many educational reformers believed that the main obstacle against making improvements to the rural educational system was the poor state of the roads. Frequently, bad weather made the roads in the countryside impassable, which led to early school closures. Dewey (1919) discussed how some rural schools instituted a divided term in order to avoid the bad roads common during the winter months. Under the divided term system, schools would start in the fall and operate until the onset of winter at which time the school would close. The school would not reopen until the spring when the roads were in better condition.

In the early 20th century, road improvement was viewed as a necessary precondition before school consolidation could be undertaken. Since consolidation required the closing of local schools in favor of a centrally located graded school, children had to travel further distances to attend school. Good roads would minimize the time children would have to spend traveling to school and would make consolidation a more attractive alternative. Coupled with laws in several states mandating the free transport of students living beyond a certain distance from school, the presence of good roads would have been a critical step in overcoming the transportation problem associated with school consolidation.

Advocates of good roads often linked their movement with the school consolidation movement.[79] State and federal school officials also stressed the important role that improved roads played in providing rural school consolidation. In his annual report of 1897, the U.S. Commissioner of Education wrote that, "Reference is made to

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[79] One good roads supporter stated that "School consolidation is dependent on the state of the highway. The transportation of pupils over long routes is impossible where their condition is very bad…. School consolidation is one of the very greatest agencies of the all-round improvement of rural society. This alone creates a mighty demand for good highways." Farwell (1913), p. 125.

the improvement of roads. Those who have been promoting this movement have not probably regarded it as a measure of educational reform; but such it is. Perhaps there is no rural interest of a social nature that would be more decidedly enhanced by good roads than the educational interest."[80] Both good roads advocates and educational reformers believed there was a connection between good roads and school consolidation. But is there supporting evidence to show that roads provided a positive social externality in the form of improved educational outcomes?

Table 3.2 lists the leading states in school consolidation for the year 1920 as measured by the percentage of total schools consolidated along with the state's ranking in terms of percentage of total roads improved. As can be seen from the table, six of the leading states in school consolidation were also among the top ten states in the percentage of improved roads in 1921. On the surface, this lends some credence to a positive correlation between improved roads and school consolidation. However, the lack of good roads did not necessarily translate into an absence of school consolidation. States such as New Mexico, Texas and Arizona were able to consolidate their schools despite being in the bottom half of states in terms of road improvement. For the states in the Southwest, the arid climate might have lessened the necessity of having good roads in place before attempting school consolidation.[81]

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[80] United States Office of Education (1897), *Report of the Commissioner of Education,* p. 842.

[81] According to the Department of the Interior, Louisiana actually had the largest percentage of schools consolidated in 1920 at 30.6 percent. The high number of consolidated schools is suspect since in the following year the state was reported to have 400 fewer consolidated schools. While the exact number of consolidated schools in Louisiana is unknown, the state was one of the leading states in the consolidation movement. The state superintendent of public instruction in Louisiana offered an interesting explanation for the rise of consolidation in the state. He credited school consolidation on a hurricane that hit the state in 1902. The hurricane destroyed a one room schoolhouse. As a result, displaced schoolchildren had to be transported to an adjoining school in the area. Students and parents soon observed the benefits of the consolidation and decided not to rebuild the old one-room school house. Neighboring communities heard of the accidental experiment and its unintended results and quickly petitioned their parish school boards to

Additional support for the relationship between rural road improvement and improvements in educational outcomes could be found in economic surveys conducted by the Department of Agriculture in 1916. In an attempt to quantify the benefits of good roads, the Department of Agriculture conducted detailed surveys in eight counties across the country to measure the economic and social conditions before and after road improvement. In four counties, the effect of road improvement on school attendance rate was specifically examined. The findings of the surveys are summarized in Table 3.3. The surveys attributed the observed jump in school attendance on the consolidation of small schools in those counties.

Contemporary observations and historical data thus offer suggestive evidence that there was a correlation between rural school consolidation and improvements in rural educational outcomes. At the same time, there is also some evidence that road improvement played a key role in explaining part of the growth in the school consolidation movement in the early decades of the 20th century. It is certainly plausible that road improvement could have positively affected improvements in education through school consolidation.

It should be mentioned that the view that road improvement was a necessary precondition to bring about school consolidation was not universally shared among contemporary observers. Some thought that school consolidation created demand for roads by the fact that children had to be transported to centralized schools. There is thus some question as to the direction of the causal relationship between roads and

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create centrally located graded schools. Department of the Interior, Bureau of Education (1924), *Rural School Leaflet No.19*, pp. 1-4.

consolidation. Section 6 will directly address this question of causality and the associated endogeneity problem.

3. Data

3.1 Education Data

To examine the relationship between school consolidation and improved roads, I collected county level educational and road data as well as data on population and agricultural control variables. The educational data were found in annual (or biennial) reports published by state education departments. State school officials were required by law to submit to the state legislature a regular report on the condition of the state school system. These reports addressed the history of the state's schools, their current condition and future outlook. While the quantity of information varied significantly across states, in general each state reported data on student enrollment, the number of schoolhouses, the number of teachers, school revenues and school expenditures. The state reports themselves were compilations of reports submitted by county school superintendents.

Actual data on school consolidation itself was limited. Some states, such as Indiana and Ohio, provided comprehensive information on school consolidation including the costs of consolidation, the cost of transporting students to consolidated schools and the number of schoolhouses abandoned due to consolidation. However, most states reported only the number of consolidated schools in each county while several states had no data on the number of schools consolidated. Given the lack of consolidation data for some states, the percentage of students enrolled in one-room schools is also used as an alternative measure of school consolidation.

3.2 Road Data

The main explanatory variable of interest in this study is the percentage of total roads that were improved in each county. Improved roads were defined as roads that had been properly drained and graded and had also been surfaced with some material or a combination of materials resulting in a smooth, firm surface. Common types of road surfaces at the time were macadam, bituminous macadam, gravel, sand-clay mixture, shell and oiled-earth roads.[82] Asphalt, concrete and brick roads were relatively expensive and not common prior to 1920. The road data was collected from publications from the Office of Public Roads. In 1904, the Office of Public Roads began the first ever survey of the road conditions of the United States. The surveys collected county level data on the mileage of improved and unimproved roads in unincorporated areas within the continental United States. The office conducted these surveys for the years 1904, 1909, 1914 and 1921.[83] This is one of the first studies to make use of this county level road data. As with the educational data, the road data relied on information obtained from county officials. For the road surveys, the Office of Public Roads would send out questionnaires to local road officials. Additional information was also gathered from local and state road associations, postal employees, automobile clubs and private individuals. In cases where the accuracy of the reported mileage was questionable, the survey was sent back for correction.[84]

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[82] Macadam roads generally consisted of a road composed of compacted layers of small stones. Bituminous macadam roads were roads where the foundation was macadam with a mixture of crushed rocks and ground glass applied on top.

[83] The Office of Public Roads officially only published the first three road surveys. The 1921 road survey was completed but never published by the Office. Visits to the National Archives in College Park, MD yielded partial data from the 1921 survey. In the end, county level improved road mileage data was found for 26 states from the 1921 survey.

[84] One issue noted with the data is that several counties actually reported significant declines in the mileage of roads improved between surveys which call into question the accuracy of some of the data provided by local officials. In one example, the total miles of improved roads in Lake County, Michigan was reported as 117 miles in 1904 but in a subsequent survey conducted in 1909 the county reported only 9 miles of improved roads. The Office of Public Roads also noted some of these discrepancies in reported improved roads between surveys. The general explanation given by the Office was that rising urbanization resulted in the decline in the reported mileage of improved roads in some counties. Since the surveys were limited

3.3 Other Data

Population measurements come from the 1900, 1910 and 1920 population censuses. One of the population control variables is the percentage of the county population born in northern European countries. Immigrants from the Scandinavian countries and Germany flocked to the states in the North Central region during this period. For this measure, I added the number of persons who were born in Denmark, Finland, Germany, Holland, Norway and Sweden in each county and divided by the total county population. Immigrants from these countries accounted for as much as a third of the total population in several counties.[85] Another population control variable is the enumeration of Roman Catholics in each county. This information was gathered from the *Censuses of Religious Bodies* of 1906 and 1916.

