The Impact of Railroads on School Enrollment in Nineteenth Century America*

Jeremy Atack, jeremy.atack@vanderbilt.edu
Robert A. Margo, margora@bu.edu
Elisabeth Perlman, perlmane@bu.edu

UNFINISHED AND INCOMPLETE

Draft: June 2012

Abstract

One of the central features of nineteenth century economic development in the United States was the so-called "Transportation Revolution." This paper uses a newly created panel data set matching information on transportation infrastructure to individual-level census data for the period 1850 to 1880 to study the impact of the diffusion of the railroad—a key component of the Transportation Revolution—on human capital investment. Using a difference-in-differences approach we find that gaining access to rail transportation in a county significantly increases the likelihood of school attendance among children ages 6-16. The treatment effect of the railroad is robust to controls for demographic characteristics, socioeconomic status, and location, and is also similar in magnitude for boys and girls. Causal mechanisms are explored, including the effects of rail on the supply of schools through higher property values.

*Acknowledgements: We are extremely grateful to Claudia Goldin and to seminar participants at the December 2011 All-UC Economic History Conference, the Harvard Economic History Tea, and the IAFFE 2011 Conference for their helpful comments. All errors are our own.

1 Introduction

The United States experienced an internal "transportation revolution" (Taylor (1951)) in the nineteenth century. By lowering the costs of moving goods and people within the country the revolution promoted economic growth by linking far-flung factor and product markets which encouraged the exploitation of regional comparative advantage ((North, 1961; Fogel, 1964; Fishlow, 1965; Goodrich, 1961; Kahn, 1988; Ransom, 1967, 1970; Williamson, 1974; Haites et al., 1975)). Additionally, the revolution also stimulated productivity growth by promoting division of labor within manufacturing and the agglomeration of economic activity within cities (Fishlow (1965); Atack et al. (2010, 2011)).

While the United States was undergoing its transportation revolution there was a concomitant expansion of education attainment—each successive of generation attended school more frequently and for more years during childhood and early adulthood. Prior to the Civil War the expansion in schooling was restricted to the white population but after the War, African-Americans too experienced substantial gains in schooling (Margo (1990)). By the end of the nineteenth century the fruits of educational expansion made the United States an international leader in human capital investment, well poised to benefit from the technological progress to come during the twentieth century which was strongly complimentary to formal schooling (Goldin and Katz (2008)).

Traditionally the transportation revolution and the schooling revolution have been treated as independent features of nineteenth century American economic development. The invention and application of steam power to transportation media—water and rail transport—is obviously central to the transportation revolution but the history of steam technology would seem to be irrelevant to to the history of education. Social and economic historians have emphasized the correlates of schooling attendance at the individual and household level—age, gender, and ethnicity, for example—along with broad secular shifts influencing the demand for and supply of schools, such as the long-term movement of labor out of agriculture or the rate and bias of technical progress, but not linkages between human capital investment and the transportation revolution (Landes and Solmon (1972); Eisenberg (1988); Goldin and Katz (2008)).

However, there are good a priori reasons to believe that long-term improvements in internal transportation were a causal factor, albeit a "deep" one, behind the expansion of schooling in nineteenth century America. The causal effects may have been both indirect and direct. For example, to the extent that parents valued the long run economic well-being of their children, and that well-being depended positively on schooling, any factor that raised parental incomes or wealth on average—which the transportation revolution surely did—would have increased school attendance—an indirect link. The transportation revolution also promoted inter- and intra-regional trade, and trade is likely to have been one sector where the rate of return of schooling was particularly high—a direct link. But not all hypothesized links may have been positive. For example, if the transportation revolution stimulated the growth of manufacturing industries or expansion of agricultural production in which child labor was used intensively, schooling might have been adversely affected.

In the end the various causal pathways linking transportation improvements to schooling decisions are arguably too numerous to cleanly identify and measure separately. However, we assert in this paper that it is possible to measure the net impact of transportation improvements on schooling and shed some light on particular causal mechanisms.

To investigate the relationship between transportation and schooling, we exploit a new database on the transportation revolution developed from digitized historical maps filtered through geospatial information system (GIS) software. This database documents various features of transportation access at the county level for the United States throughout the latter nineteenth century, generating a panel dataset. We have linked these data to samples of individuals from the 1850-1880 public use micro-data samples of the federal census (IPUMS), which include information on school attendance. The 1850 census data are the earliest for which individual level information on school attendance is available, while the 1880 census is the last available for the nineteenth century since the 1890 manuscripts were destroyed in a fire.

Any county-level panel dataset for the nineteenth century United States must confront the fact that new counties were formed over time and existing counties changed—that is, county boundaries were changing. We control for boundary changes by fixing county boundaries at 1840 values and aggregating variables for the 1850-80 period to reflect these boundaries. Any post-1840 county that is fully contained within an existing 1840 county is included in our analysis. This protocol allows us to construct a consistent panel data set covering 1,089 counties, which covers most of the land area of the nineteenth century United States except for the West—that is, the Midwest, South, and Northeast.

Our transportation database contains two types of information about transportation access at the county level. The first type is a dummy variable indicating whether a specific mode—for, example, the railroad—existed within the county as of a given census date. The dummy variables can be ascertained from digitized maps with a very high degree of accuracy, which is an obvious advantage. However, the dummy variable measure suffers from a clear disadvantage—a county without a railroad might be adjacent to one with a railroad—thereby clouding the distinction between the treatment and control group. Consequently, in addition to the dummy variable method, we use GIS to measure the share of the county's land area that was within a given linear distance "x miles" to a specific transportation mode. Although there are some inherent inaccuracies with this second variable, it has a significant advantage over the dummy variable in that it cuts across county boundaries.

Our econometric specification follows a difference-in-difference framework.

In the simplest version we regress the outcome variable—school attendance—on transportation access, past county characteristics, and county and year dummies. In effect, we are comparing the change in outcome in the treatment group—counties that gain transportation access between, say, 1850 and 1860—with a control group—counties that did not have transportation access in either year, or else had it in both years. In the most general specification, we control extensively for individual and household characteristics.

Our basic finding is that the effect of transportation on schooling was positive—school attendance rates increased in counties that gained access to the rail network. The effect is also quite large economically—using our basic estimate, changes in transportation access can account for half of the increase in mean school attendance between 1850 and 1860.

Why did schooling increase in response to the transportation revolution? One possible explanation is selectivity bias—as places became more accessible to transportation, children whose parents were more likely to send them to school constituted a larger share of the local (school age) population. We show, however, that adding controls for child and parental demographics—including, for example, parental occupation—has little or no impact on the treatment effect of transportation access. A second possibility—transportation access altered local economies in ways that made schooling either more attractive or more accessible—receives more support. In particular, if we control for land values in agriculture, the transportation treatment effect is substantially reduced. Since improved transportation is known to have raised land values, this suggests that schooling access was enhanced through, for example, higher property (or other) tax revenues. However, even controlling for land values, a significant transportation effect, about half the original effect, remains.

2 The Transportation Revolution and Schooling Choice

Although plans for railroads were first discussed in the United States in the early 1800s, it was not until late 1820s that railroad construction actually began. These early lines reflected the struggles of port cities to secure adequate inland connections to their hinterlands, like Baltimore, Boston, and Charleston, in their efforts to compete with New York City, especially post Erie Canal. By 1840, some 3,300 miles of track had been laid, of which about 2,800 miles were in operation. The majority of track was in the states along the East coast and almost all of it involved trips of short duration ("short line"). Further expansion in mileage took place in the 1840s, much of it in New England and New York.

It was in the 1850s, however, that the United States experienced its first great wave of rail expansion (Stover (1978)). Approximately 22,000 miles of track were laid during the decade, bringing the total track on the eve of the Civil War to over 30,000 miles. Although the federal government had been involved in railroad expansion prior to 1850 in an indirect way by providing land surveys free of charge (from 1824 to 1838, when the law authorizing the surveys was repealed), direct subsidies for construction in the form of land grants were first given in 1850, and later extended several times during the decade.

