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Transportation Costs in the Antebellum USA: A New County-Level Dataset with Time-, Region-, and Direction-Specific Freight Rates, 1820–1860

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We construct a county-to-county transport cost dataset for the USA from 1820 to 1860, using freight rates specific to time, region, and transport direction, alongside historical transport networks. We analyze the impact of canals and railways on transport costs, market access, and land values. By 1860, these infrastructures shifted the highest market access from the Atlantic coast to the Midwest and Great Lakes. Market access positively correlated with land value changes in 1850–1860. Both new transport infrastructure and reduced freight costs significantly lowered transport costs, driving economic shifts.

1. Introduction

In recent decades, economic history has seen an increasing use of geo-spatial methods to calculate region-to-region transport costs, allowing us to gain deeper understanding of their socioeconomic effects, and revisit old historical debates.[1] Various approaches are used: indicators of the accessibility to transport network, physical characteristics of the network such as length, or algorithms to calculate the minimal cost path between the regions. Especially the minimal-path algorithms allowed scholars to calculate the transport costs more precisely and provide monetary measures—usually in a domestic currency per ton-mile—of the costs of inter- and intraregional trade. This paper is a methodological contribution to this research. We construct a new data set of county-to-county transport costs in the USA for every decade between 1820 and 1860. The dataset is based on the time and region-varying multimodal historical transport network, and detailed multimodal freight rates which differ over time, across regions, and with the direction of transport. We use them to calculate the minimal cost path between the counties, which result in a dataset of county-pairs with transport costs (in cents per ton-mile) that capture the antebellum construction of canals,

[1] For example, Pontarollo and Ricciuti (2020), Hornung (2015), Berger (2019), Esteban-Oliver and Martí-Henneberg (2024), Alvarez-Palau and Martí-Henneberg (2020), Zimran (2020), Donaldson and Hornbeck (2016), Hornbeck and Rotemberg (2024).

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railways, expansion of navigable portion of rivers, as well as changes in the freight rates across transport modes, regions, direction of travel, and over time.

We build on the work of Atack (2015, 2016, 2017) and Donaldson and Hornbeck (2016), which we advance in three directions. First, we digitize the historical network of roads, turnpikes and exploration trails during the antebellum decades. This complements the digitized historical network of navigable rivers, canals, and railroads by Atack (2015, 2016, 2017). Second, we introduce time, and region-specific freight rates into the calculation of the minimal cost paths. And third, we incorporate direction-specific freight rates for the navigable rivers to account for different transport costs when hauling freight against the natural flow of water. The purpose of this paper is to (1) provide details of all the methodological advancements, (2) present a set of stylized facts about the time and spatial evolution of the county-pair transport costs and market access in the antebellum USA, (3) decompose changes in the county-pair transport costs between the *extensive* versus *intensive margin*—changes driven by the physical nature of the transport network versus changes driven by freight rates, and (4) illustrate the application of this new dataset by examining the effect of market potential on land values, and discusses further avenues for research. Doing so, our dataset enable us to offer quantitative assessment of Goodrich et al. (1961) and substantiate his analysis that canals were a crucial for the general decline of antebellum transport costs, and Fishlow's (1965) discussion of the antebellum land market and transport costs.

The development of transport in the antebellum era was unprecedented in US history. In the span of four decades, two new transport modes emerged—canals and railroads—freight rates plummeted, and the East Coast was linked with the western frontier by waterways as well as rail lines. During this time, none of the transport modes had an absolute dominance. Navigable rivers were still a crucial transportation artery in the south and southwest, coastal shipping still linked southern ports with New York City, and canals were relatively short-lived as in barely three decades since the opening of the Erie Canal, railroads overtook the canals as the preferred mode of inter- and intra-regional trade (Fishlow 1965). This had not been repeated since: the postbellum decades were dominated by railroads until 1950s when trucking and highways took over as the main transport arteries.[2] Therefore, constructing county-pair transport costs using all modes of transport is important not only for the historical completeness, but for an accurate portrayal of the transportation revolution that happened in the antebellum years.

1.1 Related literature

There are several studies that are methodologically related to this paper. In general, the calculation of region-to-region, and in our context county-to-county minimal transport cost, consists of three main components: digitized transportation infrastructure, cost components for each part of the infrastructure such as freight costs or/and transshipment costs, and the Dijkstra algorithm. Swisher (2017) constructs city-pair transport costs in 1860 and 1890 and uses time-varying but region- and direction-invariant freight rates. Zimran (2020) constructs county-pair transport costs between 1820 and 1850 using time-varying Geographic Information Systems (GIS) shape files by Atack (2015, 2016, 2017). The freight rates are time-, region-, and direction-invariant from around 1860 though there are two different freight rates for rivers and three for canals reflecting broadly their location. Hornbeck and Rotemberg (2024)

[2] Crafts and Klein (2014).

