Jeremy Atack, Fred Bateman, Michael Haines,
and Robert A. Margo

Did Railroads Induce or Follow Economic Growth?

Urbanization and Population Growth in the American Midwest, 1850–1860

Using a newly developed geographic information system transportation database, we study the impact of gaining access to rail transportation on changes in population density and the rate of urbanization between 1850 and 1860 in the American Midwest. Differences-in-differences and instrumental variable analysis of a balanced panel of 278 counties reveals only a small positive effect of rail access on population density but a large positive impact on urbanization as measured by the fraction of people living in incorporated areas of 2,500 or more. Our estimates imply that one-half or more of the growth in urbanization in the Midwest in the late antebellum period may be attributable to the spread of the rail network.

Social Science History 34:2 (Summer 2010)
DOI 10.1215/01455532-2009-024

Over half a century ago, George Rogers Taylor (1951) celebrated what he believed to be the central role played by "the transportation revolution" in America's social and economic changes during the nineteenth century. According to Taylor, nowhere were these changes greater than in the Midwest. There, in less than two generations, a sparsely populated frontier region was transformed into the world's breadbasket, an industrial heartland and home to the seventh, eighth, and ninth largest cities in the United States. When Ohio achieved statehood in 1803, the only ways into the region were by sail, by paddle, or on foot. Eight years later the *New Orleans* demonstrated the feasibility of steam navigation on the Ohio and Mississippi rivers. By 1818 the National Road had reached the eastern shore of the Ohio River at Wheeling; in 1825 the Erie Canal opened, creating an unimpeded water route between the Atlantic Ocean and the Great Lakes; and in 1832 the first canal in the region, the Ohio and Pennsylvania, began to carry traffic. In the years that followed, not only did these transportation networks spread throughout the region, but they were joined by a new medium, the steam railroad. Collectively, they provided ever easier means of entry for new migrants and ever cheaper means for the export of the region's produce.

The potential economic impact of improved transportation modes was recognized from the very beginning. For example, Treasury Secretary Albert Gallatin, in his famous report to Congress, noted that "good roads and canals will shorten distances, facilitate commercial and personal intercourse, and unite, by still more intimate community of interests, the most remote quarters of the United States" (U.S. Senate 1808: 725). The net result, he argued, would be an increase in national wealth. Consequently, he advocated the "early and efficient aid of the *Federal* government" to mediate market failures and the externalities associated with the supply of these transportation services (ibid.: 725; see, e.g., Paskoff 2007). Many states also took this advice to heart, with the result that most of the roads and canals were built with state sponsorship (Goodrich 1961).

Although the railroad was the latecomer to the transportation revolution, it quickly rose to dominance. By 1840 there were about as many miles of railroad in operation as of canals (Taylor 1951: 79). A decade later railroad mileage exceeded that of canals by more than two to one and was closing in on the total miles of navigable waterway in the Mississippi and Ohio river system (ibid.; Hunter 1949). By 1860 the United States had more miles of railroad than the rest of the world combined (Mitchell 2003: 673–74, series F1). Moreover, the American Midwest, which at the start of 1836 had no railroads, was by the mid-1850s the focus of much of this rail construction. Indeed, between 1853 and 1856 more than half of the new track miles in the United States were built in the Midwest, and in 1856 this share reached a remarkable 75 percent. Even more impressive, almost 40 percent of the total mileage built in 1856 was in just one state, Illinois (Fishlow 1965: 172; Carter et al. 2006: series Df882).

According to Leland H. Jenks (1944: 2–3), the expansion of this railroad network into the Midwest "to link the seaboard with the interior, the Ohio Valley with the Great Lakes, and, breaking away from the contours of water transport, to unite distant points by more direct routes . . . gave the 'railroad idea' prolonged force in American economic life. The conviction that the railroad would run anywhere at a profit put fresh spurs to American ingenuity and opened closed paddocks of potential enterprise." In short, the railroad played a central role in American economic development.

Jenks was far from the first person to make such a sweeping claim. A *New Orleans Picayune* editorial from 1860 claimed that "nine-tenths of our roads when first traversed by steam pass through long ranges of woodlands in which the ax has never resounded, cross prairies whose flowery sod has never been turned by the plow, and penetrate valleys as wild as when the first pioneers followed upon the trail of the savage" (quoted in Fishlow 1965: 166), and a British investment adviser of the late nineteenth century, Salomon Frederik van Oss (1893: 7), opined to the investing public that "the American railroad came in advance of the settlers."

Certainly, between 1840 and 1860, a period that includes the first railroad construction boom, people flooded into the American Midwest. Wisconsin's population increased more than twentyfold in these two decades; Michigan's, fifteenfold; Illinois's, almost fourfold. Moreover, vast areas of territory were transformed from what the federal government identified as "frontier"—areas where population density was below six persons per square mile (essentially less than one typical family per square mile)—to settled, and even urban, communities. Indeed, densities in the counties surrounding Cincinnati, St. Louis, and Milwaukee averaged more than 250 persons per square mile by 1860.

In one of the most famous of all cliometric works, Albert Fishlow (1965) sought to determine whether railroads were "built ahead of demand" in the antebellum American Midwest. That is, did they lead economic development? As he noted:

> The magnitude of these changes in the transportation sector was fully matched by changes in other parts of the western economy [and while] . . . a theoretical structure invoking lower transport costs can explain [the changes in the economy,] . . . such a logical relationship does not establish unequivocal causality. If population migrations had already extended the agricultural frontier, if urban agglomerations had already become prominent, transportation improvements may have justified and reinforced such development rather than initiated them. (ibid.: 163–64)

Moreover, "a key issue . . . is whether such railroad influence was primarily exogenous or endogenous, whether railroads first set in motion the forces culminating in the economic development of the decade, or whether arising in response to profitable situations, they played a more passive role" (ibid.: 203).

In his analysis Fishlow looked at a number of indicators: whether or not investors demanded a risk premium on construction bonds, the pattern of ex post profitability of the midwestern railroads, and the pattern of rail construction relative to initial population density. Each supported his basic conclusion that midwestern railroads were not built ahead of demand. Rather, the railroads diffused where they were largely profitable from the very beginning, which was where growth had been occurring and would have continued to occur in the absence of the iron horse.

This article revisits Fishlow's analysis of the role of the railroad in midwestern development, because, although he argued that the railroad was not built ahead of demand, he stopped short of quantifying the "treatment effect" of the diffusion of the railroad—that is, the causal impact from gaining access to rail transport.[1] Here, we provide estimates of treatment effects for one outcome that Fishlow considered, population density, and one that he did not, urbanization. Our results suggest that the railroad had causal effects on both of these outcomes. The effect on population density was small, as Fishlow believed. However, the effect on urbanization was quite large. Taking our results at face value, somewhat more than half of midwestern urbanization in the 1850s can be attributed to the causal impact of railroad diffusion.