By 1860, in addition to substantial coverage in the Northeast, rail lines crisscrossed Illinois, Indiana, and Ohio, with significant penetration into Wisconsin and Iowa. The South was less well-served, but it too experienced substantial growth in rail access in the 1850s.

There are good reasons to believe that the transportation revolution brought about by railroads would have affected individual schooling decisions. As a point of departure to understand how being connected to transportation might have affect a family's schooling decisions, consider a simple optimal schooling model in which parents maximize a utility function defined over current consumption and the child's future economic status, as follows:

$$\max_{s} U(C, E(s)) = U(Y_p + w(T + s), E(s))$$

Here, Y_p is parental income, T is the child's time endowment, s is time spent in school, and E is the child's future economic status, which is assumed to be a positive function of schooling. Parents maximizes utility by choosing the value of s. Note that consumption will also be affected by the cost of schooling, but we have not included this in the model. The first order condition is:

$$\frac{U_2}{U_1} = \frac{E'}{w}$$

It is straightforward to show that equals $\frac{ds}{dY_p}$ as long as E, the child's future economic status, is a normal good. Thus, changes in any one of these variables will change the schooling decisions.

In this setting, changes in transportation access can affect s in a number of ways. Consider the effects that standard trade theory suggests that an expansion of the transportation network will have. A reduction in transport cost will cause a local economy to export more of the good which is intensive in the use of the abundant local factor. If this happens to be a good that is intensive in the use of skilled labor, the returns to schooling (E') will rise, and this will also generate an increase in the school attendance rate. Transportation access will likely increase real per capita income, perhaps through returns to a locally abundant fixed factor (e.g., land), these changes generate an increase in Y_p. If, as assumed above, E is a normal good, transportation-induced increases in parental income will cause a rise in s.

Possible linkages between schooling and transportation in the simple model presented above are not the only ways in which transportation may have mattered. For example, as noted above, the model abstracts from costs of schooling except for opportunity costs as measured by the child's wage, w. In the United States, education is typically financed through taxes on property. Assuming fixed tax rates (the political process is such that they are not often changed) an increase in land values in a location will decrease the effective cost of schooling. It is known from previous work, however, that transportation access enhanced urbanization and, to a lesser extent, population density (Atack et al. (2010)); if schooling was less expensive to provide in an urban area through specialization this would have also induced higher attendance rates.

With urbanization came industrialization. To the extent that this increased children's wages or opportunities for low-skilled people, thus changing $E(s)$, this will tend to affect schooling negatively by decreasing school attendance. More generally, connecting to the transportation network opened up a local economy to the wider world. By decreasing the effective cost of migration, increased both the likelihood of future migration as well as the range of possible places to which an individual might move. Indeed, Goldin and Katz (2008) argue that one reason the United was an early leader in schooling was that Americans were more highly mobile geographically, and that schooling and migration were complements as formal school help increases an individual's flexibility.

3 Data

This paper relies on an ongoing project to construct a geospatial information system (GIS) database on transportation infrastructure in the nineteenth century United States. The project uses digitized historical transportation maps and inputs them into GIS software, which generates a county-level dataset that documents the state of the transportation network at specific points in time.

The database was constructed by starting with a relatively modern map and working backwards in time. The accuracy of mapmaking improved over time, so more modern maps are better at capturing the true location of objects. Our base map is from 1911, which is late enough in the history of American mapmaking to be very accurately drawn and yet not so recent that railroads would have gone out of service (and thus been missed in our initial rendering). Once we had the base map traced in GIS, we use earlier maps for the census years 1850-1880 to eliminate segments from the base network.[1] This data has been supplemented with data on canals, steam navigation on rivers, and ports.[2]In the form used in this paper, the transportation database provides us with county level information on access (measured in several different ways) for the census years 1850 through 1880.

To measure the impact of transportation access on schooling, we use

[1]The 1911 digitized base map is from The Gold Bug's Historic Map Libraries on CD ROM (The Gold Bug (a,b)). It had been published in The Century Dictionary and Cyclopedia, with a New Atlas of the World; a Work of General Reference in All Departments of Knowledge (Whitney and Smith (1911)). The files from the CD ROM were geo-referenced and digitally traced. The 1880 data use a 1882 map, "Colton's Intermediate Railroad Map Of The United States" (G.W. & C.B. Colton & Co. (1882)); for 1870 Colton's railroad map (intermediate size) of the United States reduced from "Colton's railroad and commercial map of the United States", copyright 1870 is used (G.W. & C.B. Colton & Co. (1870)).

[2]Another of Colton's maps is used for 1860: "Colton's new railroad & county map of the United States and the Canadas &c" (Colton (1860)), while an 1851 map "Disturnell's new map of the United States and Canada showing all the canals, rail roads, telegraph lines and principal stage routes" drawn by Henry A. Burr is used for the 1850 data (Burr (1851)).

data on school attendance from the integrated public use micro-data samples (IPUMS) from the 1850-1880 censuses (Ruggles et al. (2010)). These are nationally representative samples of the population in the specific census years and include information on the county of residence for individuals in the samples; hence, the IPUMS data can be linked directly to the transportation database.

Beginning in 1850, the census included a question on school attendance for "persons of school age." The question, which remained essentially the same over the period studied, asked whether the individual attended school at anytime during the previous year; as such, it captures exposure to schooling, but not the amount of schooling. We focus on children between the ages of 6 and 16, as these were the prime ages of school attendance during the period (see Figure 1 below).

The census also collected a variety of demographic and economic information at the household level such as age, race, and gender. We use this information to construct control variables. These variables are measured for individual children in the econometric analysis (for example, a dummy for female children) as well as for the child's parents if the child was living with them. We know about an individual's literacy and have some information on the economic status of the parents, so we are able to control for many family background effects. We are also able to control for the location of the household within the county—in particular, if the household resided in an urban area or on a farm.

Our time frame includes the Civil War which generates an added complication. The antebellum samples—1850 and 1860—contain very few observations on African-Americans because the majority vast of African-Americans at the time were enslaved and not enumerated in the population census. The 1870 and 1880 censuses were taken after the war and include formerly enslaved African-Americans. Thus the proportion of African-Americans rises sharply between 1860 and 1870 (see Table 1); it rises slightly more in our sample than in the overall population because the African-American population was younger than the overall population. As discussed below, this also has implications for changes in the mean value of the attendance rate due to the establishment of schools for black children in the post-bellum south.

As noted in the introduction, there were significant changes in county boundaries over the 1850-80 period. One simple solution is to restrict the sample to county with unchanging boundaries over the period; however, this reduces the sample size considerably. Instead, we construct the transportation database such that all included county boundaries are fixed at 1840 values. This requires that we aggregate county level variables from the census to match 1840 boundaries. To be included in the aggregation, a county must either (a) have unchanging boundaries between 1840 and 1880 or (b) be wholly contained within a broader county defined by 1840 boundaries. This excludes, in particular, counties that were formed by partially drawing land from one or more counties across 1840 boundaries. There are, however, relatively few of these, so our final data set covers most of the Northeast, Midwest, and South, see Figure 4.

4 Methods and Results

Our basic regression follows a difference-in-differences specification:

$$S_{ijt} = \gamma(TransportationAccess)_{jt} + X_{ijt}\beta_1 + X_{jt}\beta_2 + \alpha_j + \delta_t + \epsilon_{ijt}$$

Here, the subscript i indexes individuals, j counties, and t year, so X_{ijt} is a vector of individual characteristics, X_{jt} is a vector of county level characteristic, α_j is a county dummy, and δ_t is a year dummy.