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construct county-pair transport costs for 1860–1890 using the values of time-, region-, and direction-invariant freight rates for 1890 from Fogel (1964). Jaworski, Kimbrough, and Saito (2024) calculate county-pair transport costs for 1850–1870 using time-varying railroad network and time-constant waterway network from Donaldson and Hornbeck (2016) and time-, region-, and direction-invariant freight rates from Fogel (1964). As for the road network, they construct their own network to reflect their research question, which focuses on migration. Similarly, Nagy (2023) calculates transport costs during the antebellum decades using time-varying railroad and waterway network with the same freight rates from Fogel (1964) as the other studies. Methodologically different, but similar in the spirit, Jaremski (2012) calculates antebellum passenger costs from New York City and Philadelphia to any US city between 1836 and 1867. However, he uses time- and regional-varying stagecoach costs. In the context of the English economy, Alvarez-Palau et al. (2025) calculate inter-urban transport costs using time-varying multimodal transportation network combined with time-varying and region-invariant freight rates in 1680 and 1830.

Overall, existing studies combine time-varying transportation network with mostly time-, region-, and direction-invariant transport cost parameters. This approach offers econometrics advantage by limiting the scope of endogeneity of the transport costs (Donaldson and Hornbeck 2016, p. 817) and focuses on the extensive margin of transport of the transport cost reduction—reduction of the transport costs due to expanding transport infrastructure. This paper relaxes the time, region, and direction invariance of the transport cost calculations and constructs county-pair transport costs, which include both the intensive and extensive transport cost margins. These allow us to shed light not only on the role of the construction of transport network such as canals and railways, but also on the role of the freight costs charged on each transport mode that reflect technological and organizational advances. Furthermore, including the intensive margin allows us to capture transport cost changes when the transport infrastructure was completed.

The structure of the rest of the paper is the following. Section II provides a historical context by discussing the major models of antebellum transportation. Section III presents the methodology and the data sources. Section IV discusses the main trends, spatial patterns, decomposition, and counterfactual analysis. Section V applies our dataset to assess a relationship between land values and transportation sector advanced in by Fishlow (1965, p. 40) and Section VI concludes.

2. Historical context

The westward expansion of settlement beyond the original thirteen states was one of the defining characteristics of both political and economic development of the USA before the Civil War (e.g., Howe 2007; Taylor 2021). To bridge the gap between the populated eastern seaboard and largely unsettled but fertile western regions, a transportation network had to be designed and built to overcome distance, inaccessibility, and natural barriers. Canals and railways transformed and redirected regional trade from west–south–east direction to west–east direction and often steal the glory. But it would be wrong to neglect the contribution of navigable rivers to antebellum trade and technological and organizational advancements in river transport. Indeed, in the trans-Appalachian West, freight was carried primarily by the western river.[3] Contemporaries stressed the role of river steam navigation as one of the main

[3] Haites et al. (1975), pp. 4–5. Trans-Appalachian West includes all or part of the states of Ohio, Indiana, Illinois, Michigan, Wisconsin, Iowa, Missouri, Kentucky, Tennessee, Arkansas, Mississippi, Louisiana.

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colonization forces of the West (Hall 1848), and riverside towns and cities grew faster than their landlocked peers until freed by railways.[4]

Designing, approving, financing, and constructing canals and railways was a decades-long endeavor, often referred to as the "internal improvement" era.[5] The antebellum legislative record is marked by frequent attempts to establish a cohesive national policy for internal improvements. A broad consensus existed that an expanding nation needed an integrated system of roads and canals for political and economic unity. Furthermore, it was widely acknowledged that private and local interests, particularly in less populated areas, lacked the capacity to undertake such large-scale transportation projects. By the close of the eighteenth century, Congress had already funded coastal infrastructure like lighthouses, beacons, harbors, and buoys to facilitate foreign trade. Increase in westward migration stimulated demand for federal assistance to improve transportation to the nation's interior. This culminated in the 1806 passage of the Cumberland Road Act, which authorized the construction of a national road from Cumberland, Maryland, to the border of Ohio. Shortly thereafter, in 1808, Treasury Secretary Albert Gallatin introduced the first comprehensive plan for a system of internal improvements called *Report of the Secretary of the Treasury on the Subject of Public Roads and Canals*, proposing a network of roads and canals to strengthen the Union's political and commercial ties. Despite his enthusiasm for the concept of improvement, Jefferson was not sure about the government's constitutional authority to implement such a plan and recommended a constitutional amendment, though no action was ever taken on his or Gallatin's proposals.

Though the network of canals and railways eventually connected the original thirteen states with the western frontier, its development was far from straightforward or coordinated. Early canal-building attempts in the late eighteenth century largely failed, producing only about 200 miles of canals. In the early nineteenth century, political, legal, and constitutional challenges hindered interstate cooperation, leaving private companies and individual states to drive canal and railway construction.[6] This transportation revolution, despite obstacles, sparked a market revolution, integrating commodity markets and boosting efficiency (Fishlow 1965; Harrison 2023; Sellers 1994; Slaughter 2001).[7] Some historians note it overcame "the tyranny of distance" (Howe 2007, pp. 202–242). This section provides historical context for the transportation network and freight rates to support the creation and analysis of a new county-pair transport costs dataset.