We use two recent methodological innovations to reach these conclusions. The first innovation is econometric: we apply differences-in-differences and instrumental variable (IV) estimators to the problem of estimating the causal effect of gaining rail access. In a differences-in-differences analysis we compare outcomes "before-and-after" the coming of the railroad through a "treatment" group versus a "control" group. The unit of observation is the county, and the treatment group consists of counties that only gained access to the railroad during the 1850s, whereas the control group consists of counties that did not have rail access before the Civil War. We then use IV analysis as a robustness check on these differences-in-differences estimates. Specifically, we seek credible exogenous variation in rail access that can be attributed to a factor—the instrument—that predicts rail access but does not have a direct effect on the outcome in question. Both of these econometric methods are now common in economics, but their use in quantitative history has been limited. We implement these techniques with a new dataset documenting the diffusion of the railroad that we have in turn linked to economic outcomes at the county level.

Railroad Expansion in the Midwest

Although Ohio was the first midwestern state admitted to the Union and was by far the most populous state west of the Appalachians until the 1880s, it was not the first state in the region to adopt the new rail technology. Indeed, having invested heavily in the earlier canal technology, Ohio initially tried hard to discourage the interloper from devaluing the state's existing infrastructure investment. Instead, Michigan's territorial legislature (Michigan did not achieve statehood until 1837) chartered the Pontiac and Detroit Railroad in 1830. Service on that line, however, did not begin until 1838, with steam service the following year, and by then a second line, the Erie and Kalamazoo Railroad, chartered in 1833, already joined Port Lawrence, Michigan (now known as Toledo, Ohio), at the western end of Lake Erie, to a point on the Kalamazoo River, thus (theoretically) providing a link across the state to Lake Michigan. It opened to steam service in 1837 between Toledo and Adrian (Dunbar 1966; Meints 1992).[2] Railroad construction in Ohio began in 1835, and by 1837 the Mad River and Lake Erie Railroad was operating on a 4' 10" gauge. This nonstandard gauge became the standard gauge in Ohio, but happily the difference between this "Ohio gauge" and the standard gauge, 4' 8½", was sufficiently small that each could accommodate the locomotives and rolling stock of the other within the margin of error provided by the wheel tread.

Despite these pioneering efforts in the 1830s, rail construction did not begin in earnest in the Midwest until the late 1840s. Once under way, though, it proceeded rapidly (mostly on a gauge compatible with the standard 4' 8½" track, with the notable exception of the Ohio and Mississippi Railroad, built

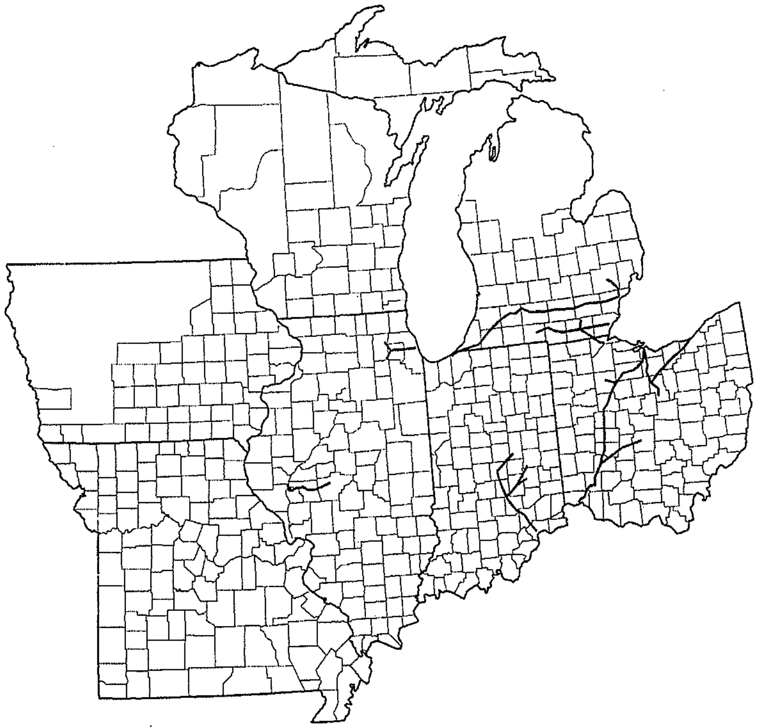

Figure 1 Progress of railroad construction in the Midwest, 1850

on a 6' gauge between Cincinnati and [East] St. Louis), and the region dominated new construction in several years. Figure 1 displays the rail network in the seven midwestern states (without distinction with regard to gauge) as of 1850 and 1860, and we compare those counties that gained access to a railroad during the 1850s with those that still did not have rail access by 1860.

The Data

The data used in this study come from two quite different sources. The first is a newly constructed geographic information system (GIS) database on transportation infrastructure for the nineteenth-century United States. This is based on the work of F. L. Paxson (1914), supplemented by other digitized

Figure 2 Progress of railroad construction in the Midwest, 1860

images, as described below, to create "shapefiles" that geolocate contemporary transportation media in a manner that the GIS software (in this case, ESRI's ArcGIS 9.3) can manipulate.[3] The GIS database is then linked to other electronic data files containing information on economic outcomes—in our case, the Inter-university Consortium for Political and Social Research's (ICPSR 197?) well-known electronic file of the published U.S. censuses, "Historical, Demographic, Economic, and Social Data: The United States, 1790–1970," as updated and modified by Michael Haines.[4]

Our GIS database for the Midwest is part of a larger project on transportation that will eventually yield similar data covering the entire country during the nineteenth and early twentieth centuries. The GIS methodology has a number of advantages over the approach taken by previous historians that typically involved matching historical transportation maps to county boundary maps by hand (and eye).[5] In recent years, however, libraries and archives across the United States have begun to digitize their holdings, including historical maps. Compared with the traditional method (which, in this case, would involve printing out the digitized maps and hand-eye tracing), GIS is more efficient and (potentially) more accurate at transforming such materials into a machine-readable database.

For five midwestern states (Illinois, Indiana, Michigan, Ohio, and Wisconsin) we have generated a complete and consistent GIS dataset. The raw materials for this were assembled more than 90 years ago by an army of University of Wisconsin students, who used contemporary travel guides, giving route maps and timetables for the convenience of the traveling public, to draw a series of small-scale maps showing the spreading rail network in these states between 1848 and 1860 (Paxson 1914). These travel guides first appeared in the 1840s and include *Disturnell's Railroad, Steamboat, and Telegraph Book*, *Doggett's Railroad Guide and Gazetteer*, *Appleton's Railway and Steam Navigation Guide for the United States and the Canadas*, *American Railway Guide and Pocket Companion for the United States*, *Lloyd's American Guide*, *Travelers' Official Railway Guide of the United States and Canada*, and *The Rand-McNally Official Railway Guide and Handbook* (Disturnell 1846; Doggett 1847; Appleton and Company 1848; Cobb 1850; Lloyd 1857; National Railway Publication Company 1868; Rand-McNally 1871). Some of these were published monthly, others semiannually or annually. Each went through many editions.[6]