Agricultural data collected include the share of farms operated by tenants, the percentage of farms less than ten acres and the average value per acre of farmland. The agricultural variables were obtained from the *Censuses of Agricultur*e of 1900, 1910 and 1920. These various data series were merged, resulting in a panel data set of 1054 counties for the years 1906 and 1916. The years were chosen to correspond closely to the availability of county-level road surveys which were conducted in five year spans.

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to the reporting of mileage in unincorporated areas of each county, an increase in urbanization would indeed result in a decline in the reported number of improved roads in some counties. This might explain the decline of improved roads in Marion County, Indiana (where Indianapolis is located) from 800 miles in 1904 to 525 miles in 1909. However, it is unlikely to explain Lake County, Michigan which had no town larger than 1,000 people. In the North Central region, there were 31 counties that reported at least 100 miles of improved roads in 1904 and which reported a decline of at least 50 percent of its improved roads by 1909. This decline could be due to urbanization, road deterioration or measurement error as described above. This could potentially lead to measurement error problems in the following estimation strategy.

[85] In some states with small numbers of a particular nationality (usually Finns), the U.S. census did not report the foreign born by county but only reported the state total. However, the populations were usually of such small numbers that they should not have had affected the results.

4. Empirical Strategy

To study the possible effect of road improvement on school consolidation, I estimate the following ordinary least squares (OLS) regression model.

$$CONSOL_{it} = \alpha_{it} + \beta_1 ROADS_{it} + \beta_2 CATHOLIC_{it} + \beta_3 NOREURO_{it} + \beta_4 RURAL_{it} + \beta_5 RURDEN_{it} + \beta_6 POPCHG_{it} + \beta_7 TENANTS_{it} + \beta_8 SMALLFARM_{it} + \beta_9 LANDVAL_{it} + \varepsilon_1 \quad (1)$$

The left hand side variable, $CONSOL_{it}$, is a measure that captures school consolidation. The direct measure of school consolidation used is the percentage of total schools that were consolidated between 1906 and 1916 in each county. However, as mentioned in the previous section, the total number of consolidated schools was not reported for each state in the region.[86] As a result, I also use an alternative measure of school consolidation by looking at the percentage of total students enrolled in one-room (or ungraded) schools. Since school consolidation would result in the abandonment of one-room schools, we should expect to see a decline in the percentage of children enrolled in such schools in areas that were consolidating.

In order to quantify the total effect of roads on school outcomes a set of reduced form equations are also estimated. It is assumed that school outcomes were determined by changes in school consolidation.

$$OUTCOME_{it} = \gamma_{it} + \lambda_1 CONSOL_{it} + \varepsilon_2 \quad (2)$$

$OUTCOME_{it}$ represent a set of school outcomes that includes attendance rates, the average number of days of attendance per enrolled pupil, school expenditures and teacher wages. The variable $CONSOL_{it}$ can be substituted from Equation (1) into Equation (2) to

[86] No school consolidation data was reported by the State Superintendent of Schools in Illinois, Michigan and Wisconsin for both 1906 and 1916. No school consolidation data was available for Minnesota, Nebraska, North Dakota and South Dakota for 1906. Some of these states reported the number of "graded" schools which would have include consolidated schools in addition to other school types.

get:

$$\text{OUTCOME}_{it} = \gamma_{it} + \lambda_1[\alpha_{it} + \beta_1\text{ROADS}_{it} + \beta_2\text{CATHOLIC}_{it} + \beta_3\text{NOREURO}_{it} + \beta_4\text{RURAL}_{it} \quad (3)$$

$$+ \beta_5\text{RURDEN}_{it} + \beta_6\text{POPCHG}_{it} + \beta_7\text{TENANTS}_{it} + \beta_8\text{SMALLFARM}_{it} + \beta_9\text{LANDVAL}_{it} + \varepsilon_1] + \varepsilon_2$$

The above equation can then be simplified to a reduced form equation which can be easily estimated using OLS.

$$\text{OUTCOME}_{it} = \pi_0 + \pi_1\text{ROADS}_{it} + \pi_2\text{CATHOLIC}_{it} + \pi_3\text{NOREURO}_{it} + \pi_4\text{RURAL}_{it} \quad (4)$$

$$+ \pi_5\text{RURDEN}_{it} + \pi_6\text{POPCHG}_{it} + \pi_7\text{TENANTS}_{it} + \pi_8\text{SMALLFARM}_{it} + \pi_9\text{LANDVAL}_{it} + \varepsilon_i$$

The reduced form coefficients (π) in Equation (4) will give the total effect of improved roads on additional educational measures beyond school consolidation. The variable of interest will be $ROADS_{it}$ which measures the percentage of total roads in each county that was improved.[87] As discussed in Section 2.3, the roads variable should be positively related to the level of school consolidation.

The model also includes a set of control variables which could also have possibly influenced school consolidation in the early 20th century. A pair of control variables looks at the effect that the religious and ethnic composition of the population had on school consolidation. $CATHOLIC_{it}$ measures the percentage of the county population that was Roman Catholic while $NOREURO_{it}$ is the percentage of the county population that was born in northern European countries.

The $CATHOLIC_{it}$ variable is expected to be negative as many Catholics believed that the school consolidation movement was an attempt by Protestants to get Catholics to

[87] As an alternative I also used the mileage of improved roads per square mile and also total road expenditures per mile for *ROADS.* The results from using these alternative measures for roads do not differ significantly from using the percentage of total roads improved. The coefficients on both measures of *ROADS* have the same sign and level of significance in all specifications.

send their children to local public schools.[88] Additionally, those Catholics, with children already enrolled in parochial schools, would be unlikely to support increases in property taxes to fund public school consolidation.[89] A priori it was unclear what effect the $NOREURO_{it}$ variable would have on the model. Rural one-room school districts were geographically small enough that a handful of neighboring farms could have had its own school. If these neighboring farms were culturally homogeneous, the local schools would have been a way ethnic communities could have passed their language and culture onto their children.[90] As a result, it might be expected that recent immigrants would oppose school consolidation as a way to preserve their cultural identity. On the other hand, immigrants from northern Europe came from countries which traditionally valued education and may have carried these strong preferences for high quality education from their countries of origin. Immigrants from northern European countries might have valued the accumulation of human capital to a higher extent than their native born neighbors and thus the presence of immigrant communities might have had a positive effect on the demand for consolidated schools.

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[88] The rural school consolidation movement in the Midwest was actively supported by Protestant leaders in the Midwest. It was the Protestant leadership of the consolidation issue that led to deep suspicion on the part of Catholics in the region. According to Reynolds (1999) anti-Catholicism and nativism ran deep among some Protestants in the Midwest. In the early 1890s, Protestants in Wisconsin and Illinois passed anti-parochial school legislation. Some Catholics viewed consolidation as yet another attempt to undermine parochial education. Reynolds (1999), p.45.

[89] A writer to Dubuque's *Catholic Tribute Weekly* summed up this argument when he wrote, "Why should we be burdened with still more taxes? We, as Catholics, know that our children belong in a Catholic school…. Why should we vote for consolidated schools when we know it is more or less for the benefits of others." Reynolds (1999), p. 168.

[90] However, it appeared that this sentiment was not universally shared among recent immigrants. Some immigrants, while valuing the importance of their native tongue, felt that instruction in their native language should not be a primary objective of the public schools. In congressional testimony before the Immigration Commission, Mr. Kustermann, a recently arrived German immigrant to Pennsylvania, told the committee that, "…the first and foremost duty a German owed to this country in coming here was to learn and to speak and to read the language." He went on to say that although he wanted his children to learn English in the public schools he encouraged them to read German papers at home so as to continue their German education. Source: United States Congress (1911), *United States Congressional Edition, Vol. 5881,* p.203.