The basic regression specification is amended by including individual and household demographic variables, and various combinations of county level covariates. The county level covariates are those that have been shown to be determinants of rail access in previous work (Atack et al. (2010)), plus lagged values of the school enrollment rate and transportation access.[3] Lagged values of the dependent variable turn out to be important because of the possibility of a (reverse) Ashenfelter dip—places that gained transportation access

[3]The basic regression includes dummy variables for each year interacted with: the percent of a county within 40 miles of a railroad in 1840 and 1850 (this well predicts future development of the rail), a dummy presence of a canal in 1850, a dummy presence of a steam navigable river in 1850, a dummy for the presence of a port in 1921 (the earliest list of ports we have found, it is from the Army Corp of Engineers), the percent of the population that is living in an urban area in 1840 and 1850, the natural logarithm of the population per square mile in 1850, and the natural logarithm of agricultural output per improved acre in1850. In addition all previous values of the percent of children in school in a county from1840, and all previous values of the relevant transportation variable from 1840 are included.

may have previously experienced development, which included rising school enrollments. To the extent that there may have been "regression to the mean", the "treatment" counties (those gaining access) would have experienced slower than average growth in enrollments, relative to the "control" counties. Including previous values of school enrollment corrects for this possibility. In some robustness checks we also include other variables measured at the county level, or interactions between the year dummies and higher order geographic variables (for example, region $\times$ year fixed effects). Standard errors are clustered at the county level to reflect the fact that the variable of interest, transportation access, varies at the county level over time.

The simplest measure of transportation access, used in previous studies of the database (for example, Atack et al. (2010)) is a dummy variable which takes the value one if the transportation method—for example, a railroad—exists within or on the boundary of a county as of a particular census date. Changes in transportation access are then measured as transitions from zero to one, and the mean value of the dummy variable measures the proportion of counties with access. The analysis in this paper begins in 1850, by which time changes in water transportation access, in particular, canals, were minimal. Thus the focus in this paper is on changes in railroad access, as this was the primary means by which the transportation revolution was realized in the second half of the nineteenth century. Water transportation is measured as of 1850 and, as mentioned above, is used as a control variable in the difference-in-difference analysis (see below).[4]

A key advantage of the dummy variable approach is that it is usually straightforward to determine whether or not a railroad existed in a county at a particular point of time with a high degree of accuracy. However, a key disadvantage is that the variable defines access with respect to the county boundary. The connection to boundaries creates two further problems. First, county boundaries frequently changed over time, typically as new counties were created as population increased. This problem can be solved by restricting the analysis in various ways—for example, to a matched or "balanced" set of counties over time. It is possible to use GIS methods to construct measures of access that cut across county boundaries by measuring the share of land area in a county that is within a certain distance of a railroad (or other transportation method) irrespective of the county boundary. In particular this can yield different results when a county does not have a railroad within its boundaries but is adjacent to another county that does. The dummy variable measure will record zero access, but the land area measure can be positive. In our analysis, we use three cutoffs for the land area measure—5, 15 and 40 miles. Five miles is about the shortest distance that can accurately measured on the maps, while 15 miles is generally taken as the limit

[4]Water transportation information includes canals, navigable rivers, and ports. Canal and river data come from the information provided in along with various nineteenth century sources and contemporary maps, such as the 1851 map mentioned above. Information on rivers started with a modern map and had navigability checked with US Army Corp of Engineers reports to Congress. Port data are from Army Corp of Engineers who has collected data on ports back to 1921.

of feasible transportation in a day's time by wagon travel. A distance of 40 miles represents the maximum for less frequent but still regular trips, as one might take to bring goods to a rail depot, and was used as such by Fogel (1964).

Table 1 shows the sample means of the school attendance and transportation access variables by year. Note that 63 percent of children ages 6 to 16 in the sample attended school in 1850. Over the next decade, the attendance rate rose by 5 percentage points or nearly 10 percent. Attendance then declined between 1860 and 1870 before rising slightly in the 1870s. The decline in attendance rate is partly (but not entirely) explained by the change in the racial composition of the sample. As noted earlier the vast majority of African-American children were enslaved in 1850 and 1860, but not in 1870. Schools (albeit segregated) were in the process of being set up for black children in the post-bellum South, but even so, the attendance rate of black children was very low in 1870.

Table 1 also shows that access to transportation expanded after 1850. This expansion is almost entirely explained by the diffusion of the railroad. The mean value of the rail access dummy doubled between 1850 and 1880, as did the proportion of land area within 5, 15 and 40 miles of a railroad. However, as dramatic as the expansion of rail access was, it is important not to overstate the gains in transportation. As our data show, 77 percent of the sample counties in existence in 1850 had either rail or water transportation access in 1850.

Table 2 shows more details about the counties that did or did not have railroad transport by region. In 1850 while many of the counties in the East did not have a railroad within their borders still had a railroad close by, whereas counties in the Midwest and South without railroads also had very limited access to them. Access to water transportation was still very common in all counties. By 1870 there were only a few counties in the east that did not have a railroad, and the vast majority people in the Midwest and South lived in counties with at least one railroad within its borders. Table 2 also shows that a higher percent of children attended school in counties that had a railroad them in those that did not.

Figure 1 shows the mean values of the school attendance variable by age. Attendance was very low at age 6 but rose sharply, peaking at age 11. After age 11 school attendance rates fell, such that by age 16 less than half of all children were attending.

Did the changes in transportation access after 1850 affect the school attendance rate? Figure 2 uses a non-parametric procedure to chart the relationship between school attendance and the proportion of land area within 15 miles of a railroad. The mean school attendance is calculated for each county in each year, and then lowess smoothing, a method that reports the results of local weighted liner regressions with no controls for each data point, with the focus data point receiving the most weight and other data points in the bin reserving progressively less weight, is used. In three of the sample years, the proportion attending rises quickly as the proportion of land area within

15 miles of a railroad increases from its lower bound (zero in each year), flattens out over a range of values, before rising again towards the maximum value of the land variable. The pattern is somewhat different in 1880 but by then very few counties have no rail access, even so in that year attendance increases with rail access.

These non-parametric estimators have the advantage of not imposing a strong structure on the data, but the disadvantage of not controlling for many other factors that could have affected school attendance. Table 3 shows the results of our base difference-in-difference estimator that has an implicit control treatment structure by including dummy variables for county and year. With this regression we are testing the predictive power of a number of different measures of transportation access, as described above, simple dummy variables and the percent of counties within 5, 15 or 40 miles of transport. In general we find a strong positive effect of access within 5 miles, and a smaller, but still significant effect at 15 miles; however, the effects at 40 miles seem to depend on exactly how transportation is measured and also the regression specification. These base effects are sizeable—for example, using the coefficient in column 4 (proportion within 5 miles of a railroad), the change in rail access over the 1850s (0.23) predicts an increase in the mean school enrollment rate of 2.8 percentage points, which accounts for 56 percent of the actual increase (= 0.028/0.05). The predictive power is smaller at 15 miles (the predicted change in school enrollment in the 1850s is 2 percentage points, about 40 percent of the actual increase) and smaller still at 40 miles. It seems that while a counties being 40 miles of transportation is a good predictor of it being settled and developing in the near future the variation among the inhabited counties is too limited for good estimation.[5]

The results in Table 3 do not control for the characteristics of the child, yet it is clear both from the change in racial composition between 1860 and 1870 seen above and from the age-specific patterns in Figure 1 that such individual characteristics mattered. Accordingly, in Table 5 we re-estimate the base model including the individual characteristics of age, race, gender, ethnicity, and disability status. For African-American children we also include interactions terms between race and a dummy for post-Civil War because the vast majority of black children in the sample in 1870/80 are either former slaves or children of former slaves. These variables do have a great deal of predictive power—note, for example, the race variables—but including child characteristics does little to alter the treatment effect of transportation. Table 6 addresses concerns that might arise because the IPUMS data are a random sample of households, not children. One child per-household has been randomly chosen to be included in this regression, and thus there is no inter-household correlation in schooling decisions. The coefficients estimating the effect of transportation change little.