The belief that these travel guides represented the best possible sources of information about rail service is market-driven and supported by contemporary claims. Competition and frequent publication should have ensured that only the more useful of these guides survived. Curran Dinsmore's guide (Cobb 1850), for example, was singled out for praise by one of the leading commercial and business publishers of the time, *Hunt's Merchants' Magazine and Commercial Review*:

> We are indebted to the publishers for a copy of the last number of their NEW GUIDE; and must say that for conciseness, mingled with complete information, neatness of execution, and convenience of reference, it fully equals our expectations of what a Railroad Guide should be. Besides the usual tables of distances, times, and fares, the traveler is provided with a handsome and complete railroad map of the whole country, and small maps of the great centers and trunk lines, with tables of reference to the details of the lines represented on them, and very perfect tables of steamboat lines on the principal rivers and waters; and appended to the whole is an excellent Railroad Gazetteer. Dinsmore, as he has always done, keeps up with the times; and it is a great inducement for him to do so, that he may furnish correct information for those whose lack of originality leads them to copy from him. We can unhesitatingly recommend *Dinsmore's American Railroad and Steam Navigation Guide* [*sic*]. (Hunt 1857: 253)

Paxson's maps compiled from these sources have been digitally rendered in GIS and fitted to other mappings of rail routes, most notably those prepared by Taylor and I. D. Neu (1956) for the same period and assembled from similar sources.[7] The GIS-generated estimates of the railroad mileage are within 3 percent of the state totals reported by Paxson.[8]

For Iowa, Fishlow used data from Henry Varnum Poor (1868). Other scholars, however, have raised serious questions about these data. Elmus Wicker, for example, has written:

> I have attempted to evaluate Poor's data for 1830–60 by comparing his estimates with those prepared by Armin Shuman for the 1880 census and also with my own estimates for eight states. . . . One plausible explanation for the discrepancy is that the differences are due simply to errors of reporting. Furthermore, there is some ambiguity as to what exactly is being measured. . . . I think that the total mileage evidence clearly shows the unreliability of Poor's annual data. . . . shortcomings in Poor's data arise also from the variety of purposes for which they have been employed. (National Bureau of Economic Research 1960: 505, 507–8)

As an alternative to Poor's retrospective data, we have used digitized contemporary state maps from the online David Rumsey Map Collection (www.davidrumsey.com) to chart the spread of railroads in Iowa and Missouri. Unfortunately, it was not possible to find a map for each state in each year, and for a variety of reasons these data are less satisfactory than the travel-guide data used by Paxson. The maps tend to be ambiguous with regard to date. Most list their copyright date rather than the date represented by the data. In drafting their maps, the mapmakers attempted to capture a flow—railroad construction—as a snapshot. Consequently, even the most accurately drawn map, if it spent a month or two in production, might miss more new railroad mileage built during that period than had existed in the entire country in the 1830s or early 1840s (Carter et al. 2006: tables Df882 and Df884). Some mapmakers tried to anticipate this fluidity by building their expectations for near-term expansion into their maps, only to see those plans go unrealized as funding fell through or construction was temporarily halted. Moreover, few of the mapmakers had personal knowledge of all of the rail systems they drew and so relied on secondhand information. Last and certainly not least, rail lines were not accurately and consistently drawn on maps, with the result that railroads sometimes appear to shift location from year to year. A few of these may have been realigned and regraded.[9] However, in most cases, once a railroad was built in a specific location, it stayed there for decades, because the bulk of the railroad's investment was not just fixed but also sunk.[10]

The rail data have been supplemented with information on navigable waterways from Goodrich 1961 and Hunter 1949, along with various nineteenth-century sources, such as Poor 1860 and contemporary maps (e.g., Disturnell's 1850 map of the United States "showing all the canals, railroads, telegraph lines, and principal stage routes" [Burr 1850]).[11] The nature of these sources is such that we measure water access as of a single benchmark date—1850—rather than change over time. Thereafter, however, there were few additions to waterways anywhere in the country.

Although the GIS software can, in principle, produce a wide range of measures of transportation access—such as the fraction of land that lay within x miles of a railroad—here we have used a simple binary variable, ACCESS, indicating whether or not a particular transportation medium crossed or formed a border for each county in existence at the census benchmark dates. We rely on this measure because our current GIS overlays, while able to create the "0–1" access variable, are not yet sufficiently accurate to produce more refined measures of access, such as total mileage or the number of station stops.[12] However, we believe that our rail access variable is the best current measure of the spread of the U.S. railroad system at the county level, even though it clearly has limitations and should be viewed with caution.[13] To summarize, our end product is a county-level panel dataset showing whether a county had rail access in 1850 or 1860 and whether it had water access in 1850.

Because we focus on the effects of gaining rail access on economic outcomes, by construction all of the variation over time in transportation access occurs in the rail variable. The GIS data have then been linked to the county-level Haines-ICPSR census data using Federal Information Processing Standard (FIPS) codes, restricting our analysis to counties that were present in 1840, had the same boundaries as determined by square mileage in 1850 and 1860, and did not have rail access as of 1850. These restrictions produce a balanced panel to 278 midwestern counties, distributed as shown in table 1, and are driven in large part by our choice of differences-in-differences as our primary estimation strategy.[14] One consequence of needing data from 1840, however, is to eliminate many counties in northern Michigan and Wisconsin and those in Iowa located farther from the Mississippi River.

Table 1 Distribution of counties by state

State	Number of counties	Percentage of total
Illinois	71	25.5
Indiana	66	23.7
Iowa	17	6.1
Michigan	12	4.3
Missouri	41	14.8
Ohio	57	20.5
Wisconsin	14	5.0

Source: Inter-university Consortium for Political and Social Research 197? [*sic*] for the 1850 and 1860 census, with transportation database.
Notes: To be included, counties must (1) be present in 1840, 1850, and 1860; (2) have fixed county boundaries; and (3) lack rail access in 1850 but have it by 1860 (treatment group) or lack it in both 1850 and 1860 (control group). There are 278 counties in the sample.

In the differences-in-differences approach, the data are divided into two groups: a treatment group and a control group. In our case, the treatment is gaining rail access in the 1850s. Consequently, our treatment group consists of those counties that did not have rail access in 1850 but that did by 1860. The most natural control group with which to contrast the treatment group is counties that still lacked rail access in 1860. Use of 1840 data then allows us also to control for preexisting trends in the counties.