Another set of control variables measures the composition of the rural population. These variables include $RURAL_{it,}$ which represents the percentage of a county's population residing in rural areas, $RURDEN_{it}$ which measures the number of rural persons per square mile in each county, and $POPCHG_{it}$ which is the percentage change in rural population between the decadal censuses. Since school consolidation was promoted as a reform to improve the quality of country life it is expected that consolidation would most likely have occurred in counties with a high percentage of the population living in rural areas ($RURAL_{it,}$). Likewise, the quality of life argument for consolidation would imply that counties which were experiencing slow or negative rural population growth ($POPCHG_{it}$) would be more likely to embrace school consolidation as a means to stem the outflow of population to urban counties. Lastly, densely populated counties ($RURDEN_{it}$) would most likely have found it easier to consolidate their schools compared to less densely populated areas. Transport costs would have been lower thus decreasing the cost of consolidation. It should be expected that there was a positive relationship between consolidation and population density.

The final set of control variables measures the effect that changes in the agricultural sector might have had on school consolidation. These changes were particularly evident in the states in the North Central region. The period from 1893 to 1919 saw rising agricultural prices, growing incomes for farmers, higher land values, rising agricultural productivity and increased commercialization and mechanization of the farms. Two resulting consequences of these changes were the rise of tenant farming and the increase in average farm size. The $TENANTS_{it}$ variable measures the share of farms in each county that was operated by a tenant farmer while $SMALLFARM_{it}$ is the percentage of farms that were less than 10 acres. An additional variable which would have affected school consolidation is the value of farmland per acre which is captured by the $LANDVAL_{it}$ variable.

The rise of farm tenancy during this period was due to a shift away from household farming towards commercial farming resulting in an increase in capital requirements.[91] Tenant farmers were younger, poorer and more likely to be recent immigrants compared to those who operated their own farms. Unlike some farm owners who could afford to send their children to private or city schools, tenant farmers had little choice but to send their children to the local rural schools. Additionally, a tenant farmer had on average more children living on the farm than a farmer who owned his own farm.[92] As a result, it was expected that higher tenancy rates would lead to a greater percentage in the number of schools consolidated.

It is not immediately clear the direction of the relationship between farm size and school consolidation. Since small farmers operated only a few acres of land they had to pay relatively little in property taxes as opposed to big land owners. For this reason, we might speculate that small landowners would support school consolidation. On the other hand, rural educational reformers pointed out that areas with large average sized farms would be prime candidates for school consolidation. The argument was that as farm size increased in a county, the number of farm families residing in rural areas would decline. One of the consequences would be a fall in local one-room school enrollment. Rural reformers argued that such schools would become increasingly inefficient and should be

[91] Atack and Passell (1994) in summarizing the literature on Northern agriculture concluded that rising capital costs coupled with rising land values led to barriers to entry in farming which forced many farmers to become tenants.
[92] Merritt and Hatch (1916), p. 28.

consolidated.[93] Thus, it may be possible that in counties with large average farm size, school consolidation would be more likely to occur.

School revenues in the North Central region were determined primarily by the property tax rates assessed per acre of land. Higher land values ($LANDVAL_{it}$) would have resulted in higher school revenues. Given that consolidated schools were more expensive than rural one-room schools, at least in the short-run, it is expected that communities that saw the greatest gains in land values would have been able to afford consolidation.[94]

5. OLS Results

Table 3.4 reports the estimated coefficients of the model with different measures of school consolidation as the dependent variable. Column 1 in Table 3.4 utilizes the direct measure of the percentage of total schoolhouses consolidated as the dependent variable. Column 2 utilizes a broader measure of the percentage of total schoolhouses that were graded. While the dependent variable in Column 3 is the percentage of total students enrolled in one-room schoolhouses. State and year fixed effects are included in all the specifications of the OLS regression. I find that the coefficient of roads has the expected sign and is statistically significant in all specifications used. The estimate of the road coefficient in Column 1 of Table 3.4 suggests that a 10 percent increase in the percentage of improved roads would increase the percentage of consolidated schools by 0.57 percentage points. To put this in perspective, the average percentage of total schools

[93] A study of economic factors that affected rural education in Wisconsin pointed out the negative relationship between average farm size and average family size. The study's conclusions are based of a detailed analysis of Iowa County, Wisconsin. Merritt and Hatch (1916), *Some Economic Factors Which Influence Rural Education in Wisconsin,* p. 3-28.

[94] Arp (1918) estimated that the cost of operating 9 one-room school houses annually would amount to $8100 in total while the cost of operating a consolidated school to replace the schoolhouses would cost $13,790. He estimates that the difference is due to the bond interest payments for the new schoolhouse and the increased expenditure in the transport of students. In general, consolidated schools would have higher short-term costs over one-room schools due to the construction of a new school house, the hiring of additional teachers, and transport costs.

consolidated in the sample of counties was only 2.82 percent in 1916.[95]

The results suggest that improved roads were positively correlated with school consolidation. But how much of the observed increase in school consolidation in the early 20th century can be directly attributed to the good roads movement? Using a simple back of the envelope calculation, a rough estimate of the importance of roads to school consolidation is calculated. Between 1906 and 1916 the percentage of schools that were consolidated increased from 1.29 percent to 2.82 percent in the North Central region. During the same period, the percentage of improved roads in the region increased from 8.83 percent to 11.61 percent. By multiplying the change in road improvement by the OLS estimate found in Column 1, it is estimated that approximately 11 percent of the observed change in school consolidation was due to improvements in the road network.

One drawback of using the percentage of schoolhouses consolidated measure is that it gives a misleading picture of the true scope of the consolidation movement. Although a tiny fraction of schools were consolidated during this period, approximately 12 percent of rural schoolchildren were enrolled in such graded schools. As a result, as an additional check on the impact of roads on school consolidation, I also use the total percentage of students enrolled in one-room (or ungraded) schools as a proxy measurement for school consolidation. The results for that dependent variable are presented in Column 3 in Table 3.4.

The coefficient on the Catholic variable in column 1 is negative as expected, but the result is not statistically significant. The results from Table 3.4 also do not bring a clear picture regarding the impact that recent immigrants from northern European

[95] The weighted sample average was calculated by including only those states which reported consolidation data. The standard deviation was 5.56.

countries had on school consolidation. The coefficient is negative but not statistically significant when the percentage of schools consolidated is used as the dependent variable. But, when the percentage of schools that are graded is on the left hand side, the estimated coefficient on the European immigrant variable is positive and statistically significant.

Given that consolidation was a movement to improve the quality of country life, it is not surprising to find that the rural population coefficient is positive and statistically significant in column 1. One unexpected result was that the coefficient on the number of rural population per square mile is negative and strongly significant. This suggests that densely populated rural areas had less consolidation than sparsely populated counties. A possible explanation is that densely populated areas needed fewer schools to serve its population. These schools might have been larger than the one-room schools that typically served rural communities. Given the presence of larger schools there would have been less need for consolidation in densely populated counties. There appears to be little evidence to support the view that the school consolidation movement was a response to the outflow of population from rural areas. In none of the specifications in Table 3.4 is the coefficient on the rural population change variable statistically significant.

The results from Table 3.4 show that counties with a higher percentage of tenant farmers were more likely to consolidate their schools, although this result is not statistically significant in column 1. A possible explanation for the positive coefficient is the fact that in many states tenant farmers were allowed to vote in local school elections even though they did not own property.[96] In addition, many landowners had moved to

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[96] In the past, tenant farmers were prohibited in voting in local elections. These restrictions were gradually lifted by the early 20th century.

towns and cities and were no longer residing in farming communities. As a result, the primary beneficiaries of rural school consolidation would have been the children of tenant farmers. Tenant farmers may have believed that they would not have had to bear the full burden of the cost of school consolidation. In the public choice literature, this is known as "renter illusion."[97] If renter illusion existed then tenants would be more likely to support consolidation than if they had owned their own farms.

The coefficient on land value is positive and strongly significant in column 1, but is not statistically significant in the other specifications. Lastly, the OLS results in Table 3.4 do tend to support the notion that counties with smaller sized farms were more likely to consolidate their schools as the coefficients on the farm size variable are positive and significant in column 2. Since school consolidation would result in the closure of one-room schools, the signs on the road coefficient in column 3 should have been negative. As shown in column 3, the coefficients on the control variables do have the expected opposite signs from columns 1 and 2.