2.1 Roads

Wagon transport was indispensable during westward settlements into regions where waterways were scarce or unnavigable. Similarly, anywhere in the country, overcoming distances when transporting freight to the nearest port—be it on river, ocean, lake, and later canal or railway depo—had to be done via roads and using wagons. Even though freight rates were orders of magnitude higher than those on rivers, and later canals and railways, road transport was an important transport mode throughout the entire nineteenth century.

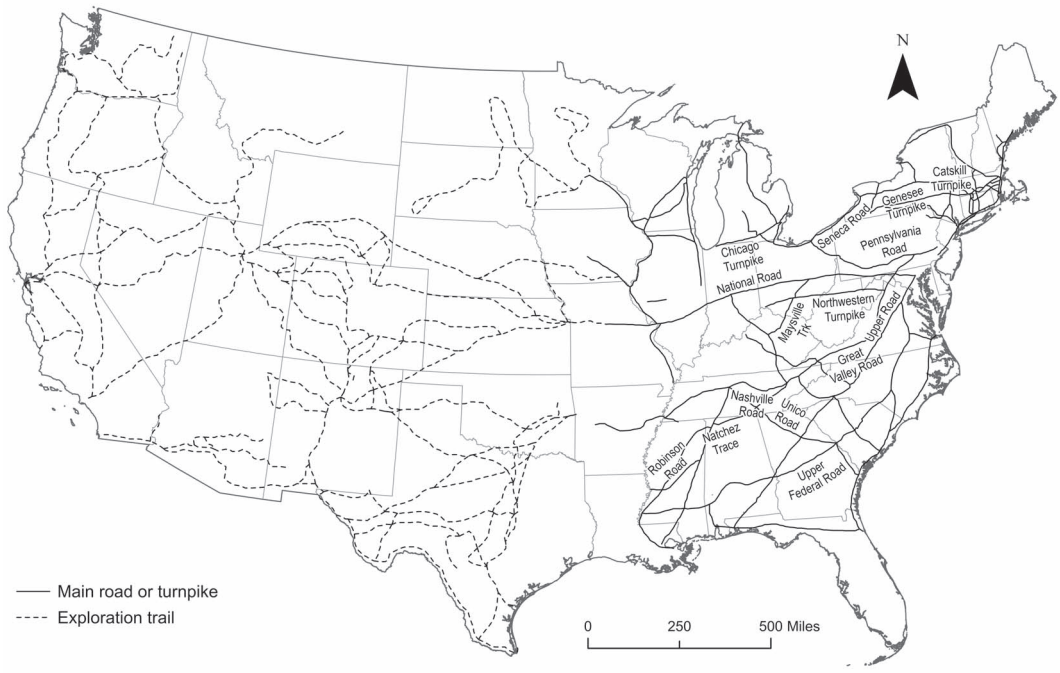
[4] Twelfth Census of the United States taken in the Year 1900 n.d., Volume 1, Table 6, pp. 430–433. Also see, for example, Mahoney (1990) on the role of rivers in the settlement of the Midwest.

[5] An excellent monograph on the history of the antebellum internal improvement programs is Larson (2001).

[6] Minicucci (2004). This does not mean that in the antebellum decades, the federal government was not involved in infrastructure projects at all. For example, construction of lighthouses was a federal endeavor.

[7] Other work on market integration involving US and the Atlantic economy is Jacks (2005) and Jacks (2006).

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Map 1. Roads, turnpikes, and exploration trains, USA 1835–1850. *Source:* National Atlas of the United States (1970), Map: Exploration and Settlement 1835–1850′