Measuring the Effect of the Railroad on Population Density and Urbanization

To estimate the economic impact of the railroad, we need county-level indicators of economic development that are consistently defined over time. Although there are a number of possibilities in the census data (some of them suggested by Fishlow), we focus on two related measures: population den-

Table 2 Sample means of percent urban, log population density, and rail access in 1850 and 1860

Variable	1850	1860	1860 – 1850
Rail = 1	0.000	0.717 {0.785}	0.717 {0.785}
Percent urban	0.067	0.117	0.048
Log (population density)	2.882	3.447	0.565

Source: See text and table 1.
Notes: The sample consists of counties that gained rail access between 1850 and 1860 (treatment group) and counties that did not have rail access before the Civil War (control group); see the notes to table 1. Rail = 1 if railroad passes through county boundary, 0 otherwise. By construction, no counties have rail access in 1850. Percent urban = (population residing in villages, towns, cities of 2,500 or more)/(total population). Log (population density) = log (total population/land area of county in square miles). {} = counties are weighted by average population in 1840, 1850, and 1860. Figures outside {} in columns 2 and 3 are weighted averages of county values. For percent urban, the weight is a county's average population in 1840, 1850, and 1860. For rail access and log of population density, the weight is a county's area in square miles in 1850. Column 4 = column 3 – column 2.

sity and the fraction of a county's population living in urban areas.[15] These are among the most reliable and consistently defined numbers reported by the censuses, and there are, as Fishlow himself pointed out, good economic reasons to expect transportation improvements like the railroad to have had a positive effect on population growth and urbanization.

By construction none of the counties in our sample had rail access in 1850. By 1860, however, 195 of the 278 counties, making up almost 72 percent of the land area in the panel, had direct access to at least one railroad (table 2). Weighted by average population over the period, the increase was even more impressive, with 78.5 percent gaining access to rail during the 1850s.[16] Population per square mile grew an average of almost 76 percent (i.e., by $[\exp(0.565) - 1] \times 100$ percent), and the fraction of population living in urban areas grew from 6.7 percent to 11.7 percent. Weighted by county population, the increase in urbanization was slightly smaller, 4.8 percentage points.

Table 3 reports our base differences-in-differences estimates. We compute the decadal changes in the outcome (percent urban or log population density) separately for the treatment group (counties that gain rail access) and the control group (counties without rail access before the Civil War) and compute the difference. As can be seen from the figures in column 6, row 3, of either panel, the increases in urbanization or population density between 1850 and 1860 were larger for the treatment counties than for the control

Table 3 Differences in urbanization and population density between the control and treatment counties, 1840–1860

Variable	*N*	1840	1850	1860	1860 – 1850 (DD)	1850 – 1840
Panel A: Percent urban						
Treatment	195	0.029	0.084	0.143	0.059	0.055
Control	83	0.000	0.003	0.025	0.022	0.003
Treatment – control		0.029	0.081	0.118	0.037* (0.012)	0.058
Panel B: Log of population density						
Treatment	195	2.224	2.953	3.527	0.574	0.733
Control	83	2.148	2.703	3.245	0.542	0.555
Treatment – control		0.076	0.250	0.282	0.032 (0.052)	0.178

Source: See text and table 1.
Notes: Treatment = a county did not have rail access in 1850 but gained it by 1860. Control = a county had no rail access before the Civil War. Figures shown in columns 3–5 are weighted averages of county values. For panel A, the weight is a county's average population in 1840, 1850, and 1860; for panel B, it is a county's area in square miles in 1850. Column 6 = column 5 – column 4. Column 7 = column 4 – column 3. DD = differences-in-differences. () = standard error.
*Significant at the 5 percent level.

counties. In the case of urbanization, the "excess" growth in urbanization attributed to the coming of the railroad in the 1850s is 3.7 percentage points, with a standard error of 1.2 percentage points. This effect is not only statistically significant but economically very large, considering that the sample mean value of percent urban in 1850 was only 6.7 percent. By contrast, the effect of railroad expansion is very modest, 0.032 log points, or 3.2 percent, and not statistically significant.

Ideally, in a differences-in-differences analysis we would like to "match" the treatment and control counties so that the groups are observationally equivalent except for the treatment. However, this was clearly not the case with respect either to the levels of urbanization and population density in 1850 or to trends in these over the 1840s. Indeed, the differences are quite stark. As early as 1840 almost 3 percent of the population in the treatment group lived in urban areas, whereas none of the population in the control group counties lived in urban areas (panel A). By 1850 the level of urbanization in the treatment group had almost tripled to 8.4 percent, an increase of 5.5 percentage points, almost 20 times greater than the increase in the control group's urbanization rate. During the 1850s urbanization in the treatment group increased by another 5.9 percentage points, to 14.3 percent of the population in the treatment counties by 1860, whereas the fraction of the population living in urban areas in the control counties in 1860 was still below the level achieved in the treatment group by 1840.

The differences in population density (panel B) are not as dramatic as those in urbanization rates between the treatment and control group counties, but these differences (which are in logs) are large, and the pattern is the same as that in panel A. Indeed, population density grew especially rapidly in the treatment group counties in the decade prior to the coming of the railroad. Density in the treatment group counties more than doubled during the 1840s. In the control group counties it still grew rapidly, though only by 75 percent. It grew somewhat more slowly in both groups during the 1850s, especially in the treatment group counties, so that the differences in population density growth between the treatment and control groups narrowed sharply during the decade, but the treatment group counties continued to pull ahead of the control group counties.

Indeed, if we computed the base differences-in-differences estimator using the change in outcomes from 1840 and 1850 reported in table 3, we would apparently find effects attributable to the railroad (the differences between the control and the treatment groups) *before* these could have logically occurred—that is, during the 1840s, in advance of the railroad's arrival in any of the counties in the panel (see row 3, column 7, of panels A and B).

The correlations between "pretreatment" changes in density and urbanization and gaining rail access that are evident in panels A and B of table 3 are symptoms of a more general phenomenon: railroads were built not randomly but purposely. Railroad promoters and investors did not lay out their lines blindly but sought locations where the chances of success—profitability—were greatest. Table 4 illuminates key correlates of gaining rail access by presenting linear probability regressions. In column 2 the independent variables are the 1840 values of percent urban and log population density plus the changes in these variables over the 1840s. All of the coefficients are positive, and two are statistically significant (the population density variables) at the 5 percent level. In column 3 we have added a measure of agricultural productivity to the regression, the log of the value of agricultural output per acre (i.e., the yield), and dummies for water transportation access. Counties that had greater agricultural revenues per acre were much more likely to get a

Table 4 County-level correlates of gaining rail access in the 1850s: Linear probability estimates

Variable	Coefficient	Coefficient	Coefficient
Constant	0.322*	0.332*	0.456
	(0.098)	(0.124)	(0.150)
Percent urban, 1840	0.093	0.246	0.614
	(0.727)	(0.679)	(0.680)
Log (population density), 1840	0.113*	0.013	−0.001
	(0.032)	(0.040)	(0.050)
Δ (percent urban), 1850 − 1840	0.635	0.916*	0.760*
	(0.380)	(0.361)	(0.371)
Δ log (population density), 1850 − 1840	0.187*	0.092	0.010
	(0.050)	(0.054)	(0.075)
Log (agricultural yield), 1850		0.306*	0.308*
		(0.076)	(0.092)
Canal = 1		0.140*	0.125
		(0.071)	(0.078)
Navigable river = 1		−0.256*	−0.244*
		(0.054)	(0.058)
Great Lakes = 1		−0.064	−0.006
		(0.120)	(0.124)
State dummies	No	No	Yes
Adjusted R^2	0.067	0.177	0.200

Source: See text and table 1.
Notes: The unit of observation is the county ($N = 278$). Dependent variable = 1 if a county gains rail access by 1860 (treatment group), 0 otherwise (control group). Agricultural yield = value of agricultural output/(improved + unimproved acres in agriculture). Observations are weighted by county square miles prior to estimation. () = standard error.
*Significant at the 5 percent level.

railroad. It also appears that canals and railroads were complements, whereas the presence of a navigable river slowed rail expansion, perhaps because it raised the costs of railroad building (i.e., bridges) and represented low-cost competition for traffic. Column 4 adds state dummies to the regression. Collectively, while these are significant, controlling for individual state effects does not alter the significance of agricultural yields or the navigable river dummy and has only a small impact on the change in percentage of the population living in urban areas.