Overall, there appears to be a relationship between the improvement of roads and the consolidation of rural schools. The estimated coefficient of the improved roads variable had the correct sign and was strongly significant when looking at its effect on the percentage of schools consolidated. However, it is possible that the estimated model may fail to identify the true effect of road improvement on school consolidation (and other measures of school outcomes) due to problems with endogeneity. This issue will be directly addressed in the next section.

6. Endogeneity

In the model mentioned in Section 4 it was assumed that road improvement would

[97] For a discussion of renter illusion see Oates (2005).

lead to an increase in rural school consolidation. However, it is possible that the causal relationship between roads and school consolidation could have worked in reverse. Localities might have established consolidated schools and then built the necessary road infrastructure to bring the students to those schools. A minority of contemporary observers questioned the premise that good roads were necessary in order to build consolidated schools. J.D. Eggleston, the state superintendent of public instruction in Virginia, wrote that "…experience and observation have shown that good schools do not necessarily follow good roads. In fact in this state, with the exception of one county, the counties which have the best roads have schools which are below the average in quality and above the average in quantity. On the other hand, experience and observation have shown that good roads do follow good schools…. The consolidation of schools invariably brings to bear on the county road authorities great pressure for the improvement of roads leading to such schools."[98] Another problem that must be addressed is the possibility that a third factor affected both consolidation and road improvement. Such a factor could have been the spirit of progressivism that was sweeping the nation during this period which may have contributed to both the Good Roads Movement and the school consolidation movement. In order to deal with these potential endogeneity issues, which would result in biased OLS estimates, several instruments are proposed for rural road improvement to ensure the identification of the true effect of road improvement on rural school consolidation and school outcomes.

6.1 Rural Free Delivery (RFD) as an Instrument

One possible instrument for rural roads is the number of rural free delivery (R.F.D.) post offices that were established in each county in 1900. The statistics for each

[98] Bruere and Eggleston (1913), p. 186.

R.F.D. post office in operation as of June 30, 1900 is directly found in the *Annual Report of the Postmaster General* for 1900. As the name would suggest, R.F.D. was a program established by the Postal Service to deliver the mails to rural communities. R.F.D. routes were first proposed by Congress in 1892 with trial routes initiated in 1896. The service proved to be immediately popular with rural communities and service expanded exponentially. While there were 1,259 rural free delivery routes in 1900, by 1910 there were 41,079 routes in operation.[99] However, the assignment of R.F.D. routes was not distributed evenly. While some counties had dozens of R.F.D. routes and offices, other counties were unable to secure any R.F.D. services. It is this difference between counties in establishing post offices and R.F.D. routes that could play a large role in explaining the differences in rural road improvement across counties.

Initially, the Postal Service delegated the process of proposing R.F.D. routes to Congress. Congressmen would forward a request for a postal route within their district to the Postal Service. The evaluation of the proposed rural delivery routes would be made by political appointees within the department.[100] Not surprisingly, claims of political favoritism in the assignment of the postal routes were made. Southern Democrats argued that the Postal Service would routinely reject their requests for rural delivery routes in favor of assigning routes to the districts of Republican congressmen.[101] Kernell and McDonald (1999) directly examined the process by which R.F.D. routes were assigned.

[99] U.S. Post Office Department (1910), *Annual Report of the Postmaster General*, p. 342.
[100] From 1897 to 1913, the Republican Party controlled the executive branch. During this era of political patronage, many workers in the postal service were Republican.
[101] One South Carolina congressman argued in 1906, "The state of Kansas as rock-ribbed and everlasting in her republicanism as South Carolina in her democracy…. had in operation 1,555 routes, as against 532 from South Carolina---a difference of over a thousand routes in favor of Republican Kansas." Another congressman from Alabama defended his inability to secure a RFD route for his district by stating that he had "…been exceedingly active, but I did not happen to be a Republican." Kernell and McDonald (1999), p. 799.

Employing a maximum-likelihood estimation (MLE) procedure, they found strong evidence for partisan considerations in the assignment of rural delivery routes. The evidence showed that freshmen Republican Congressmen who were facing difficult campaigns in 1900 (those members who defeated a Democratic incumbent in the 1898 midterm election) were more likely to secure R.F.D. routes for their congressional district. On the other hand, vulnerable freshmen Democratic incumbents who defeated a Republican incumbent in 1898 were the least likely to secure postal routes for their district.[102] There appears to be strong evidence that political motives were a prime factor in deciding where to assign rural post offices and R.F.D. routes.

While there may be a link between political affiliation and R.F.D. routes, it must also be shown that there was a clear correlation between R.F.D. and roads. Many contemporary observers noted their belief that good roads and rural free delivery were indeed closely connected. In his 1900 report, the Postmaster General stated that, "The influence of rural free delivery in stimulating the work for good roads has been powerful in not a few instances in securing appropriations for the bettering of roads, the building of bridges, the repair of culverts, and the maintenance of way. Special agents are instructed not to lay out routes over roads which can only be traversed with difficulty."[103] First

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[102] Perhaps the most blatant example of the political pressures placed on the Postal Service comes from a 1902 letter written by Representative Charles Landis, a Republican representing Indiana's 9th Congressional District to the Superintendent of Rural Free Delivery. In the letter Landis wrote, "It will do me lots of good personally if it [a rural free delivery route] goes into operation not long before election. I want it humming along when I canvass the county. Do not, as you value your life, fail to get this service started Oct. 1st. It would cost me hundreds of votes, if it did not go in according to promise." Fuller (1964), p. 68. While it was unclear whether Landis persuasive abilities resulted in his rural free delivery route, he did manage to win re-election that year.

[103] U.S. Post Office Department (1900), *Annual Report of the Postmaster General*, p.119.

hand observations by field agents and postal workers also provide strong evidence of the perceived link between improved roads and rural free delivery.[104]

At the outset, the Postal Service stated that an important consideration in determining the placement of free delivery routes was the condition of the public roads. By 1899, the Postal Service declared that all awarded rural delivery routes must be accompanied by improvements in the local roads. Rejected petitions for R.F.D. routes were often denied on the grounds that the roads were unfit for R.F.D. vehicles. As a result, many rural communities believed that they had to improve their roads in order to secure the coveted R.F.D. route. Roads were inspected periodically and any locality that was found to have a deficient road would be admonished to make immediate improvements on the roads. Failure to undertake such improvements could lead to the discontinuation of the postal route. As a result of this threat several states passed good roads legislation in order to protect their R.F.D. routes.[105] Thus, there is suggestive evidence that the number of rural free delivery routes present in a county in 1900 would be positively correlated with the percentage of roads improved in later years. However, we would not expect that the number of R.F.D. routes should be correlated in any way with the number of consolidated schools which would make it a viable instrumental variable for roads.

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[104] One agent assigned to the Western Division in Iowa wrote, “The evidence of appreciation in those communities in which service is in operation are many. The tendency for better roads is universal. It is impossible for me to name the number of individual pledges to put the roads in better condition and clear the snowdrifts in the winter. Road officers and county supervisors by the score have voluntarily pledged themselves to expend the road revenue for the improvement of rural free delivery route.” U.S. Post Office Department (1900), *Annual Report of the Postmaster General*, pp. 119-120.

[105] For example, Indiana passed a law in 1907 which required that any road in which RFD service traveled upon must be properly maintained. Failure of county supervisors to maintain the roads would result in a fine of up to $25 for every day the road remained deficient. Fuller (1955), p. 74.

6.2 Geographical Variables as Instruments

A second set of instruments looks at cross-county variation in geography in order to predict the percentage of roads improved. Differences between counties in their mean elevation, mean land gradient and soil drainage type are used to predict the amount of improved roads in each county. It is not expected that geographical variables will affect school consolidation through any other variable other than through improved roads.

The land gradient (slope) should be an important factor in explaining road improvement. Road engineering manuals in the early 20th century emphasized the need to take into account gradients when deciding which roads to improve. Engineers were advised that roads should only be improved in cases where the current road had a gradient of less than 5 percent. Any attempt to improve steeper roads would result in roads with inordinately high maintenance costs. Due to the type of crushed stone that was commonly used to improve the roads, roads with steep gradients resulted in a greater risk of injury to horses. Additionally, improved roads with a higher gradient would be subject to higher maintenance cost due to the frequent braking of the wheels that would occur as vehicles descended the road.[106] As a consequence counties that had a high average gradient would be less likely to improve their roads.