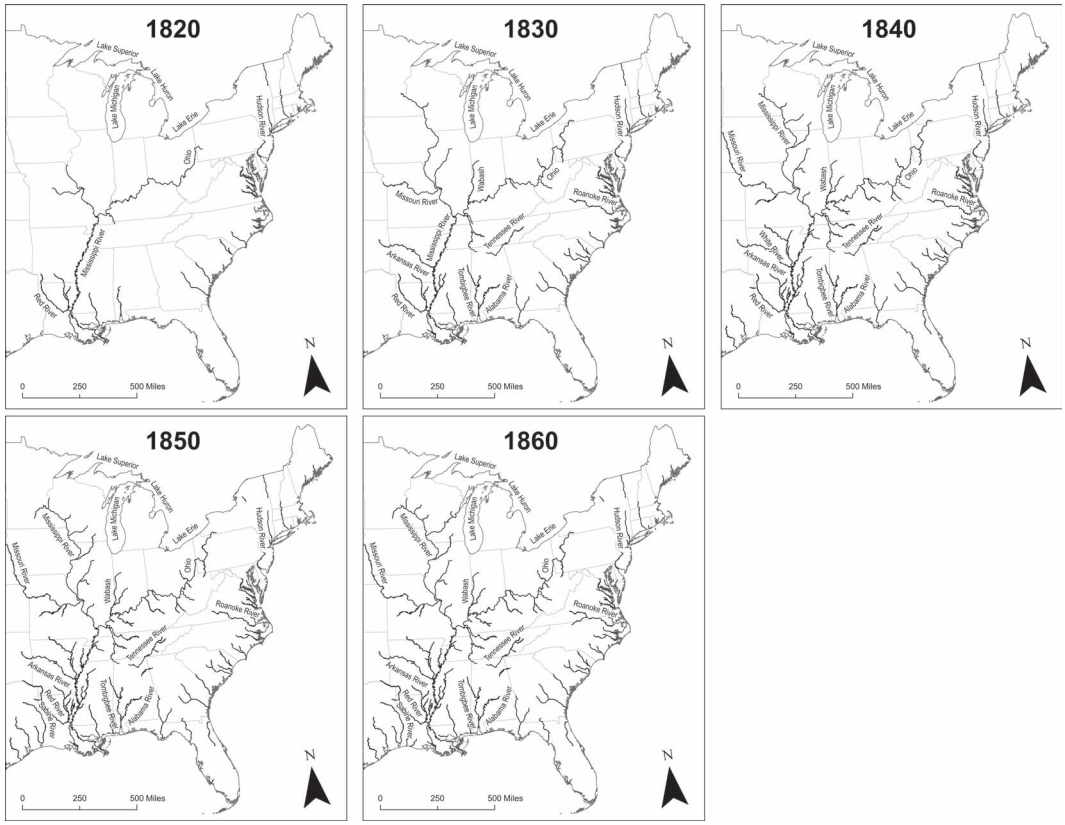
To improve the road quality and reduce the transport costs, a systematic involvement of the federal government would have been preferable. However, more interested in constitutional matters that the construction of an interstate transportation network involved, rather than building one, private enterprises and state initiatives filled the gap left by the federal government. Since it was not an easy endeavor due to legal, technical, financial, and geographical issues, entrepreneurs were looking for existing solutions. They found them in Europe, particularly in Britain (Bogart 2005, 2007, 2009), through advanced road-building techniques using durable stone-surfaced roads, as well as legal and financial innovations that led to the establishment of turnpikes (Raitz and O'Malley 2007, pp. 3–5).

Turnpikes presented a technological advancement in road building relative to the existing roads and Map 1 shows them with other roads and exploration trails. Road improvements consisted of reduction of hills, a formation of convex roadbed with ditches on the side of the road, road surfacing with natural soil or gravel. These improvements, especially in road surfacing, reduced friction and improved carrying capacity. When canals and railways were built and offered a viable and substantially cheaper transport alternative, turnpike mileage dropped, but their usefulness did not disappear. On the contrary: canals and railways needed feeder roads, and turnpikes offered shorter toll roads (Klein and Majewski 1992).

2.2 Navigable rivers

During the early antebellum period, western settlement moved mostly along the Mississippi river and its tributaries. Fur traders and trappers were soon replaced by settlers who, after

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Map 2. Navigable river system, USA 1820–1860. *Source:* Atack (2015)

crossing the Appalachian Mountains to Pittsburgh, purchased supplies, a family flatboat, and when the water level was high enough, they floated to their destinations. River navigability was crucial.[8] It wasn't static but was changing over time as efforts were made to improve their capacity to deliver goods and passengers, as seen on Map 2, which shows the network of navigable rivers between 1820 and 1860.

There were three main river-transport modes: keelboat, flatboat, and steamship.[9] Each had their heydays, experienced changes in freight rates, competed, but also coexisted alongside each other. The flatboat was one of the principal modes of downstream transportation on the Mississippi river before steamships (Clark 1966; Haites, Mak, and Walton 1975). Even after the introduction of steam shipping, flatboats on the Mississippi river kept arriving in New Orleans until 1850s.[10] Flatboat freight rates declined dramatically in both nominal and

[8] See Atack (2015) for detailed discussion of the navigability of the US River system.

[9] A flatboat was a simple, flat-bottomed, rectangular boat with straight sides, typically constructed from wood. It had no keel and was designed for one-way downstream travel. A keelboat was a narrow, and elongated boat with a keel that provided stability and allowed for better maneuverability. It was designed for both upstream and downstream travel.

[10] In 1808, 1,049 flatboats arrived in New Orleans, 1,287 in 1826, 1,365 in 1835, 2,792 in 1846–1847, and 1,047 in 1852–1853 (Haites et al. 1975, Table 4, p. 21).