Because of the significant explanatory power of these variables for whether or not a county obtained rail access during the 1850s and because it

Table 5 Differences-in-differences regression estimates: Effects of gaining rail access on urbanization and population density

Variable	Percent urban	Percent urban	Log (population density)	Log (population density)
Rail = 1	0.037*	0.036*	0.032	0.042**
	(0.012)	(0.013)	(0.052)	(0.022)
(Year = 1860) multiplied by				
Percent urban, 1840		−0.101		1.672*
		(0.078)		(0.427)
Δ (percent urban), 1850 − 1840		−0.168*		0.533*
		(0.069)		(0.181)
Log (population density), 1840		0.041*		−0.480*
		(0.014)		(0.028)
Δ log (population density), 1850 − 1840		0.065*		−0.375*
		(0.022)		(0.040)
Log (agricultural yield), 1850		0.030		0.119*
		(0.023)		(0.046)
Canal = 1		0.021		0.016
		(0.013)		(0.033)
Navigable river = 1		0.027*		0.031
		(0.013)		(0.026)
Great Lakes = 1		0.043		0.125
		(0.026)		(0.071)
State dummies		Included		Included

Source: See text and table 1.

Notes: Figures outside parentheses are coefficients of Rail =1 (county gains rail access in the 1850s). Row 1: base specification = county and year fixed effects. Row 2: base specification plus interaction terms between (Year = 1860) independent variables in table 3, column 4. The unit of observation is the county. In the percent urban regression, counties are weighted by their average population in 1840, 1850, and 1860. In the density regression, counties are weighted by area in square miles. Standard errors are clustered by county. *Significant at the 5 percent level. **Significant at the 10 percent level.

is easy to imagine that many, if not all, of the variables had direct effects on the changes in urbanization and population density, it is crucial that we control for them in the differences-in-differences analysis. Columns 2 and 4 in table 5 reproduce the base differences-in-differences estimates but computed here within a regression context. By construction these are the same as the effects reported in column 6, row 3, of panels A and B in table 3. Columns 3 and 5 present regression estimates of these coefficients after controlling for the additional variables.

Even though the controls are clearly correlated with gaining rail access, including them in the regression has virtually no effect on our estimate of the treatment coefficient in the urbanization regression. In the population density regression, controlling for the additional variables does increase the magnitude and statistical significance of the treatment effect, although the coefficient is still small in magnitude.

Adding the additional variables to the differences-in-differences analysis largely validates the conclusions that we reached in our base analyses shown in panels A and B of table 3, but it is still possible that the expanded regressions in table 5 are invalid because the treatment—gaining rail access—is correlated with the error term. The most likely source of such correlation is the one revealed in table 3 and discussed by Fishlow, namely, that counties grew in anticipation of gaining rail access in the future. In this case the control group is not really independent of the treatment group.

An appropriate robustness check for this sort of bias is to estimate the relationship between rail access and urbanization and the log of population density using an IV. This is a variable that predicts gaining rail access in the 1850s, controlling for other factors, but one that is otherwise uncorrelated with the outcomes we are examining; that is, it is a variable that isolates plausibly exogenous variation in rail access, as if rail access had been randomly assigned between countries.

The historical narrative of internal improvements in America, particularly canal construction, typically assigns an active role to government in promoting these advances. One such source of aid was the use of the Army Corps of Engineers to conduct surveys. Beginning in 1824 with the passage of the General Survey Bill, the president was granted authority to survey routes for "such roads and canals as he may deem of national importance, in a commercial or military point of view, or necessary for the transportation of the public mail" (U.S. Senate 1824: 23). The General Survey Bill does not mention railroads, but beginning in 1825, with a survey to "ascertain the practicability of uniting the headwaters of the Kenawha [*sic*] with the James river and Roanoke river, by Canals or Railways" (Haney 1908: 277), railroads quickly came to the fore. This law remained in effect until it was repealed by the Andrew Jackson administration, effective in 1838. According to Haney (ibid.: 283), 61 distinct railroad surveys are mentioned in congressional documents with 59 being reported.

Our IV is derived from these government surveys. First, we identified the pair of counties that constituted the starting and endpoint of all railroad surveys listed in *American State Papers* from 1824 to 1838 and reported by Haney (ibid.)—for example, the 1831 railway survey from Portage Summit on the Ohio Canal (near Akron) to the Hudson River (we used Albany, New York, as the terminus) (ibid.: 286). Many of the authorizations had less clear endpoints, requiring that some reasonable judgment be made. For example, in 1832 a survey was authorized between the Mad River and Lake Erie in Ohio, and a year later an appropriation was made for completing reports and drawings for this railroad (ibid.). We used Springfield and Sandusky as the termini of this road.

We then drew a straight line between the center of the "start" and "end" counties. Counties that lay along this straight line received a value of 1, while those that did not were coded as 0. That is, if a railroad was built, our instrument presumes that it was built on a straight line, representing the shortest distance between two points.[17] Moreover, existence of such a survey raised the likelihood that a railroad would be built, because these surveys provided valuable information about topography and other factors that clearly affected potential construction costs. As Taylor (1951: 95) notes, "As trained engineers were still very scarce . . . the government rendered a uniquely valuable service by making its experts available for such surveys." Indeed, Haney (1908: 284) remarks: "It is of some significance that in most cases the routes of these government surveys were early taken by railways. . . . in the great majority of cases these early surveys have been closely followed." Based on when the surveys were taken (mostly in the early 1830s), our "congressional survey" instrument is well suited to predict gaining rail access in the 1850s.

Table 6 reports our IV estimates. Our congressional survey instrument does quite well in predicting treatment (gaining rail access in the 1850s), even when we control for all of the other variables included in column 4 of table 5 (this is the "first-stage" coefficient shown in row 2 of table 6).[18] We use this first-stage regression to predict treatment and then use the predicted value of treatment in the second-stage, or "two-stage least squares" (2SLS), regression of 1860 outcomes.