Although Table 5 controls for child characteristics, it does not control for the characteristics of the household, including those of the parents. Con-

[5]This is a large part of why Donaldson and Hornbeck (in progress), using updated methods finds greater social savings than Fogel (1964).

sequently, in Table 7 we restrict the sample to children with both parents present in their place of residence, and add their demographic and available socioeconomic information to the regression. If the positive effect of rail access was due to changes in the economic status of parents in the treated counties, the transportation coefficients should be smaller in magnitude. Another possible explanation for the positive effect of transportation access on school attendance is through changes in the structure of the local economy. In particular, Atack et al. (2010) show that, on balance, changes in rail access were associated with increased urbanization in the Midwest before the Civil War. Previous research suggests that urban children were more likely to attend school than rural children either on cost grounds (schools were more available in urban areas) or because the rate of return to schooling was higher (Soltow and Stevens (1977)).

Table 7 also add dummy variables for urban and farm status to the regression. This regression also includes region×race interaction, with African-Americans pre- and post-civil war again coded differently, as one might expect different races in different areas to have very different experiences. However, as can be seen from the table, the effect of rail access is still positive, highly significant, and similar in magnitude to the coefficients in the previous tables.

One of the central effects of the transportation revolution was to raise land values. Higher land values may have led to increased school attendance in two distinct ways—greater household wealth would have led parents to send their children more frequently through an income effect, while higher land values in general would have provided more tax revenue for schools. Table 8 the logarithm of the average value of farm land, taken from the agricultural census (Haines (2010)), to the regression from Table 7, Note that the point estimates of the coefficients of the transportation measures are smaller and the average value of farm land is positive and statistically significant. However, we still observe a positive impact of access at 5 miles after controlling for land values, suggesting that there is something more to the transportation effect than simply a higher level of local development.

If part of the increase in schooling comes from farmers' wealth increasing we might expect that the effects of transportation access depend on where children live. Table 9 shows the transportation measure interacted with age and farm status. Note that the overall positive effect of transportation is larger for children living on a farm then for those not living on a farm, and that this effect varies greatly by age. For children younger than 11 the point estimate for children not living on a farm is larger, while for older children the point estimate for children living on a farm is larger. Indeed for children aged 14-16 the point estimate for non-farm children is negative. Perhaps greater transportation access opened up jobs for older children not living on a farm. Thus Table 9 shows one way in which the effects of transportation access may have been heterogeneous.

In summary, our preliminary findings indicate that the increase in access to transportation in the United States between 1850 and 1880 is positively associated with higher rates of school attendance. The treatment effect of transportation access is robust to including an extensive array of individual, parental, and family variables, including the location of the household within the county. The average value of farmland seems to explain a portion of this effect but more work is needed to pin down the other possible ways that transportation access mattered.

5 Concluding Remarks

This paper has presented preliminary findings on the relationship between transportation access and school attendance in the United States during the second half of the nineteenth century. Using a newly constructed panel data set on transportation access linked to samples of individuals from the 1850-1880 IPUMS, we show that improvements in access to transportation—specifically, the railroad—were associated with gains in school attendance, accounting for perhaps as much as 40% of the observed increase in schooling. The treatment effect of the railroad is largely robust to the inclusion of controls for demographic and socioeconomic characteristics of children and their parents, as well as household location, which suggests that the effect is capturing a response to changes in the returns to schooling relative to other uses of children's time or to the option value of schooling with respect to future geographic mobility. Indeed, an increase in the counties' wealth, as measured by land values, seems to reduce this effect slightly. Future work will assess further the robustness of the relationship as well as the underlying causal mechanisms.

References

Atack, J., Bateman, F., Haines, M. R., and Margo, R. A. (2010). Did Railroads Induce or Follow Economic Growth?: Urbanization and Population Growth in the American Midwest, 1850-1860. *Social Science History*, 34(2):171–197.

Atack, J., Haines, M. R., and Margo, R. A. (2011). Railroads and the Rise of the Factory: Evidence for the United States, 1850-1870. In Rhode, P., Rosenbloom, J., and Weiman, D., editors, *Economic Evolution and Revolutions in Historical Time*, pages 162–179. Stanford University Press, Palo Alto, CA.

Burr, H. A. (1851). Disturnell's New Map of the United States and Canada Showing All the Canals, Rail Roads, Telegraph Lines and Principal Stage Routes.

Colton, J. H. (1860). Colton's New Railroad & County Map of the United States and the Canadas &c.

Donaldson, D. and Hornbeck, R. Railroads and the Development of the American Economy.

Eisenberg, M. J. (1988). Compulsory Attendance Legislation in America, 1870 to 1915.

Fishlow, A. (1965). *American Railroads and the Transformation of the Ante-Bellum Economy.* Harvard University Press, Cambrige, MA.

Fogel, R. W. (1964). *Railroads and American Economic Growth: Essays in Econometric History.* Johns Hopkins University Press, Baltimore, MD.

Goldin, C. D. and Katz, L. F. (2008). *The Race between Education and Technology.* Belknap Press, Cambrige, MA.

Goodrich, C., editor (1961). *Canals and American Economic Development.* Columbia University Press, New York.

G.W. & C.B. Colton & Co. (1870). Colton's Railroad Map (Intermediate Size) of the United States Reduced from "Colton's Railroad and Commercial Map of the United States.". New York. Library of Congress Geography and Map Division Washington, D.C. 20540-4650 USA.

G.W. & C.B. Colton & Co. (1882). Colton's Intermediate Railroad Map of the United States.

Haines, M. R. (2010). Historical, Demographic, Economic, and Social Data: The United States, 1790-2002 [Computer file].

Haites, E. F., Mak, J., and Walton, G. M. (1975). *Western river trans-*

portation: The Era of Early Internal Development, 1810-1860. The Johns Hopkins University Press, Baltimore, MD.

Kahn, C. M. (1988). The Use of Complicated Models as Explanations: A Re-Examination of Williamson's Late 19th-Century America. *Research in Economic History*, 11:185–216.

Landes, W. M. and Solmon, L. C. (1972). Compulsory Schooling Legislation: An Economic Analysis of Law and Social Change in the Nineteenth Century. *The Journal of Economic History*, 32(1):54–91.

Margo, R. A. (1990). *Race and Schooling in the South, 1880-1950: An Economic History.* University of Chicago Press, 1990.

North, D. C. (1961). *The Economic Growth of the United States, 1790-1860.* Prentice-Hall, Englewood Cliffs, NJ.

Ransom, R. L. (1967). Interregional Canals and Economic Specialization in the Antebellum United States. *Explorations in Entrepreneurial History*, 5:12–35.

Ransom, R. L. (1970). Social Returns from Public Transport Investment: A Case Study of the Ohio Canal. *Journal of Political Economy*, 78(5):1041–1060.

Ruggles, S., Alexander, J. T., Genadek, K., Goeken, R., Schroeder, M. B., and Sobek, M. (2010). Integrated Public Use Microdata Series: Version 5.0 [Machine-readable database].

Soltow, L. and Stevens, E. (1977). Economic Aspects of School Participation in Mid-Nineteenth-Century United States. *The Journal of Interdisciplinary History*, 8(2):221–243.

Stover, J. F. (1978). *Iron Roads to the West: American Railroads in the 1850s*. Columbia University Press, New York.

Taylor, G. R. (1951). *The Transportation Revolution, 1815–1860. Vol. 4 of The Economic History of the United States*. Holt, Rhinehart, and Winston, New York.

The Gold Bug. Historic Map Libraries on CD ROM: Eastern United States 1911.

The Gold Bug. Historic Map Libraries on CD ROM: Western United States 1911.

Whitney, W. D. and Smith, B. E. (1911). *The Century Dictionary and Cyclopedia, with a New Atlas of the World; a Work of General Reference in All Departments of Knowledge*. Century, New York.

Williamson, J. G. (1974). *Late Nineteenth-Century American Development: A General Equilibrium History*. Cambridge University Press, New York.