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real terms and the major reasons were shorter return journey, and river improvements as flatboating was a hazardous business and greater safety reduced passage time, even made it easier and less costly for flatboating to operate at night. [11] Regarding keelboats, historical estimates indicate that, at their peak, a mere 300 keelboats operated across all western rivers combined (Baldwin 1941, p. 181). Keelboating was a long and arduous journey with a round trip from Pittsburgh to Louisville taking nearly 2 months and boats made typically three round trips a year.[12] The freight rates declined by early 1820s from $5.00 per hundred pounds to $1.25 per hundred pounds.[13] However, it was not enough when they faced competition from steamships whose low freight rates practically ended the use of keelboats on the major trunk routes.

Introduction of steamship led to a substantial decrease in freight rates and passenger rates.[14] The sources of the freight rate decline were numerous, including increase in the ratio of carrying capacity to tonnage, the fall of insurance costs, and shorter journey times.[15] Steam boating was not restricted to major western rivers such as Mississippi and Ohio. Tributaries saw the introduction of steam-powered vessels too, though later, and the freight rates were three to four times higher than the usual ones to New Orleans.[16] Since steamboats on tributaries provided less dramatic cost saving than keelboating or flatboating, all three river transportation technologies could coexist in the antebellum times.[17]

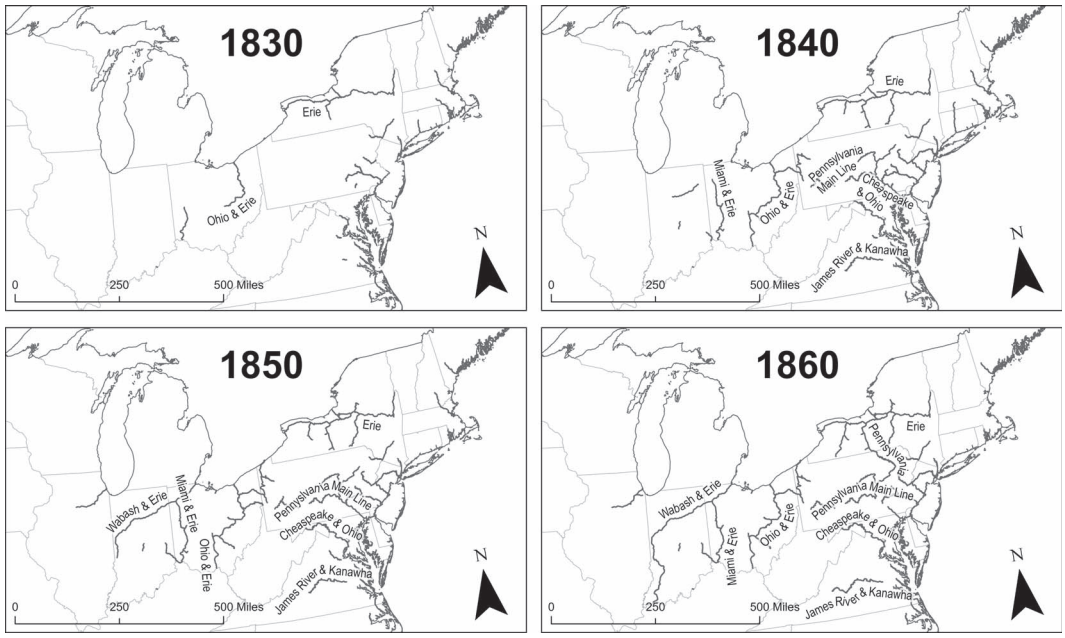
2.3 Canals

Water transportation was further extended by canals. Connecting natural waterways or parallel to a single stream to avoid obstructions, canals created a network of routes allowing more effective transportation. The first canals were built in the late eighteenth and early nineteenth centuries and by 1860 over 4,000 miles of them crisscrossed the northeast, what would be later known as Midwest, and some parts of the south.[18] Map 3 shows the canals system for each decade between 1830 and 1860, and Table 1 breaks down the canal system by regions and mileage.

The effect of the canal system on transportation costs needs to be assessed carefully.[19] Undoubtedly, the freight rates declined. For example, in 1817, the average freight rate for shipments between Buffalo and New York using wagons and Hudson River was 19.12 cents per ton-mile. Once the Erie Canal was completed, this rate fell to 1.68 cents per ton-mile and by mid-1850s, the average freight rate between Albany and Buffalo was one cent.[20] The Erie Canal on its own was a striking success and the most important interregional mode of transport in the antebellum period. Its traffic, which consisted mainly of agricultural

[11] The patterns of freight rates in flatboating were influenced by seasons and a detailed discussion about it is offered in Haites et al. (1975), pp. 82–87.
[12] Haites et al. (1975), p. 19.
[13] Haites et al. (1975), p. 40.
[14] We document them in Appendix, Table A5.
[15] Dixon (1909): table called "Average time of steamboats between points named," p. 29.
[16] Table A9 in Appendix shows typical freight rates between Louisville and selected tributaries, and between Louisville and New Orleans, in the 1840s.
[17] Haites et al. (1975), p. 55.
[18] Report on the Canals of the United States (1883), Tables 1 and 2.
[19] For a critical discussion of the research on the US canals, see, for example, Ransom (1964), and Shaw (1984).
[20] Goodrich et al. (1961), pp. 227–228.