Elevation might affect the improvement of roads as rainfall is usually greater in areas with higher elevation. One study conducted by the United States Geological Survey found that the increase in precipitation due to elevation was approximately 0.6 inches for each 100 feet rise in elevation.[107] Areas with greater amounts of precipitation would more likely experience muddy roads and would be most adversely affected by

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[106] League of American Wheelmen (1892), *Good Roads, Vol. 2*, p. 14.
[107] United States Geological Survey (1903), *Water Supply and Irrigation Paper No. 81*, p.355.

unimproved roads. However, it is possible that low lying areas may have also been affected by the rainfall that occurred at higher elevations. In counties with high mean land gradient, runoff from the higher elevations could have created areas of stagnant water below which would have led to poor road conditions.

Soil drainage also played an important role in determining the feasibility of road improvement. Differences in soil drainage meant that some localities would have poorly drained soil in which water was absorbed and held in the soil for long periods of time while other areas would have relatively dry soil in which the ground was porous and water drained quickly. Road improvement would be easiest in locations with dry soil as opposed to wet soil. An article in the *Good Roads* magazine published by the League of American Wheelmen mentioned that "…drainage of a roadway foundation is not only important, but in many cases absolutely necessary to the maintenance of a permanent structure; for if an undue amount of moisture be permitted to remain in the soil, it not only invites the sinking and disintegration of the macadam layers during the wet seasons, but it makes certain the introduction of frost during the Winter months and the consequent heaving and breaking of the stone superstructure."[108] Localities with poor soil would have to constantly repair or replace newly constructed roads within a few years. Thus, the higher maintenance costs associated with constructing or improving a road in locations with wet soil made it less likely that the roads would be improved in areas with that soil type. Soil drainage type was classified into seven categories ranging from "excessively drained" to "very poorly drained". The data identified the percentage of land in each county that was of a particular soil type. I will use both the set of geographical variables and the R.F.D. variable as instruments to control for any

[108] League of American Wheelmen (1893), Good Roads, Vol. 3, p. 105.

endogeneity bias that may be present.

6.3 IV Results

Table 3.5 uses the number of R.F.D. offices in 1900 and the set of county geographical variables as instruments. In column 1, the dependent variable is the percentage of total schoolhouses consolidated. In column 2, the measure of consolidation is the percentage of total schoolhouses graded, and in column 3 the percentage of total students enrolled in one-room schools is used as the dependent variable. The IV results are similar to the OLS results presented in Table 3.4.

One notable difference is that the IV coefficients on the road variable in columns 2 and 3 are significantly higher than the OLS estimates in Table 3.4. An explanation for the higher IV estimates is that there could exist some measurement error in the variables. This problem is commonly referred to as "classical measurement error". Classical measurement error will not only lead to biased OLS coefficients but will also result in IV coefficients which are significantly larger than the OLS results. Measurement error of the dependent variable may exist due to the fact that educational reports published by the various states relied exclusively on reports submitted from local county education officials. Using county level educational data increased the possibility for measurement error since there was a chance that local school officials made errors in the reporting of the required information to state officials. Additionally, counties may have had different notions on what constituted regular school attendance which may also have led to measurement issues. The measurement error problem, however, is not limited to just the dependent variable. As discussed in Section 3.2, some of the reported road mileage by local road officials was deemed questionable by the Office of Public Roads. For this reason, it is possible that the measures of school consolidation and/or road mileage used in the model may not accurately reflect the actual school consolidation or road improvement that occurred. The consequence would be significantly higher IV estimates. Nevertheless, the IV results reinforce the OLS estimates found in Table 3.4 that road improvement had a positive and significant effect on the percentage of total schoolhouses that were consolidated.

The Sargan test statistic is also reported in Table 3.5. The Sargan test statistic is a popular test of the validity of the instruments in the model. The null hypothesis of the test is that the set of instrumental variables are uncorrelated with the error term. If the p-value of the Sargan test statistic is below the level of significance then the null hypothesis is rejected and the instruments are not valid.[109] In Table 3.5, the p-values of the Sargan test statistic are well above the level of significance of 10 percent and this implies that the set of instruments used is valid.

I also report the Durbin-Wu-Hausman (DWH) test statistic to test for endogeneity. If the test statistic is not significant at the 10 percent level then the inference would be that there is no evidence of endogeneity. In the absence of endogenity, the OLS estimate is the preferred estimate to use since it would be efficient.[110] If, on the other hand, the test statistic is statistically significant then there is evidence of some correlation between the road variable and the error term in Equation (1). Should the test statistic be statistically significant then the IV estimator would be the preferred choice as it will be the only estimator that is consistent. The results show that in none of the specifications are the DWH test statistics statistically significant at the 10 percent level. Thus,

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[109] For this paper I will use 10 percent as the critical level of significance.
[110] The absence of endogeneity means that the OLS and IV estimates are both consistent, however only the OLS estimator would be efficient.

endogeneity would not appear to be a significant problem and the OLS results in Table 3.4 are validated.[111]

7. Roads and School Outcomes

School consolidation was expected to lead to improvements in rural education by increasing attendance rates, length of school year and school quality. Having established a positive link between roads and school consolidation, it may be possible to quantify the overall impact that improved roads had on various measures of school outcomes both directly and indirectly through its effect on consolidation.

The school outcomes of interest are school attendance rates, the average number of days schools were held in session, teacher pay and expenditures per school-age child. All four measures increased during the first two decades of the 20th century. Rural school attendance rates in the North Central region rose from 72.3 percent in 1904 to 80.7 percent in 1916, while the average number of days rural schools were held in session increased by nearly 11 days during this same twelve year period. Rural teacher salaries and rural school expenditures per school-age child jumped by 21 percent and 68 percent respectively in the region. How much of the observed rise in school outcomes in the region could be explained by the improvement in the rural road network?

Table 3.6 present the estimates of the reduced form coefficients of Equation (4). The effect of roads on school attendance rates is shown in columns 1 and 2. The results suggest that improved roads had a positive impact on school attendance rates. A ten percent increase in the percentage of total roads improved is predicted to increase school attendance rates by 1.2 percentage points. I can perform a simple calculation to provide an estimate of the effect that improved roads had on school attendance rates.[112]

Between 1904 and 1916 the percentage of enrolled students attending class daily in the region increased by 8.4 percentage points. Approximately 8 percent of the total rise in attendance can thus be attributed to improvements in rural roads. The modest result of roads on school attendance suggests that other factors were more significant in explaining the rise of school attendance rates during this period. Changes in the enforcement of compulsory school laws and child labor laws along with demand side factors could also have been important drivers in advancing school attendance rates in the North Central region.

The number of days schools were held in session in the rural areas of the North Central region increased from an average of 155 days in 1904 to 167 days in 1916. Columns 3 and 4 in Table 3.6 estimate the effects of roads on the average number of days school were held in session. The OLS estimate is positive and statistically significant, although the IV estimate is not significant. The test statistics, which are not reported, suggest that endogeneity does not appear to be a significant problem and thus the OLS estimates are used. The OLS estimate on roads in Column 3 implies that a one-percentage increase in the total percentage of roads improved would lead to a 3.6 percentage increase in the number of days schools were in session.[113] It is thus estimated that approximately 42 percent of the total rise in the number of days schools were held in session can be accounted for as a function of road improvement.

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[112] The calculation is done by multiplying the road coefficient by the observed increase in the percentage of total roads improved. The result will give the increase in attendance rate that is attributable to changes in roads.

[113] The dependent variable is the log of average number of days schools were held in session. The coefficients in Columns 3 and 4 are interpreted differently than the coefficients found in Columns 1 and 2. In this case, a one-unit change in the independent variable will lead to a 100 * (coefficient) percentage change in the number of days attended.

The results indicate that improved roads had a much greater effect on the number of days schools were operating than on the actual attendance rate. A possible explanation is that attendance was calculated as the number of enrolled students who attended a minimum number of weeks of school.[114] Road improvement, although increasing access to schools, may have had a limited effect on the attendance rate in areas where enforcement of compulsory school laws was strongest. If most children in a given locality were already attending the mandated minimum number of days of schooling, the improvement of the roads would have little effect on the school attendance rate at the margin. The impact of roads on education would be best observed through its impact on the average number of days schools were held in session. The improvement of roads allowed children to attend school even during inclement weather ensuring an increase in the number of days of instruction.