Table 1: Means by Year

	(1) 1850	(2) 1860	(3) 1870	(4) 1880
Attended School Dummy	0.63	0.68	0.56	0.58
Rail Dummy	0.48	0.81	0.88	0.94
% within 5mi of RR	0.23	0.45	0.55	0.68
% within 15mi of RR	0.48	0.80	0.86	0.93
% within 40mi of RR	0.72	0.96	0.98	1.00
Transportation Dummy	0.75	0.90	0.95	0.97
% within 5mi of Transport	0.37	0.54	0.62	0.73
% within 15mi of Transport	0.71	0.87	0.92	0.96
% within 40mi of Transport	0.94	0.98	1.00	1.00
Transportation or Port Dummy	0.77	0.91	0.95	0.97
% within 5mi of Transport or Port	0.41	0.57	0.64	0.73
% within 15mi of Transport or Port	0.72	0.88	0.92	0.96
% within 40mi of Transport or Port	0.94	0.99	1.00	1.00
Black	0.02	0.02	0.15	0.16
Observations	46,728	55,434	76,579	88,430

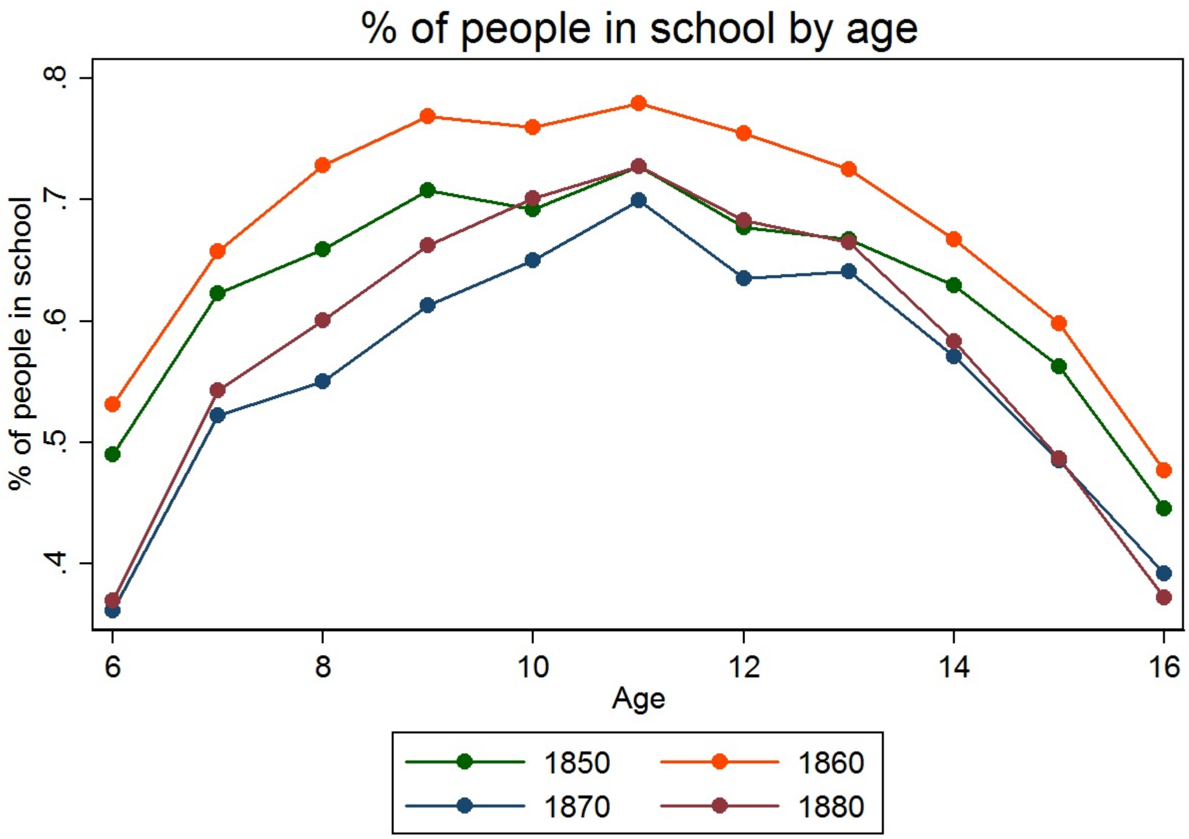
Sources: Railroad data from Atack, Bateman, Haines, & Margo (2010). Census data from IPUMS.

Note: The large jump in the African-American population is due to the inclusion of emaciated slaves post-civil war. The drop in overall school levels between 1860 and 1870 is partly due to lower levels of schooling among African-Americans.

Table 2: Sample Means by Year, Region, and Railroad Dummy

	East No Rail	East Rail	Midwest No Rail	Midwest Rail	South No Rail	South Rail
1850						
Attended School Dummy	0.74	0.76	0.60	0.72	0.44	0.45
% within 5mi of RR	0.04	0.51	0.00	0.42	0.00	0.41
% within 15mi of RR	0.29	0.89	0.06	0.92	0.05	0.85
% within 5mi of Transport	0.22	0.58	0.24	0.53	0.15	0.51
% within 15mi of Transport	0.62	0.92	0.60	0.96	0.39	0.91
Black	0.02	0.02	0.01	0.01	0.03	0.07
Observations	4,659	14,604	9,276	3,947	10,336	3,906
1860						
Attended School Dummy	0.76	0.76	0.70	0.73	0.49	0.50
% within 5mi of RR	0.07	0.62	0.02	0.54	0.02	0.43
% within 15mi of RR	0.42	0.94	0.34	0.93	0.19	0.86
% within 5mi of Transport	0.14	0.66	0.23	0.62	0.17	0.52
% within 15mi of Transport	0.57	0.95	0.71	0.95	0.48	0.92
Black	0.02	0.01	0.01	0.01	0.03	0.05
Observations	1,367	20,564	2,885	15,330	6,272	9,016
1870						
Attended School Dummy	-	0.73	0.64	0.71	0.23	0.26
% within 5mi of RR	-	0.72	0.02	0.63	0.01	0.46
% within 15mi of RR	-	0.97	0.37	0.96	0.24	0.88
% within 5mi of Transport	-	0.75	0.26	0.68	0.22	0.55
% within 15mi of Transport	-	0.97	0.73	0.96	0.61	0.93
Black	-	0.01	0.04	0.03	0.31	0.42
Observations	-	24,958	1,943	23,225	6,846	19,429
1880						
Attended School Dummy	-	0.70	0.63	0.69	0.38	0.38
% within 5mi of RR	-	0.84	0.06	0.79	0.03	0.52
% within 15mi of RR	-	0.98	0.58	0.99	0.36	0.91
% within 5mi of Transport	-	0.85	0.31	0.82	0.20	0.59
% within 15mi of Transport	-	0.99	0.85	0.99	0.61	0.95
Black	-	0.01	0.02	0.03	0.30	0.44
Observations	-	28,387	577	27,748	4,472	27,242