As can be seen, the 2SLS coefficients, shown in row 3 of table 6, are positive and larger than the differences-in-differences coefficients (row 1, columns 3 or 5, of table 5), indicating the presence of omitted variables in the differences-in-differences regressions that were negatively correlated with gaining rail access.[19] However, while the magnitudes of the 2SLS coefficients are larger than our other estimates of the impact of rail access, they are imprecisely estimated, and we cannot reject the hypothesis that the 2SLS and differences-in-differences coefficients are the same (see row 4 of table 6).

Table 6 Instrumental variable regressions, 1860 cross section: First-stage and 2SLS coefficients

Variable	Percent urban	Log (population density)
First stage, congressional survey instrument	0.275*	0.295*
	(0.056)	(0.062)
2SLS, predicted rail access	0.089	0.107
	(0.065)	(0.111)
Significance level, 2SLS − DD coefficient of rail access (from table 3, panel A, column 3 or 5) = 0	0.442	0.559

Notes: The sample consists of an 1860 cross section of treatment and control counties. First-stage coefficient = coefficient of congressional survey of instrumental variables from a regression of rail access in 1860. 2SLS = coefficient of predicted rail access on percent urban or log (population density). Other independent variables are the same as in table 3, column 4. Counties in the percent urban regression are weighted by the county's average population in 1840, 1850, and 1860; counties in the log (population density) regression are weighted by 1850 area in square miles. Robust standard errors are shown in parentheses. 2SLS − DD = difference between the 2SLS coefficient and the differences-in-differences coefficient from table 3, panel A, column 3 or 5 (0.036, percent urban; 0.042, log [population density]).
*Significantly different from 0 at the 5 percent level.

Based on our analysis and the other tests we have applied, we have a reasonable degree of confidence in the robustness of our differences-in-differences estimates of the impact that rail access had on urbanization and population density.[20] Consequently, in table 7 we have used the differences-in-differences coefficients to compute the "percent explained": how much of the increase in percent urban or population density can be attributed to the railroad. We do this by multiplying the differences-in-differences coefficients by the change in rail access shown in table 2 and then dividing by the actual change in the outcome of interest. There are slight differences in this computation between the two columns due to differences in how the data are weighted (urbanization is weighted by population, and density is weighted by square miles).

Taking the results in table 7 at face value, the coming of the railroad does *not* appear to have been a major factor behind midwestern population growth in the 1850s, just as Fishlow originally thought. However, we also

Table 7 Percentage of urbanization and population density explained by railroad expansion, 1850–1860

	Percent urban	Log (population density)
Predicted change, 1850–60	0.028	0.030
Actual change, 1850–60	0.048	0.565
Percentage explained	58.3	5.3

Notes: Predicted change = differences-in-differences coefficient from table 5, column 3 (percent urban) or column 5 (population density) multiplied by change in rail access from 1850 to 1860 (0.785, percent urban calculation; 0.717, population density calculation). For example, the predicted change in percent urban, $0.028 = 0.036 \times 0.785$. Percentage explained = row 2/row 3×100 percent.

conclude that the railroad was a significant "cause" of midwestern urbanization, accounting for more than half of the increase in the percentage of the population residing in urban places in the sample counties in the 1850s.

There are three reasons to expect to see an effect on urbanization. First, the railroad clearly lowered transportation costs, thereby encouraging trade, especially (as Fogel [1964] showed) relative to intraregional wagon transportation. Trade did not take place in the middle of nowhere; rather railroads stopped in "central places," namely, urban areas, especially at points where multiple lines crossed. Second, the gains from trade raised midwestern incomes and real wages (see Margo 1999), and some of these income gains translated into increased demand for goods and services more efficiently produced (and traded) in urban areas. Third, once a railroad came to a particular central place in a county, the probability of "feeder lines" connecting other towns and villages increased. Consistent with our IV results, this created an incentive for individuals to move to such places in advance of the railroad (demand, so to speak, ahead of building).

Conclusion

This article has described a new research project, marrying GIS software to digitized archives and enabling the construction of a county-level panel dataset that documents the spread of railroads in the midwestern United States during the mid-nineteenth century. We have linked these transportation data to standard census data for the period to estimate the causal impact of the coming of the railroad on two important indicators of economic development and settlement: a county's rate of growth of population density and its extent of urbanization. We find that the causal impact of the railroad on both outcomes was positive. The effect on population density was small, consistent with Fishlow's (1965) original contention that midwestern railroads were not built ahead of demand and that midwestern development was already well under way when the railroads came on the scene. However, the causal impact of the railroad on urbanization was quantitatively large: somewhat more than half of midwestern urbanization in the 1850s is explained by the expansion of the rail network, according to our estimates.

Our finding that the railroad "caused" urbanization may have important ramifications beyond the debate over Fishlow's hypothesis. Among urban economists, it is widely believed that city growth can contribute to "endogenous growth" by raising the rate of aggregate total factor productivity. The mechanisms, which are complex and difficult to document, include the full range of agglomeration economies usually attributed to urbanization as well as the possibility, raised long ago by the sociologist Jane Jacobs, that the rate of innovative activity is higher in urban areas. It should be kept in mind that we have *not* shown that agglomeration economies were present in the urban Midwest in the 1850s or that expansion of water transportation (canals and other navigable waterways) also spurred urbanization. However, our results do suggest that further research on both issues is warranted.

Above all, we believe our article illustrates that GIS techniques have come of age in historical research. Conventional libraries and archives store an abundance of historical maps and related media, much of them already or eventually to be digitized. GIS software, used in conjunction with the sorts of econometric techniques employed in this article, offer the opportunity to reexamine classic questions in quantitative history and address new issues involving geographic variation that would be nearly impossible to study in the absence of these methods.

Notes

We gratefully acknowledge comments from three referees and from workshop participants at the 2008 University of Essex Historical GIS Conference, the 2008 Social Science History Association meetings, Case Western Reserve University, Columbia University, and the University of California, Los Angeles.

1 This should not be thought of as a failing in Fishlow's work. The computing and

econometric technology necessary to estimate these effects simply did not exist when he wrote his pioneering book.

2 One important point to this discussion is the distinction between the authorization, construction, and completion of a rail line and the beginning of regularly scheduled steam service. Our data on the Midwest come from contemporary travel guides and thus clearly refer to the latter.

3 In a nutshell, our procedure was to georeference the digitized historical map image to a shapefile (ESRI's parlance for a boundary file) and then create a new shapefile of the specific geographic feature we were interested in that traces the features from the historical image onto the same space as the geographically coordinated boundary file. We created separate files for navigable rivers, canals, and railroads. The resulting files can then be manipulated and used for computations using the GIS software. Historical county boundary files, along with a wide variety of historical U.S. census data, are freely available from the National Historical Geographic Information System at the University of Minnesota (www.nhgis.org).