As mentioned earlier in the paper, one of the main differences between urban and rural schools was the quality of instruction. I use two measures to proxy for the quality of schools. Using teacher pay as a proxy for teacher quality, it is shown in Columns 5 and 6 in Table 3.6 that road improvement led to higher teacher pay. The road coefficient is statistically significant in both the OLS and IV specification. When teacher pay is the dependent variable, the DWH test statistic suggests that the OLS estimate is more efficient that the IV estimate. Using the result from Column 5, it is calculated that road improvement could explain as much as a third of the observed increase in teacher quality as measured by teacher pay. Likewise, Columns 7 and 8 in Table 3.6 show that school expenditures per school-age child are also positively related to road expenditures. The presence of improved roads appears to have had a significant positive impact in the

[114] The minimum threshold of attendance for states in the Midwest varied between 10 to 20 weeks.

average number of days schools were operating, on teacher pay and on school expenditures. The results suggest that the rise in educational outcomes observed in the early 20th century can be attributed at least in part to the improvement of the rural roads.

8. Conclusion

This paper provides evidence that investment in road infrastructure led to observed improvements in rural educational outcomes. I find that an increase in the percentage of total roads improved during the years 1906 to 1916 could account for as much as 10 percent of the observed increase in the percentage of total schools that were consolidated. The external benefits of roads were also apparent through other measures of educational outcomes. While modestly affecting school attendance rates, the presence of improved roads appears to have had a significant impact in the operational school year and on measures of school quality such as school expenditures and teacher pay. Without good roads to transport students, school consolidation would have faced steep obstacles in its implementation. I find that there is compelling evidence that the rise in educational outcomes observed in the early 20th century can be attributed in part to the investment in good roads.

The results from this analysis have important implications for the growth and development literature. Many researchers have pointed out the importance of human capital in explaining economic growth.[115] A prominent example was Lucas (1988) who showed that the growth rate of per capita income directly depends on the growth rate of human capital. The rapid growth in the American educational system could thus help explain the observed rapid growth of the American economy in the 20th century. The

[115] Claudia Goldin (2001) leaves no doubt on her thoughts of the importance of the rise of education in the United States when she referred to the 20th century as the "Human-Capital Century".

findings of a positive association between roads and school consolidation suggest that the growth in education may not have been as significant without the necessary investments in road infrastructure. Improved roads facilitated the ability to transport rural children greater distances, which allowed for the construction of consolidated schools and rural high schools, which in turn improved the quality of education. Any study that attempts to measure the impact of investments in public capital goods, such as roads, on economic growth must take into account the spillover effects that may result from such investments. It is likely that the measured effect of roads on aggregate output reported in the current growth literature has underreported the true benefits of road investment.

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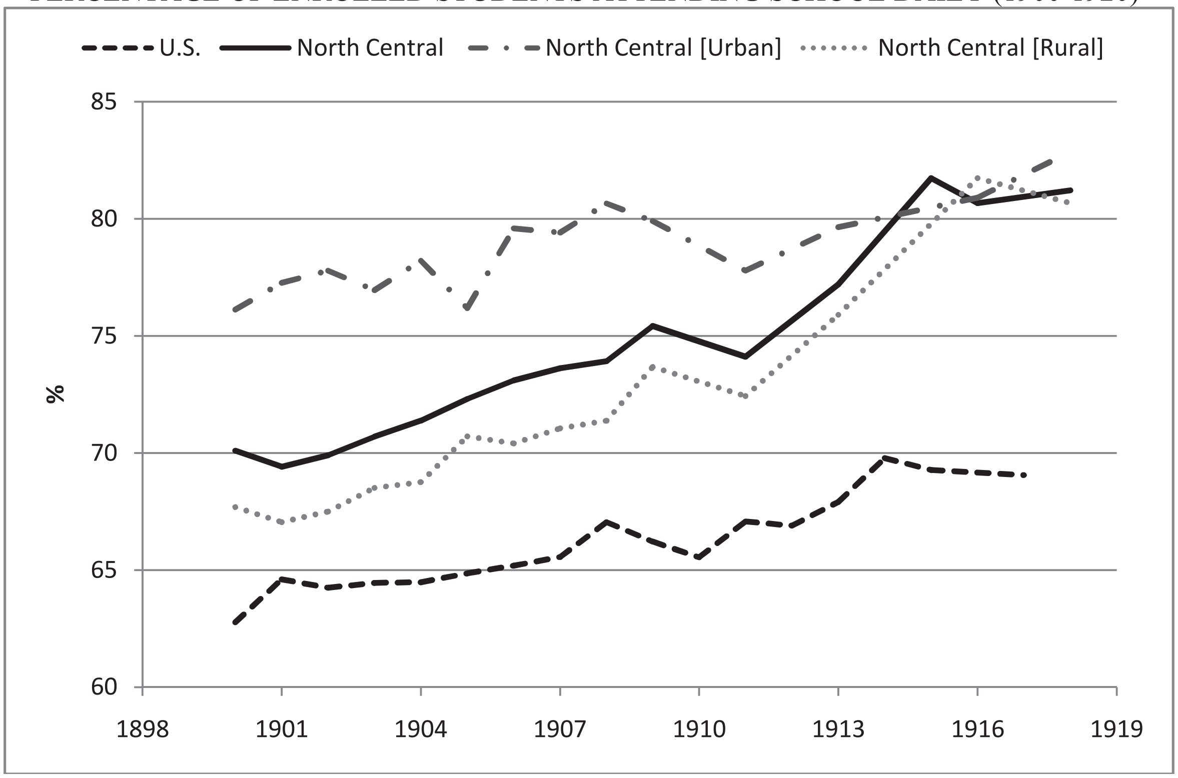
TABLE 3.1
SCHOOL CONSOLIDATION (1920)

Region	Number of One-Room Schools	% of Schools One-Room	No. of Consolidated Schools	% of Schools Consolidated
North Atlantic	25,480	96.8	830	3.2
South Atlantic	25,062	95.8	1,092	4.2
South Central	36,498	91.8	3,240	8.2
North Central	92,381	95.3	4,535	4.7
Western	15,485	94.9	827	5.1

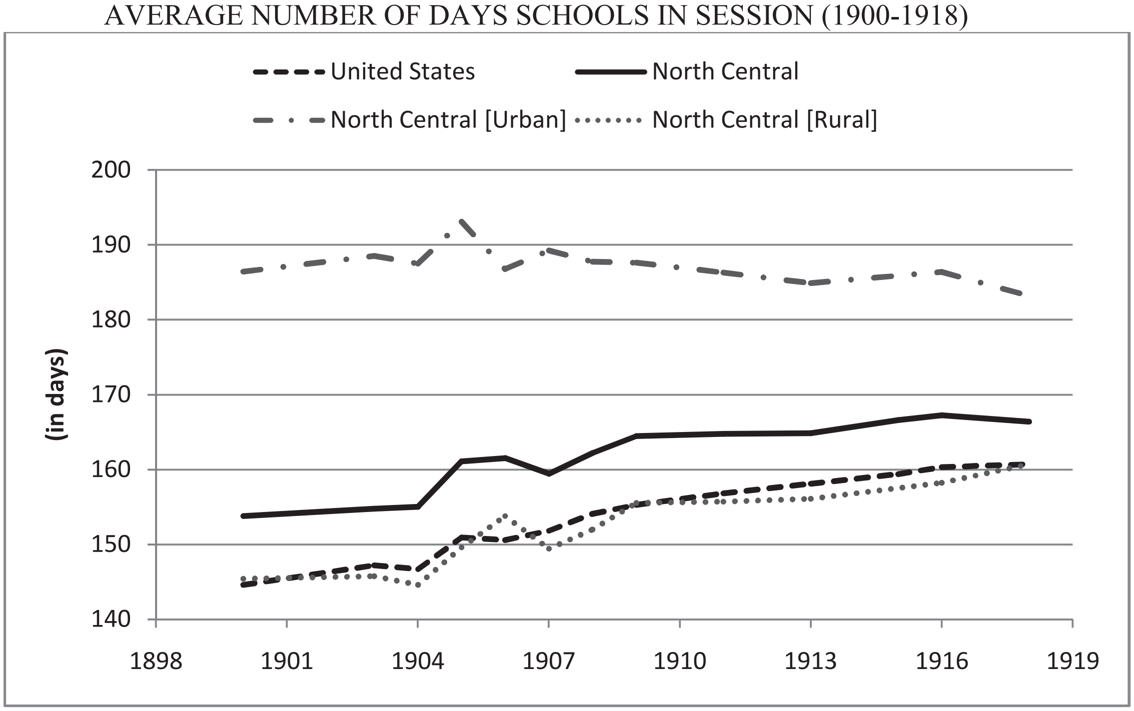
Notes: Census defined regions are categorized as follows: North Atlantic Region: ME, NH, VT, MA, RI, CT, NY, NJ, PA. South Atlantic: DE, MD, VA, WV, NC, SC, GA, FL. South Central: AL, KY, TN, MS, LA, TX, AR, OK. North Central: OH, IL, IN, IA, KS, MI, MN, MO, NE, ND, OH, SD, WI. Western: MT, WY, CO, NM, AZ, UT, NV, ID, WA, OR, CA.
Source: Department of the Interior (1928), *Rural School Consolidation: Pamphlet No. 6,* Table 1.