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Map 3. Canal system, USA 1830–1860. *Source:* Atack (2017)

Table 1. *US canal system by regions: 1820–1860.*

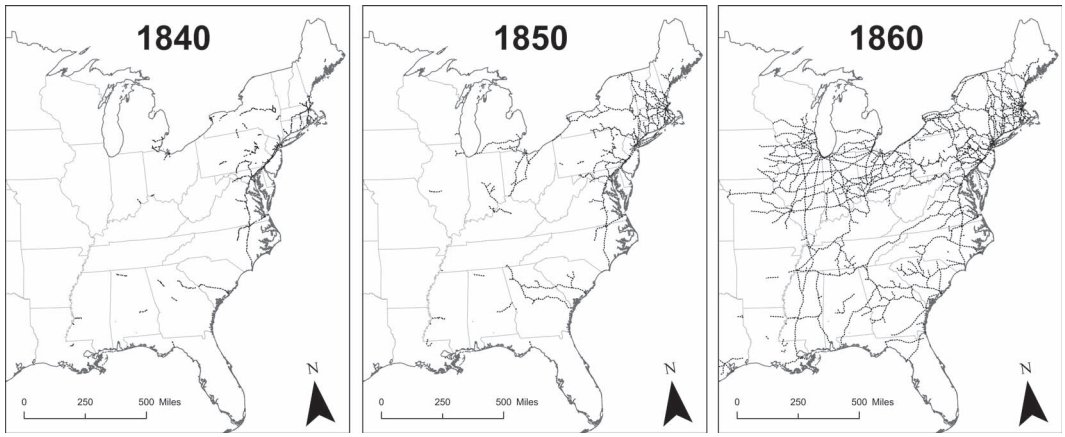
Year/Region	1820	1830	1840	1850	1860
	Panel A: total canal mileage				
New England	77	189	250	123	46
Middle Atlantic	25	875	2,037	2,134	2,255
East North Central		280	771	1,288	1,368
South Atlantic	92	149	407	506	494
East South Central		4	4	4	4
United States	194	1,496	3,469	4,056	4,168
	Panel B: percentage from US total				
New England	39.8%	12.6%	7.2%	3.0%	1.1%
Middle Atlantic	12.8%	58.5%	58.7%	52.6%	54.1%
East North Central		18.7%	22.2%	31.8%	32.8%
South Atlantic	47.5%	10.0%	11.7%	12.5%	11.8%
East South Central		0.3%	0.1%	0.1%	0.1%
United States	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Atack (2016).

commodities, increased from 54,000 tons in 1836 to 1.9 million in 1860.[21] On the other hand, the Erie Canal proved to be the only financially successful venture, with others failing to develop a large volume of traffic, so that in 1859, the Erie Canal accounted for more than 30 percent of the total US canal transportation services, but the Pennsylvania Canal system,

[21] Goodrich et al. (1961), p. 229.

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Map 4. Railway system, USA 1840–1860. *Source:* Atack (2016)

a distant second, barely 10 percent, and the rest split among the remaining thirteen canal systems.[22] Nonetheless, the canal system led to a significant decline in transportation costs and many view canals as an important factor that changed the patterns of domestic trade.[23]

2.4 Railroads

The 1830s witnessed the first round of railway construction with over 3,000 miles of railways laid by 1840. As we can see on Map 3, the emerging network had two directions. Railways in the east–west direction included the ill-fated Erie Railroad of New York venture, the Western Railroad in Massachusetts, two Pennsylvania lines and the original Baltimore and Ohio Railroad. The second direction was north–south along the Atlantic coast. The regional distribution of mileage in Table 2 shows that the South had 42 percent of US railroads while the Northeast had 58 percent. The depression from 1839 to 1843 slowed down construction, pausing the expansion of the east–west railways before they reached their western terminus, though western interior lines, which relied on state assistance, were more affected than those in New England. Lines in the South suffered the same fate as the western lines, as is evident from Map 4 and Table 2. Nonetheless, railway construction continued, and total mileage still increased between 1840 and 1850 from about 3,100 to over 8,500 miles. An important feature of early railways was their termination at canals, navigable rivers, the Great Lakes, or coastal ports. Only later, once proven financially successful, did railways venture out on their own, beyond being waterway feeders.