4 These data will, in due course, update the ICPSR series.

5 See, e.g., Craig et al. (1998), who visually compared historical maps to county boundaries (which generally did not appear on the historical maps). Craig (pers. com., June 26, 2007) describes their procedure as follows:

> The way in which the counties were coded was simple: I reserved space in our library's map room one summer ('96, I think). I then collected histories containing maps of transportation improvements in general and the railroad industry in particular. (These include the histories cited in the JREFE [*Journal of Real Estate Finance and Economics*] article in the issue you edited [see volume 16, 1998].) I also had the librarians dig out old maps that had county lines on them. (I don't think these maps are cited in the paper. In fact, there were many of them and the librarians just laid them out for me.) I then spent much of the summer going one county at a time from the ICPSR list for 1850 and 1860, visually ID-ing if a particular railroad (or canal or river) ran through that county in that year.
>
> As for the coding itself, there were four specific problems that I ran into, each of which might reasonably lead to some counties being coded differently using a different approach.
>
> One was that the counties themselves changed over time. I did not always have a local map with the counties in the exact year that I needed. In these cases my rule was to use the ICPSR county names for the counties in question and the map that was the closest in date to the year in question—though "closest in date" here often meant much later. (This also created some problems when we did the maps in the paper—i.e. Figures 1 and 2. The technician who knew the software mapped the counties in the data files into GIS; thus the counties in the figures most likely reflect 1990 boundaries.)
>
> Two was that the railroad maps did not always agree with one another—that is, some maps had some lines that did not appear on or in other sources, and the years in which various lines opened were not always consistent. In these cases my rule was to accept the rail lines I saw. In other words, if source A had a line that source B did not, then I used source A.
>
> Three was that the rail maps did not have county boundaries on them; so I had to either (a) eyeball where the lines ran on the maps with counties or (b) in some cases I had later maps that had later rail lines that looked to follow the same route as the 1850 or 1860 lines. In those cases where I had a later map, and they looked to be the same route, I used (b); otherwise I used (a). In either case, it was eyeballing, because even in case (b) I was eyeballing to make sure the line in question followed the some route on both maps.
>
> Finally, there were clearly some counties, usually small counties, especially in New England, that had "rail access" but no railroads running directly through them. Our rule was: counties that had no rail line but were within 10 miles of a rail line in two or more adjacent counties—and that were not separated by a major natural obstacle, such as a navigable river or mountain range were coded as having rail access.

It should be noted that the traditional approach has one advantage over GIS: it is more forgiving of imperfections in the original maps (e.g., inaccurate surveys) that sometimes make accurate use of GIS close to impossible.

6 Unfortunately, few have survived to the present, and we have yet to assemble enough of them to construct as complete a time series as that to which Paxson's students had access. All of the guides that we have physically handled are fragile, especially the multipage foldout maps, and not sturdy enough for scanning or copying, although a few guides have been digitized and are available online. See, e.g., the June 1870 copy of the *Travelers' Official Guide of the Railways and Steam Navigation Lines in the United States and Canada* from the Central Pacific Railroad Photographic History Museum (cprr.org/Museum/Books/I_ACCEPT_the_User_Agreement/Travellers_Guide_6-1870.pdf). There are also at least two editions of Appleton's guide on Google Books (e.g., books.google.com/books?vid=UOM39015016751375) as well as a number of other guides. See www.lib.utexas.edu/maps/map_sites/hist_sites.html.

7 Indeed, such sources were used by Taylor and Neu (1956) in drawing up their maps of the U.S. rail network as of April 1861 and also seem to have been relied on by Paxson (1914).

8 We compute the county by county mileage using the AnalysisTools/Overlay/Intersect tool in ArcGIS 9.3 with the decennial county boundary layers for the five midwestern states and the entire railroad network in the region as of 1861. This generates a new layer composed of segments of each railroad's track within each county in each year. Linkage with the Taylor-Neu data, in particular, also generates information regarding each railroad's track gauge, which was not standardized at 4' 8½" until the 1880s.

9 For example, following the merger of the Boston and Lowell Railroad with the Boston and Maine in 1845, track between Wilmington, Massachusetts, and Boston was initially abandoned (only to be later reused by the Boston and Lowell for its Wildcat Branch). In 1848 the Boston and Maine abandoned another original section of track as a new alignment was built from Wilmington north to North Andover so as to serve Lawrence better. In 1873 a new alignment to Portland was opened, splitting from the old route at South Berwick, and the old route was subsequently abandoned (www.answers.com/topic/boston-and-maine-railroad).

10 For example, according to the 1880 census, more than 80 percent of railroad investment went into construction costs, of which only 1 or 2 percent represented the cost of the land itself; the rest went into surveying, grading, removing or bridging obstacles, and laying the track. While ties, ballast, and the rails might be reused and the land itself could be resold, the grading, cuttings, embankments, bridges, and drainage ditches had few alternative uses in the nineteenth century, although today many have found recreational use in the rails-to-trails movement.

11 In determining whether a river was navigable, we adopted a pragmatic viewpoint and defined a navigable waterway as one that accommodated steamboats on a *regular* basis; that is, we required evidence of more than one successful voyage and excluded those waterways used only by bateaux. Thus, for example, we excluded the White River in Indiana and the Miami and the Scioto rivers in Ohio. But we included the Wisconsin River, which for some reason was not included in the 1890 census of transportation tabulations (U.S. Census Office 1894 [1890]) and thus was excluded by Fogel (1964). In the nineteenth century steamboats navigated the Wisconsin River from its junction with the Mississippi River at least as far as Portage in Columbia County (and close to the head of navigation of the Fox River) and sometimes ventured as high as Nekoosa in Wood County. See www.hmdb.org/marker.asp?marker=1193. We are currently redoing our shapefiles by starting with relatively recent and accurate mappings from the early twentieth century, when the rail network was close to its zenith, and then subtracting routes that did not exist earlier.

12 Two limitations are that the access variable does not capture within-county variation in access and that counties obviously differed in size. In our econometric analysis we can (and do) weight by land area, but we are unable at present to adjust for cases in which the railroad lies close to the county boundary but adjacent counties do not have rail access. County boundaries, in other words, are arbitrary ways of delineating local economies; the average farmer in a geographically small county in our control group that happened to be adjacent to a large county in the treatment group might have had better access to the railroad than the average person in the large county. If this circumstance was common, it would produce a downward bias in our estimated treatment effects. Although we do not consider this bias important empirically, we admit that the question is open.

13 By "balanced" we mean that the same counties appear in 1850 and 1860; no new counties enter the sample during the 1850s. Balancing ensures that county fixed effects are "differenced away" when we compute the change in economic outcomes from 1850 to 1860; this would not be the case if new counties entered the sample in the 1850s. We restrict our basic analysis to counties with a fixed land area, because the ICPSR census data are not adjusted for changes in land area over time. The results are qualitatively the same if we do not impose the restriction that a county lacked rail access in 1850 or that county boundaries were the same in 1850 and 1860 (see, however, n. 20).

14 Our definition of *urban* follows the census convention: persons living in incorporated villages, towns, or cities with a population of 2,500 or more.