FIGURE 3.1
PERCENTAGE OF ENROLLED STUDENTS ATTENDING SCHOOL DAILY (1900-1920)



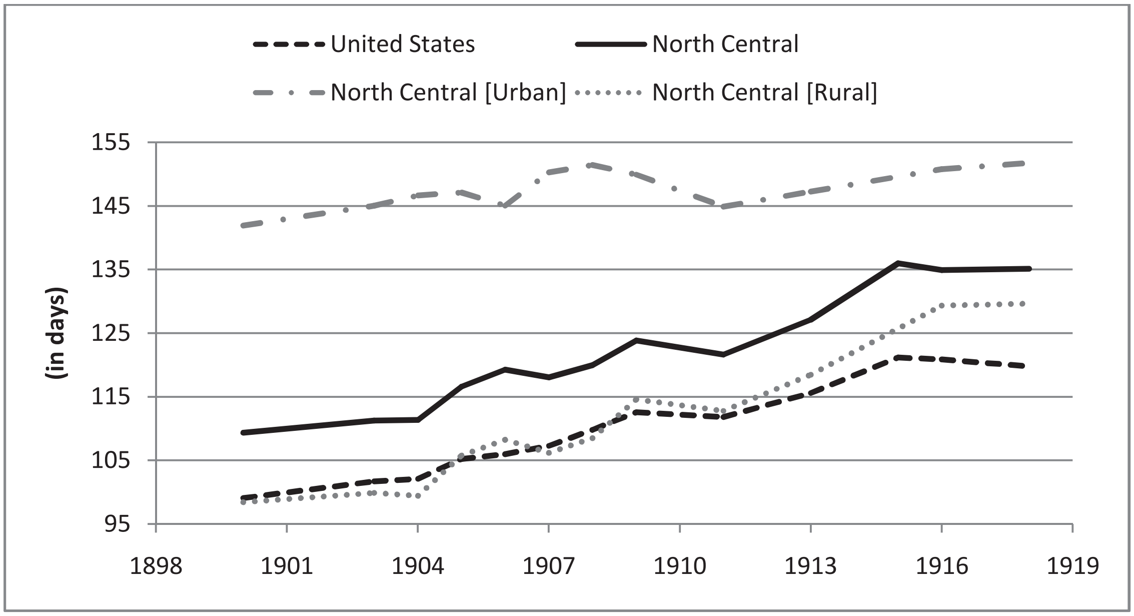
Source: United States Office of Education (Various Years), Report of the Commissioner of Education.

FIGURE 3.2
AVERAGE NUMBER OF DAYS SCHOOLS IN SESSION (1900-1918)



Source: United States Office of Education (Various Years), Report of the Commissioner of Education.

FIGURE 3.3
AVERAGE NUMBER OF DAYS ATTENDED BY EACH ENROLLED PUPIL (1900-1918)



Source: United States Office of Education (Various Years), Report of the Commissioner of Education.

TABLE 3.2
TOP SCHOOL CONSOLIDATION STATES IN 1920

State	Percent of Rural Schools Consolidated (1920)	Percent of Total Roads Improved (1921)	State Ranking in Road Improvement (1921)
Indiana	17.6	52.3	1
New Mexico	14.7	4.0	38
Massachusetts	13.8	34.9	3
Washington	13.6	26.3	5
New Jersey	12.3	24.2	9
Ohio	10.4	42.8	2
Texas	10.4	8.9	33
Maryland	10.1	24.8	7
Arizona	9.9	5.8	36
U.S. Average	4.9	13.1	N/A

Note: The state's ranking in road improvement in 1921 is out of 48 states.
Sources: U.S. Department of the Interior (1928), *Rural School Consolidation: Pamphlet No. 6 ,* Table 1 and U.S. Department of Agriculture, Bureau of Public Roads (1925), *Rural Highway Mileage, Income, and Expenditures, 1921 and 1922*, Table 1.

TABLE 3.3
EFFECT OF ROAD IMPROVEMENT ON SCHOOL ATTENDNACE

Location	School Attendance Prior to Road Improvement	School Attendance After Road Improvement
Dallas County, Alabama	71.0	77.0
Franklin County, New York	66.9	72.0
Story County, Iowa	63.7	73.0
Lauderdale County, Mississippi	72.0	81.0

Source: U.S. Department of Agriculture (1916), Bulletin No. 393.

TABLE 3.4
OLS REGRESSION: ROAD IMPROVEMENT AND SCHOOL CONSOLIDATION
NORTH CENTRAL REGION (1906-1916)

Variable	(1)	(2)	(3)
Percentage of Total Roads Surfaced	0.057***	0.033*	-0.038**
	(0.016)	(0.020)	(0.019)
Share of County Population Catholic	-0.013	0.065**	-0.060**
	(0.016)	(0.029)	(0.028)
Share of County Population Born in Northern Europe	-0.003	0.183***	-0.166***
	(0.025)	(0.055)	(0.054)
Share of County Population Residing In Rural Area	0.013*	-0.078***	0.077***
	(0.007)	(0.016)	(0.015)
Log Rural Population Density	-0.020***	0.0001	0.004
	(0.003)	(0.006)	(0.006)
Decadal Percentage Change In Rural Population (1900-1910)	-0.001	0.002	-0.002
	(0.001)	(0.002)	(0.002)
Share of Farms Operated by Tenants	0.009	0.075**	-0.067**
	(0.015)	(0.030)	(0.030)
Log Land Value per Acre	0.021***	-0.003	-0.006
	(0.004)	(0.008)	(0.008)
Share of Total Farms Less than 10 Acres	-0.011	1.084***	-0.994***
	(0.091)	(0.266)	(0.259)
State Fixed Effects Included	Y	Y	Y
Year Fixed Effects Included	Y	Y	Y
Number of Observations	1147	1588	1588
R-Squared	0.311	0.448	0.530

Notes: Robust standard errors are reported in parentheses. The sample includes county-level observations from the twelve states that comprise the North Central region.
In Column (1) the dependent variable is the percentage of total schoolhouses consolidated.
In Column (2) the dependent variable is the percentage of total schoolhouses graded.
In Column (3) the dependent variable is the percentage of total students enrolled in one-room schoolhouses
* denotes statistical significance at the 90 percent level of confidence, ** at 95 percent, and *** at 99 percent.