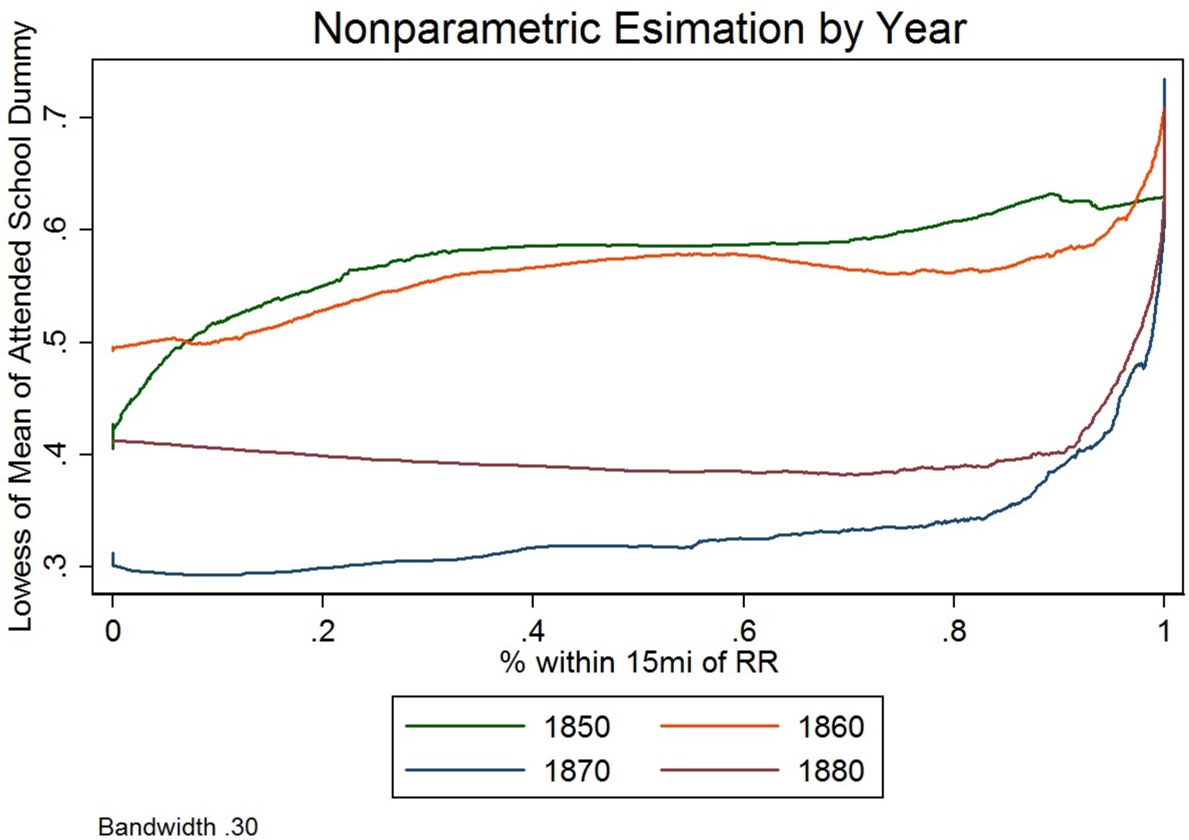
Figure 1: Percent of Childern in School by Age



Sources: Railroad data from Atack, Bateman, Haines, & Margo (2010). Census data from IPUMS.

Note: The large jump in the African-American population is due to the inclusion of emaciated slaves post-civil war. The drop in overall school levels between 1860 and 1870 is partly due to lower levels of schooling among African-Americans.

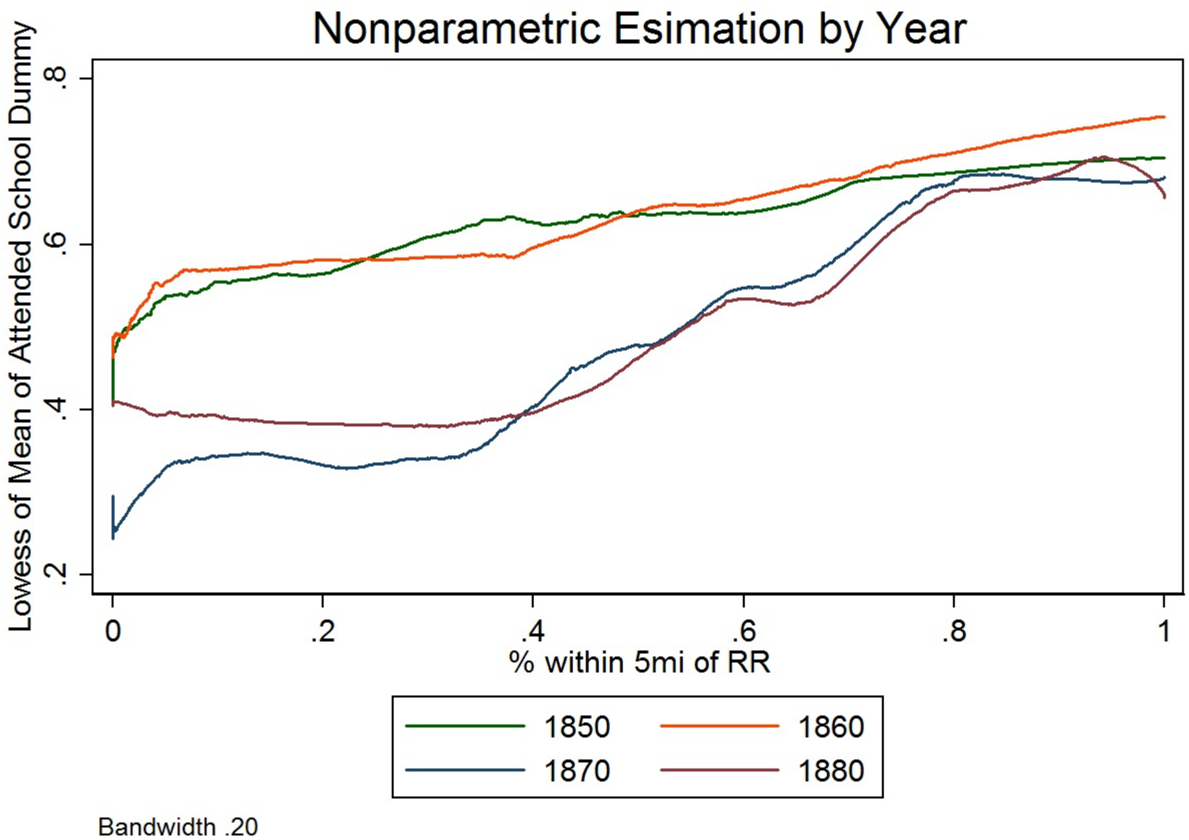
Figure 2: Nonparametric Regressions of School Attendance on the Percent of a County within 15 Miles of the Railroad



Sources: Railroad data from Atack, Bateman, Haines, & Margo (2010). Census data from IPUMS.

Note: The large jump in the African-American population is due to the inclusion of emaciated slaves post-civil war. The drop in overall school levels between 1860 and 1870 is partly due to lower levels of schooling among African-Americans.

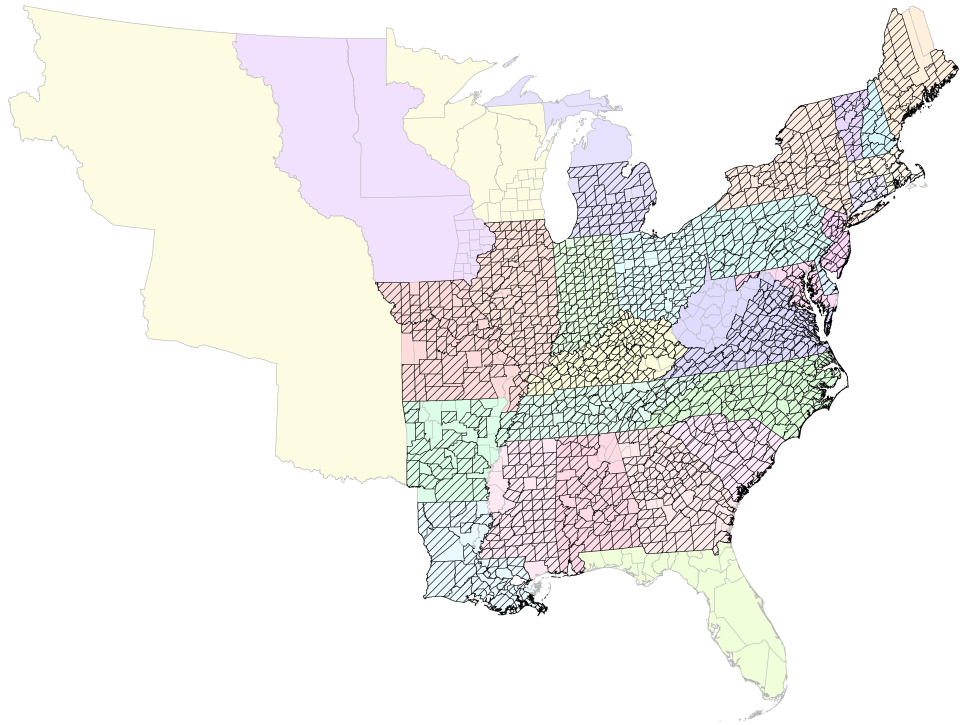
Figure 3: Nonparametric Regressions of School Attendance on the Percent of a County within 5 Miles of the Railroad



Sources: Railroad data from Atack, Bateman, Haines, & Margo (2010). Census data from IPUMS.