15 The somewhat higher gain in access when the data are weighted by population reflects that railroads were built where the initial population density was higher and rising during the 1840s.

16 Our use of a "straight-line" instrument is inspired in part by Banerjee et al. (2006), who construct a similar instrument for their study of the impact of rail access in modern China on wages. Of course, many features of topography other than the shortest-distance criterion—grade, hills or mountains, and so on—influenced railroad building, but these features probably affected density and urbanization directly and thus are not candidates for IVs (they fail the exclusion restriction).

17 That is, our instrument satisfies the relevancy requirement of being correlated with the treatment. However, it might still fail the exclusion restriction of being directly correlated with the outcome variables. With a single IV, we cannot conduct the usual test (an overidentification test) of the exclusion restriction; however, in such cases it is useful to examine whether the instrument is correlated with pretreatment changes in the outcomes (i.e., the changes in population density or urbanization over the 1840s). If we regress the changes over the 1840s in population density and urbanization on our instrument, controlling for initial values (population density and urbanization in 1840) and dummies for water transport and state, the coefficients on the instrument are close to 0 and statistically insignificant. This suggests that the exclusion restriction is satisfied by our instrument.

18 The most likely explanation, as noted earlier, is that the pretreatment trends are evident in table 3; that is, counties that did not get rail access in the 1850s grew in advance, rationally expecting to gain rail access in the future.

19 We conducted a number of robustness checks in addition to applying IV. First, we replicated the differences-in-differences and IV analysis using a different measure of urbanization, a dummy variable of whether or not the county had at least one urban area. This is a useful check, because many counties had no urban areas in 1840. The results revealed a large positive effect of gaining rail access on this alternative measure of urbanization, consistent with the more conventional measure used in the text. Second, we replicated the differences-in-differences analysis while restricting the sample to counties that had the same land area in 1840–60 (rather than just 1850–60). While this drastically reduced the sample size (to 188 counties), the results for percent urban were very similar to those for the broader sample, but we do estimate a larger treatment effect on population density in the restricted sample. However, even allowing for the larger treatment effect on population density, the substantive con-

clusion—that the railroad's effect on population density was modest—remains true in the restricted sample. Details of these additional robustness checks are available from Robert A. Margo.

References

Appleton, D., and Company (1848) Appleton's Railway and Steam Navigation Guide for the United States and the Canadas. New York: Appleton.

Banerjee, A., E. Duflo, and N. Qian (2006) "The railroad to success: The effect of infrastructure on economic growth." Unpublished presentation, Department of Economics, Brown University.

Burr, H. A. (1850) Disturnell's New Map of the United States and Canada: Showing All the Canals, Rail Roads, Telegraph Lines, and Principal Stage Routes. New York: Disturnell.

Carter, S. B., et al. (2006) Historical Statistics of the United States. Millennial ed. online. New York: Cambridge University Press.

Cobb, C. (1850) American Railway Guide and Pocket Companion for the United States. New York: Dinsmore.

Craig, L. A., R. B. Palmquist, and T. Weiss (1998) "Transportation improvements and land values in the antebellum United States: A hedonic approach." Journal of Real Estate Finance and Economics 16: 173–89.

Disturnell, J. (1846) Disturnell's Railroad, Steamboat, and Telegraph Book: Being a Guide through the Middle, Northern, and Eastern States and Canada. . . . New York: J. Disturnell.

Doggett, J. (1847) Doggett's Railroad Guide and Gazetteer . . . with Sectional Maps of the Great Routes of Travel. New York: Doggett.

Dunbar, W. F. (1966) All aboard! A History of Railroads in Michigan. Grand Rapids, MI: Eerdmans.

Fishlow, A. (1965) American Railroads and the Transformation of the Antebellum Economy. Cambridge, MA: Harvard University Press.

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

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

Haney, L. H. (1908) A Congressional History of Railways in the United States. Bulletin of the University of Wisconsin, nos. 211, 343. Madison, WI: Democrat.

Hunt, F., et al. (1857) Merchants' Magazine and Commercial Review 36, no. 2 (February 1).

Hunter, L. C. (1949) Steamboats on the Western Rivers: An Economic and Technological History. Cambridge, MA: Harvard University Press.

Inter-university Consortium for Political and Social Research (ICPSR) (197? [*sic*]) Historical, Demographic, Economic, and Social Data: The United States, 1790–1970. Ann Arbor, MI: Inter-university Consortium for Political and Social Research, doi:10.3886/ICPSR00003.

Jenks, L. H. (1944) "Railroads as an economic force in American development." Journal of Economic History 4: 1–20.

Lloyd, E. (1857) Lloyd's American Guide: Containing New Arranged Time Tables, So Simple and Correct That a Child Can Understand Them. . . . Philadelphia: Lloyd.

Margo, R. A. (1999) "Regional wage gaps and the settlement of the Midwest." Explorations in Economic History 36: 128–43.

Meints, G. M. (1992) Michigan Railroads and Railroad Companies. East Lansing: Michigan State University Press.

Mitchell, B. R. (2003) International Historical Statistics. New York: Palgrave Macmillan.

National Bureau of Economic Research (1960) Trends in the American Economy in the Nineteenth Century: A Report of the National Bureau of Economic Research, New York. Princeton, NJ: Princeton University Press.

National Railway Publication Company (1868) Travelers' Official Railway Guide of the United States and Canada. Ann Arbor, MI: Printed for the National Railway Publication Company by University Microfilms.

Paskoff, P. F. (2007) Troubled Waters: Steamboat Disasters, River Improvements, and American Public Policy, 1821–1860. Baton Rouge: Louisiana State University Press.

Paxson, F. L. (1914) "The railroads of the 'Old Northwest' before the Civil War." Transactions of the Wisconsin Academy of Sciences, Arts, and Letters 17: 247–74.

Poor, H. V. (1860) History of the Railroads and Canals of the United States. New York: Schultz.

——— (1868) Poor's Manual of Railroads. 1st–57th annual number: 1868/69–1924. New York: Poor.

Rand-McNally (1871) The Rand-McNally Official Railway Guide and Handbook. Chicago: Rand-McNally.

Taylor, G. R. (1951) The Transportation Revolution, 1815–1860. New York: Holt, Rinehart and Winston.

Taylor, G. R., and I. D. Neu (1956) The American Railroad Network, 1861–1890. Cambridge, MA: Harvard University Press.

U.S. Census Office (1894 [1890]) Eleventh Census: 1890; Report on Transportation Business, vol. 14, pt. 2. Washington, DC: U.S. Government Printing Office.

U.S. Senate (1808) "Roads and canals." Report communicated to the Senate, April 6. American State Papers 037, Miscellaneous, vol. 1, 10th Cong., 1st sess., pub. no. 250.

——— (1824) United States Statutes at Large, Act of April 30, 1824, chap. 46, 4 Stat. 22-3.

van Oss, S. F. (1893) American Railroads as Investments: A Handbook for Investors in American Railroad Securities. New York: Putnam.