TABLE 3.5
IV REGRESSION: ROAD IMPROVEMENT AND SCHOOL CONSOLIDATION
NORTH CENTRAL REGION (1906-1916)

Variable	(1)	(2)	(3)
Percentage of Total Roads Surfaced	0.056	0.170**	-0.198***
	(0.041)	(0.080)	(0.077)
Share of County Population Catholic	-0.013	0.057**	-0.050**
	(0.016)	(0.024)	(0.023)
Share of County Population Born in Northern Europe	-0.003	0.158***	-0.136**
	(0.036)	(0.057)	(0.055)
Share of County Population Residing In Rural Area	0.013*	-0.077***	0.075***
	(0.008)	(0.013)	(0.013)
Log Rural Population Density	-0.020***	0.005	-0.002
	(0.004)	(0.006)	(0.006)
Decadal Percentage Change In Rural Population (1900-1910)	-0.001	0.001	-0.002
	(0.001)	(0.002)	(0.002)
Share of Farms Operated by Tenants	0.009	0.074**	-0.066**
	(0.018)	(0.030)	(0.029)
Log Land Value per Acre	0.021***	-0.012	0.005
	(0.004)	(0.008)	(0.008)
Share of Total Farms Less than 10 Acres	-0.012	0.877***	-0.756***
	(0.100)	(0.182)	(0.176)
State Fixed Effects Included	Y	Y	Y
Year Fixed Effects Included	Y	Y	Y
Number of Observations	1141	1582	1582
R-Squared	0.311	0.423	0.497
First Stage F-Statistic	26.17	57.97	78.61
Sargan Test Statistic	3.712	4.850	4.535
[p-value]	[0.446]	[0.28]	[0.32]
Durbin-Wu-Hausman Test Statistic	5.687	3.262	4.853
[p-value]	[0.093]	[0.071]	[0.028]

Notes: Standard errors are reported in parentheses. The sample includes county-level observations from the twelve states that comprise the North Central region.
In Column (1) the dependent variable is the percentage of total schoolhouses consolidated.
In Column (2) the dependent variable is the percentage of total schoolhouses graded.
In Column (3) the dependent variable is the percentage of total students enrolled in one-room schoolhouses
* denotes statistical significance at the 90 percent level of confidence, ** at 95 percent, and *** at 99 percent.

TABLE 3.6
ROAD IMPROVEMENT AND SCHOOL OUTCOMES (1906-1916)

Variable	(1) OLS	(2) IV	(3) OLS	(4) IV
Percentage of Total Roads Surfaced	0.116*** (0.018)	0.098 (0.122)	0.036** (0.019)	0.158 (0.185)
Share of County Population Catholic	-0.034 (0.029)	-0.036 (0.025)	0.085*** (0.029)	0.066 (0.042)
Share of County Population Born in Northern Europe	-0.060 (0.046)	0.135** (0.069)	0.028 (0.069)	0.024 (0.100)
Share of County Population Residing in Rural Area	-0.073*** (0.017)	-0.033** (0.015)	-0.028* (0.017)	-0.025 (0.019)
Log Rural Population Density	0.030*** (0.007)	-0.102* (0.006)	-0.056*** (0.010)	-0.057*** (0.007)
Decadal Percentage Change In Rural Population (1900-1910)	0.002 (0..004)	0.002 (0.002)	0.002 (0.004)	0.001 (0.003)
Share of Farms Operated by Tenants	-0.325*** (0.033)	-0.139*** (0.031)	-0.007 (0.041)	-0.004 (0.040)
Log Land Value per Acre	0.071*** (0.006)	0.066*** (0.007)	0.115*** (0.010)	0.113*** (0.009)
Share of Total Farms Less than 10 Acres	0.092 (0.186)	0.057 (0.199)	0.101 (0.198)	-0.040 (0.281)
State Fixed Effects Included	Y	Y	Y	Y
Year Fixed Effects Included	Y	Y	Y	Y
Number of Observations	1309	1305	1184	1181
R-Squared	0.336	0.491	0.671	0.666
First Stage F-Statistic		66.14		137.11

Notes: Standard errors are reported in parentheses. The sample includes county-level observations from the twelve states that comprise the North Central region.
In Column (1) the dependent variable is the percentage of enrolled students attending school daily.
In Column (2) the dependent variable is the percentage of enrolled students attending school daily.
In Column (3) the dependent variable is the log number of days schools were held in session.
In Column (4) the dependent variable is the log number of days schools were held in session.
* denotes statistical significance at the 90 percent level of confidence, ** at 95 percent, and *** at 99 percent.

TABLE 3.6 (Continued)
ROAD IMPROVEMENT AND SCHOOL OUTCOMES (1906-1916)

Variable	(5) OLS	(6) IV	(7) OLS	(8) IV
Percentage of Total Roads Surfaced	0.356***	0.406**	0.656***	1.297***
	(0.063)	(0.178)	(0.074)	(0.371)
Share of County Population Catholic	0.005	0.002	-0.524***	-0.570***
	(0.053)	(0.049)	(0.144)	(0.129)
Share of County Population Born in Northern Europe	0.053	0.057	-0.551***	-0.494***
	(0.085)	(0.092)	(0.200)	(0.209)
Share of County Population Residing in Rural Area	-0.191***	-0.190***	0.136	0.148*
	(0.041)	(0.044)	(0.087)	(0.077)
Log Rural Population Density	-0.048***	-0.050***	-0.575***	-0.593***
	(0.009)	(0.014)	(0.025)	(0.025)
Decadal Percentage Change In Rural Population (1900-1910)	0.004*	0.004*	0.011	0.010
	(0.002)	(0.002)	(0.013)	(0.010)
Share of Farms Operated by Tenants	0.121***	0.142*	-1.008***	-0.844***
	(0.039)	(0.077)	(0.128)	(0.166)
Log Land Value per Acre	0.056***	0.054***	0.546***	0.519***
	(0.009)	(0.011)	(0.025)	(0.030)
Share of Total Farms Less than 10 Acres	-0.101	-0.251	3.413***	1.901*
	(1.415)	(1.149)	(0.966)	(1.114)
State Fixed Effects Included	Y	Y	Y	Y
Year Fixed Effects Included	Y	Y	Y	Y
Number of Observations	1650	1645	1837	1833
R-Squared	0.244	0.241	0.332	0.307
First Stage F-Statistic		34.22		90.51

Notes: Standard errors are reported in parentheses. The sample includes county-level observations from the twelve states that comprise the North Central region.
In Column (5) the dependent variable is the log teacher wages
In Column (6) the dependent variable is the log teacher wages
In Column (7) the dependent variable is the log school expenditures per child
In Column (8) the dependent variable is the log school expenditure per child
* denotes statistical significance at the 90 percent level of confidence, ** at 95 percent, and *** at 99 percent.

DATA APPENDIX

1. Number of Days Attended per Enrolled Pupil

A limitation of using the state reports of the departments of public instruction is that there was a lack of uniformity in the data reported.

Some states directly reported the average number of days attended per enrolled pupil. However, most states did not report this educational measure. However, using the simple formula below, the statistic was easily determined.

$$\text{Number of Days Attended per Enrolled Pupil} = \frac{\text{Aggregate Number of Days Attended}}{\text{Number of Enrolled Pupils}}$$

All states reported the number of enrolled pupils in the public school system. However, several states did not report the aggregate number of days in attendance. For those states I estimated the aggregate number of days in attendance by using the following formula:

Average Number of Days Attended = Avg Daily Attendance x Average Length of School Term in Days.

Some states reported school term length in weeks and not in days. In those instances, I multiplied the number of weeks by 21 days to convert school length in days.

2. Rural Educational Statistics

The rural and urban statistics shown in Figures 3.1 through 3.3 were derived from the Annual Report of the Commissioner of Education. The report published educational data for state school systems and city school systems. State school system data was inclusive of the city school system data. Rural educational statistics although not directly reported was found by backing out the city school system numbers from the state school system data. City school systems in this paper are defined as any locality with an overall population greater than 8,000.

Starting in 1910, the Report changed it definition of city school systems. After the 1910 report, the Commissioner of Education defined city school systems as any locality with an overall population greater than 5,000. In order to closely match data prior to 1910 with data subsequent to that year, I defined an urban area as any locality with an overall population greater than 10,000 for the reports published after 1910. There is therefore a small number of cities with populations between 8,000 and 10,000 that were classified as urban prior to 1910 in my paper, but which were subsequently classified as rural after 1910. This should not have had a major impact in explaining the observed rise in rural education observed in Figures 3.1 through 3.3.