Note: The large jump in the African-American population is due to the inclusion of emaciated slaves post-civil war. The drop in overall school levels between 1860 and 1870 is partly due to lower levels of schooling among African-Americans.

Figure 4: Map of U.S. Counties in 1840



Shaded counties are including in our sample.

Table 3: 1850-1880

VARIABLES	(1) Schooling Dummy	(2) Schooling Dummy	(3) Schooling Dummy	(4) Schooling Dummy	(5) Schooling Dummy	(6) Schooling Dummy	(7) Schooling Dummy	(8) Schooling Dummy
Transportation Dummy	0.051**							
	(0.015)							
Rail Dummy		0.040**						
		(0.011)						
% within 5mi of RR			0.123**					
			(0.017)					
% within 15mi of RR				0.065**				
				(0.015)				
% within 40mi of RR					0.059*			
					(0.027)			
% within 5mi of Transport						0.128**		
						(0.019)		
% within 15mi of Transport							0.058**	
							(0.020)	
% within 40mi of Transport								-0.037
								(0.052)
Elasticity–Full Sample	0.080	0.057	0.107	0.090	0.095	0.128	0.088	-0.063
Pretrends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Counties	1089	1089	1089	1089	1089	1089	1089	1089
Observations	267,171	267,171	267,171	267,171	267,171	267,171	267,171	267,171
R-squared	0.163	0.163	0.164	0.164	0.163	0.164	0.163	0.163

Robust standard errors in parentheses. Standard errors clustered by county.

** p<0.01, * p<0.05, + p<0.1

Sources: Railroad data from Atack, Bateman, Haines, & Margo (2010). Census data from IPUMS.

Table 4: 1850-1860, 1860-1870, 1870-1880

VARIABLES	(1) Schooling Dummy	(2) Schooling Dummy	(3) Schooling Dummy	(4) Schooling Dummy	(5) Schooling Dummy	(6) Schooling Dummy
% within 5mi of RR	0.057**	0.213**	0.084**			
	(0.021)	(0.038)	(0.026)			
% within 15mi of RR	0.041*	0.129**	0.032			
	(0.018)	(0.036)	(0.031)			
% within 5mi of Transport				0.054*	0.248**	0.068*
				(0.025)	(0.040)	(0.029)
% within 15mi of Transport				0.019	0.138**	0.008
				(0.025)	(0.046)	(0.042)
Elasticity–Full Sample 5mi	0.031	0.170	0.095	0.038	0.230	0.083
Elasticity–Full Sample 15mi	0.040	0.177	0.052	0.024	0.206	0.013
Pretrends	Yes	Yes	Yes	Yes	Yes	Yes
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Counties	1089	1089	1089	1089	1089	1089
Observations	102,162	132,013	165,009	102,162	132,013	165,009
R-squared	0.141	0.208	0.204	0.141	0.208	0.204
Years	1850-1860	1860-1870	1870-1880	1850-1860	1860-1870	1870-1880

Robust standard errors in parentheses. Standard errors clustered by county.

** p<0.01, * p<0.05, + p<0.1

Sources: Railroad data from Atack, Bateman, Haines, & Margo (2010). Census data from IPUMS.

Table 5: 1850-1880 with Basic Demographics

VARIABLES	(1) Schooling Dummy	(2) Schooling Dummy	(3) Schooling Dummy	(4) Schooling Dummy	(5) Schooling Dummy	(6) Schooling Dummy	(7) Schooling Dummy	(8) Schooling Dummy
Transportation Dummy	0.051**							
	(0.014)							
Rail Dummy		0.042**						
		(0.010)						
% within 5mi of RR			0.105**					
			(0.015)					
% within 15mi of RR				0.065**				
				(0.013)				
% within 40mi of RR					0.065*			
					(0.025)			
% within 5mi of Transport						0.106**		
						(0.017)		
% within 15mi of Transport							0.054**	
							(0.018)	
% within 40mi of Transport								-0.040
								(0.052)
Female	-0.010**	-0.010**	-0.010**	-0.010**	-0.010**	-0.010**	-0.010**	-0.010**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Black Pre-1860	-0.270**	-0.270**	-0.267**	-0.270**	-0.270**	-0.268**	-0.270**	-0.269**
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Black Post-1860	-0.005	-0.006	-0.006	-0.006	-0.005	-0.006	-0.005	-0.006
	(0.041)	(0.040)	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)
Other Race	-0.327**	-0.326**	-0.325**	-0.322**	-0.329**	-0.325**	-0.322**	-0.329**
	(0.087)	(0.087)	(0.085)	(0.086)	(0.087)	(0.085)	(0.087)	(0.086)
Foreign Born	-0.220**	-0.220**	-0.221**	-0.220**	-0.220**	-0.220**	-0.220**	-0.220**
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Disabled	-0.412**	-0.411**	-0.413**	-0.412**	-0.411**	-0.413**	-0.412**	-0.411**
	(0.026)	(0.026)	(0.025)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)
Elasticity–Full Sample	0.086	0.075	0.102	0.108	0.119	0.110	0.088	-0.067
Pretrends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Age Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Counties	1089	1089	1089	1089	1089	1089	1089	1089
Observations	267,171	267,171	267,171	267,171	267,171	267,171	267,171	267,171
R-squared	0.235	0.235	0.235	0.235	0.234	0.235	0.235	0.235

Robust standard errors in parentheses. Standard errors clustered by county.

** p<0.01, * p<0.05, + p<0.1

Sources: Railroad data from Atack, Bateman, Haines, & Margo (2010). Census data from IPUMS.

Table 6: 1850-1880 with Basic Demographics, One Child Per-Household

VARIABLES	(1) Schooling Dummy	(2) Schooling Dummy	(3) Schooling Dummy	(4) Schooling Dummy	(5) Schooling Dummy	(6) Schooling Dummy	(7) Schooling Dummy	(8) Schooling Dummy
Transportation Dummy	0.045**							
	(0.015)							
Rail Dummy		0.038**						
		(0.010)						
% within 5mi of RR			0.097**					
			(0.015)					
% within 15mi of RR				0.057**				
				(0.014)				
% within 40mi of RR					0.075**			
					(0.027)			
% within 5mi of Transport						0.098**		
						(0.018)		
% within 15mi of Transport							0.045*	
							(0.019)	
% within 40mi of Transport								0.002
								(0.053)
Female	-0.015**	-0.015**	-0.015**	-0.015**	-0.015**	-0.015**	-0.015**	-0.015**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Black Pre-1860	-0.248**	-0.248**	-0.246**	-0.248**	-0.248**	-0.246**	-0.248**	-0.247**
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Black Post-1860	0.005	0.004	0.005	0.004	0.005	0.005	0.005	0.005
	(0.043)	(0.042)	(0.042)	(0.042)	(0.042)	(0.042)	(0.043)	(0.042)
Other Race	-0.275**	-0.272**	-0.273**	-0.271**	-0.275**	-0.273**	-0.271**	-0.275**
	(0.085)	(0.085)	(0.085)	(0.085)	(0.085)	(0.085)	(0.085)	(0.085)
Foreign Born	-0.215**	-0.215**	-0.215**	-0.215**	-0.215**	-0.215**	-0.215**	-0.215**
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Disabled	-0.367**	-0.366**	-0.369**	-0.367**	-0.367**	-0.368**	-0.367**	-0.367**
	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)
Elasticity–Full Sample	0.079	0.061	0.100	0.092	0.139	0.116	0.078	0.003
Pretrends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Age Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Counties	1089	1089	1089	1089	1089	1089	1089	1089
Observations	118,037	118,037	118,037	118,037	118,037	118,037	118,037	118,037
R-squared	0.229	0.229	0.230	0.229	0.229	0.230	0.229	0.229

Robust standard errors in parentheses. Standard errors clustered by county.