After the sluggish 1840s, construction accelerated and by 1860, the total railway mileage almost quadrupled to over 30,000 miles. The regional difference, which began to emerge in the 1840s, became more pronounced as the Northeast region now had more than 62 percent of the railways network, and the South only about 33 percent. In addition, different gauges prevailed until their unification in 1886 (Gross 2020). This regional disparity is clearly visible in Map 3. The Midwest was the principal region of rail construction and Chicago

[22] The calculation is based on Fishlow (2000), Table 13.3, p. 562.
[23] Clark (1966), chapter X, Pred (1980), chapter 3.

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Table 2. *US railway system by regions: 1830–1860.*

Year/Region	1830	1840	1850	1860
	Panel A: total rail mileage			
New England		520	2,492	3,436
Middle Atlantic	41	1,071	2,338	5,765
East North Central		223	1,280	9,673
South Atlantic	20	1,189	2,011	5,870
East South Central		118	330	3,295
West South Central		30	76	846
West North Central				1,370
Mountain				
Pacific				23
US	61	3,151	8,527	30,277
	Panel B: percentage from US total			
New England		16.5%	29.2%	11.3%
Middle Atlantic	67.5%	34.0%	27.4%	19.0%
East North Central		7.1%	15.0%	31.9%
South Atlantic	32.5%	37.7%	23.6%	19.4%
East South Central		3.8%	3.9%	10.9%
West South Central		1.0%	0.9%	2.8%
West North Central				4.5%
Mountain				
Pacific				0.1%
US	100.0%	100.0%	100.0%	100.0%

Source: Atack (2015).

emerged as a crucial railway center and node of ten different railway lines spanning over 4,000 miles. Initially, the freight rate differential between canals and railways favored canals, but by 1860 the difference had been dramatically reduced, largely due to the increased factor productivity (Fishlow 2000). Although the freight costs advantage of canals, and waterways in general, persisted, railways offered other advantages, including greater speed, all-year-long transportation, and less transshipment, which ultimately allowed railways to succeed canals as the main mode of transportation.

3. Methodology and data

In this section we discuss the methodological approaches and the datasets we use in this paper. It consists of two main parts. In the first part, we present the methodology that calculates the county-pair lowest cost transport costs for each decade between 1820 and 1860 and in the second, we discuss the data sources.

3.1 Methodology

The calculation of the lowest cost route between the pair of counties *o-d* (origin–destination) at time *t* requires two inputs. The first input is the network of available transportation routes between counties *o-d* in year *t*. The transportation network consists of nodes and arcs where the nodes are points in space, and arcs are means of transportation available in year *t*. Arcs

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include all available modes of transportation, for example navigable rivers, canals, or rails. The second input is the cost of transporting freight along each arc in each year t.

The calculation of minimal transport cost between counties o-d in year t consist of three steps: (1) construction of transportation network in year t where $t = \{1820, 1830, 1840, 1850, 1860\}$ with all available modes of freight transport, (2) calculation of the cost of freight transport along the arcs between the pair of counties o-d at time t, hence historical freight rates for each of the existing transport modes, (3) applying Dijkstra algorithm to calculate the lowest cost route between the pair of counties o-d in year t.

3.1.1 *Input 1: transportation network.* We create a US historical transportation network by combining GIS shape files of all modes of transportation that existed in year t (hence in years 1820, 1830, 1840, 1850, and 1860). Specifically, we use historical transport routes of navigable rivers, canals, and railways as digitized by Atack (2015, 2016, 2017, and the subsequent updates) and lakes and ocean shipping lines created by Donaldson and Hornbeck (2016). We enhance these GIS shape files by digitizing the network of roads, turnpikes, and exploration trails from the National Atlas of the United States (1970).[24] We follow the approach of Donaldson and Hornbeck (2016) to create linkages between different network components to account for the transshipment costs that occurred when freight was being transferred to or from one of six modes of transportation: roads, navigable rivers, lakes, canals, ocean, or rail. Then, we connect these network components to the geographical centroids of individual counties and calculate the transport costs between each county-pair.

Connecting each county centroid to navigable rivers, canals, and railways presents a challenge. In the antebellum USA, wagons played an important role in transporting freight from a place in a county to the nearest navigable river, canal, or railway (e.g., Larkin 1988; Mahoney 1990). The challenge we face is that the nearest distance of the county geographical centroid to the river, canal, or railway is usually different from the average distance that wagons travel to deliver freight. Fogel (1964) was among the first to recognize the importance of measuring the within-county distance and suggested splitting each county into grids and calculating the average of the nearest distances from each grid. We follow the procedure developed by Donaldson and Hornbeck (2016), which offers a refined way of connecting county centroids to the nearest transport mode. Specifically, within each county, we have created 200 random points, calculated the distance from each point to the nearest river, canal, or rail respectively, and taken the average of the distances. The result is a historical transportation network in the benchmark years of 1820, 1830, 1840, 1850, and 1860. We should note at this point that nodes and arcs are time- and region-varying because of the construction of canals and railways, improvements in rivers, and the westward expansion of the USA. As for the county borders, we use county crosswalks constructed by Eckert et al. (2020) in which historical county borders from 1790 to 2010 are projected onto 1990 constant borders. The analysis in the rest of the paper is conducted on the USA as of 1860, which includes 2,656 counties.