** p<0.01, * p<0.05, + p<0.1

Sources: Railroad data from Atack, Bateman, Haines, & Margo (2010). Census data from IPUMS.

Table 7: 1850-1880 with Family Demographics and Location

VARIABLES	(1) Schooling Dummy	(2) Schooling Dummy	(3) Schooling Dummy	(4) Schooling Dummy	(5) Schooling Dummy	(6) Schooling Dummy
Transportation Dummy	0.049**					
	(0.015)					
Rail Dummy		0.045**				
		(0.011)				
% within 5mi of RR			0.106**			
			(0.016)			
% within 15mi of RR				0.073**		
				(0.014)		
% within 5mi of Transport					0.105**	
					(0.018)	
% within 15mi of Transport						0.060**
						(0.019)
Urban	-0.003	-0.003	-0.004	-0.003	-0.003	-0.003
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Farm	0.009+	0.009+	0.009+	0.009+	0.009+	0.009+
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Elasticity–Full Sample	0.078	0.059	0.093	0.102	0.109	0.095
Pretrends	Yes	Yes	Yes	Yes	Yes	Yes
Region Race Interaction	Yes	Yes	Yes	Yes	Yes	Yes
Parents' Demographics	Yes	Yes	Yes	Yes	Yes	Yes
Father's Occupation	Yes	Yes	Yes	Yes	Yes	Yes
Family Size	Yes	Yes	Yes	Yes	Yes	Yes
Basic Demographics	Yes	Yes	Yes	Yes	Yes	Yes
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Counties	1089	1089	1089	1089	1089	1089
Observations	209,882	209,882	209,882	209,882	209,882	209,882
R-squared	0.244	0.244	0.245	0.244	0.244	0.244

Robust standard errors in parentheses. Standard errors clustered by county.

** p<0.01, * p<0.05, + p<0.1

Sources: Railroad data from Atack, Bateman, Haines, & Margo (2010). Census data from IPUMS.

Table 8: 1850-1880 Farm Values

VARIABLES	(1) Schooling Dummy	(2) Schooling Dummy	(3) Schooling Dummy	(4) Schooling Dummy	(5) Schooling Dummy	(6) Schooling Dummy
Transportation Dummy	0.029*					
	(0.014)					
Rail Dummy		0.029**				
		(0.010)				
% within 5mi of RR			0.052**			
			(0.017)			
% within 15mi of RR				0.036*		
				(0.014)		
% within 5mi of Transport					0.039*	
					(0.019)	
% within 15mi of Transport						0.016
						(0.019)
log Cash Value of Farms	0.099**	0.097**	0.092**	0.092**	0.095**	0.096**
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Elasticity–Full Sample	0.051	0.040	0.045	0.058	0.041	0.025
Pretrends	Yes	Yes	Yes	Yes	Yes	Yes
Location Variables	Yes	Yes	Yes	Yes	Yes	Yes
Family Demographics	Yes	Yes	Yes	Yes	Yes	Yes
Basic Demographics	Yes	Yes	Yes	Yes	Yes	Yes
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Counties	1089	1089	1089	1089	1089	1089
Observations	209,882	209,882	209,882	209,882	209,882	209,882
R-squared	0.247	0.247	0.247	0.247	0.247	0.247

Robust standard errors in parentheses. Standard errors clustered by county.
** p<0.01, * p<0.05, + p<0.1
Sources: Railroad data from Atack, Bateman, Haines, & Margo (2010). Census data from IPUMS.

Table 9: 1850-1880, Transportation Measure Interacted with Age and Farm Status

	% within 5mi of RR interacted with		% within 15mi of RR interacted with		% within 5mi of Transport interacted with		% within 15mi of Transport interacted with	
	Not Farm	Farm	Not Farm	Farm	Not Farm	Farm	Not Farm	Farm
VARIABLES	Schooling Dummy		Schooling Dummy		Schooling Dummy		Schooling Dummy	
All Ages	0.077**	0.133**	0.042**	0.080**	0.080**	0.131**	0.031+	0.068**
	(0.015)	(0.015)	(0.013)	(0.013)	(0.017)	(0.017)	(0.018)	(0.018)
Interaction with:								
Age 6	0.101**	0.106**	0.072**	0.072**	0.097**	0.095**	0.064**	0.062**
	(0.023)	(0.020)	(0.018)	(0.016)	(0.024)	(0.022)	(0.023)	(0.022)
Age 7	0.177**	0.153**	0.109**	0.085**	0.177**	0.151**	0.107**	0.083**
	(0.020)	(0.020)	(0.017)	(0.016)	(0.022)	(0.022)	(0.023)	(0.022)
Age 8	0.187**	0.179**	0.124**	0.109**	0.194**	0.182**	0.119**	0.100**
	(0.019)	(0.019)	(0.017)	(0.016)	(0.021)	(0.021)	(0.022)	(0.022)
Age 9	0.176**	0.155**	0.102**	0.083**	0.185**	0.168**	0.108**	0.092**
	(0.020)	(0.019)	(0.017)	(0.016)	(0.022)	(0.021)	(0.022)	(0.021)
Age 10	0.171**	0.165**	0.107**	0.098**	0.176**	0.167**	0.103**	0.092**
	(0.019)	(0.018)	(0.017)	(0.016)	(0.021)	(0.020)	(0.022)	(0.022)
Age 11	0.143**	0.140**	0.095**	0.095**	0.150**	0.151**	0.090**	0.091**
	(0.018)	(0.018)	(0.016)	(0.016)	(0.020)	(0.020)	(0.022)	(0.022)
Age 12	0.121**	0.142**	0.081**	0.097**	0.122**	0.143**	0.067**	0.081**
	(0.017)	(0.017)	(0.016)	(0.015)	(0.019)	(0.019)	(0.021)	(0.021)
Age 13	0.068**	0.139**	0.034*	0.082**	0.077**	0.146**	0.032	0.079**
	(0.018)	(0.018)	(0.017)	(0.017)	(0.020)	(0.021)	(0.023)	(0.023)
Age 14	-0.032+	0.113**	-0.038*	0.065**	-0.030	0.105**	-0.054*	0.045*
	(0.018)	(0.018)	(0.017)	(0.016)	(0.020)	(0.020)	(0.022)	(0.021)
Age 15	-0.152**	0.072**	-0.124**	0.042*	-0.147**	0.065**	-0.149**	0.011
	(0.023)	(0.020)	(0.022)	(0.017)	(0.026)	(0.023)	(0.027)	(0.023)
Age 16	-0.237**	0.037+	-0.185**	0.022	-0.246**	0.010	-0.226**	-0.027
	(0.022)	(0.020)	(0.022)	(0.017)	(0.025)	(0.022)	(0.027)	(0.023)
Female	-0.009**		-0.009**		-0.009**		-0.009**	
	(0.002)		(0.002)		(0.002)		(0.002)	
Black Pre-1860	-0.263**		-0.264**		-0.263**		-0.264**	
	(0.006)		(0.006)		(0.006)		(0.006)	
Black Post-1860	-0.010		-0.007		-0.010		-0.006	
	(0.041)		(0.041)		(0.041)		(0.041)	
Other Race	-0.317**		-0.309**		-0.319**		-0.311**	
	(0.083)		(0.085)		(0.083)		(0.086)	
Foreign Born	-0.205**		-0.207**		-0.205**		-0.207**	
	(0.008)		(0.008)		(0.008)		(0.008)	
Disabled	-0.407**		-0.407**		-0.406**		-0.405**	
	(0.027)		(0.027)		(0.027)		(0.027)	
Pretrends	Yes		Yes		Yes		Yes	
County Dummies	Yes		Yes		Yes		Yes	
Year Dummies	Yes		Yes		Yes		Yes	
Counties	1089		1089		1089		1089	
Observations	267,171		267,171		267,171		267,171	
R-squared	0.245		0.242		0.245		0.242	

Robust standard errors in parentheses. Standard errors clustered by county.

** p<0.01, * p<0.05, + p<0.1

Sources: Railroad data from Atack, Bateman, Haines, & Margo (2010). Census data from IPUMS.