3.1.2 *Input 2: historical freight rates.* Our main principles in deciding what historical freight rates to use were threefold: (1) provide time variation of mode-specific freight rates, (2)

[24] We have used a map "Exploration and Settlement 1835–1850" from https://maps.lib.utexas.edu/maps/united_states/exploration_1835.jpg

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provide regional variation of mode-specific freight rates, (3) provide direction-specific freight rates. These principles are grounded in the historical realities of antebellum freight transportation, which we have discussed in Section II. Starting with roads, antebellum decades saw its expansion as well as improvements in quality, which affected wagon freight rates. Introduction of steamships in the early decades of the nineteenth century crucially changed transportation on navigable rivers, lakes, and along coasts: it lowered the freight rates and reduced travel time for downstream and especially upstream return journeys. Furthermore, since there was a time lag in the implementation of this technology, especially on the tributaries of the Mississippi and Ohio rivers, freight rates were not only direction-specific but also exhibited time and regional variation. The decades between 1820 and 1860 witnessed the construction of the canal system, which was not uniform in time or space, introducing time and regional variation in the canal freight rates as well. The emergence of the railway system was, similarly to the canals, an endeavor that varied greatly by decades and across regions, thus affecting freight rates over time and across regions.

The historical freight rates were collected or calculated from several sources and are presented and discussed in detail in the Appendix, Part 1. Freight rates for rivers come from the detailed and authoritative study on Western River transportation by Haites, Maik, and Walton (1975), which, using historical sources, provides a quantitative assessment of the transportation sector on navigable rivers in the antebellum decades. This is accompanied by the classical studies of Hunter (1949) on the steamboats on western rivers, and by Taylor (1957) on the transportation sector in general. Furthermore, we use a recent study by Binder (2011) on the antebellum transportation sector, and the US Census report on the transportation sector by Newcomb and Ward Jr. (1901). Freight rates for canals were collected and calculated from historical sources, including von Gerstner (1842–3), Annual Report of the State Engineer and Conveyor of the State of New York (1854), US Census Report on Canals (1883) and Aldrich, Falkner, and McCain (1893). These were complemented by the studies of Ransom (1967) and Scheiber (1969).

Railway freight rates come from the study of von Gerstner (1842–3), who assembled vast historical sources about the early railways, especially in the 1840s. The Census report by Newcomb and Ward Jr. (1901) and Fishlow (1965) provide data for the remaining years. Freight rates on the Great Lakes come from Newcomb and Ward Jr. (1901) and Binder (2011). Coastal shipping is calculated using 1816 benchmark freight rates between New York and New Orleans from Binder (2011), which were then projected to 1860 using an ocean freight index between 1816 and 1860 constructed from Carter et al. (2006) and Klovland (2008). Road freight rates are calculated using an approach by Alvarez-Palau et al. (2025) that incorporates road slope, road quality, wagon and load weight, and wagon speed. We estimate slope values on wagon routes using "Shuttle Radar Topography Mission" data (Jarvis et al. 2008). Road freight rates are from Carter et al. (2006), Vitaliano (2016), Ringwalt (1888) and Atack and Passell (1994). Wagon weight, wagon load are from Ringwalt (1888) and wagon speed from Ringwalt (1888) and Mahoney (1990).

Transshipment rates in the antebellum economy are probably the most challenging historical transport data. We follow Zimran (2020), Hornbeck and Rotemberg (2024), and Jaworski et al. (2024), who use the transshipment rate of fifty cents based on Fogel (1964). These charges are based on the "Report of the Commissioner of Corporations of Transportation by Water in the United States, Part III: Water Terminals" from 1910 (Fogel 1964, p. 44, footnote 52) and refer to the charges incurred in the first decade of the twentieth century. We supplement this rate with the transshipment charges from the "Report of the Selected Committee on Transportation Routes to the Seaboard with Appendix and

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Evidence" published in 1874 and which reports average transshipment charges in five cities between 1868 and 1872: New York City, Buffalo, Chicago, St. Louis, and New Orleans.

3.1.3 *Transport cost calculation.* We construct a dataset of county-to-county transport costs in the USA for benchmark years from 1820 to 1860 by integrating historical transportation networks with freight rates specific to time, region, and transport direction. Using the Dijkstra algorithm, we calculate the minimum transport costs for each county-pair, resulting in a comprehensive dataset of freight costs. During this period, the USA expanded southward and westward, with shifting boundaries as new territories were settled before formal organization as states or territories. This poses a challenge: should we include only counties within the historical US boundaries for each benchmark year, or all forty-eight contiguous states, including areas settled but not yet formally annexed? Since historical boundaries are nested within the forty-eight contiguous states, calculating costs for all counties automatically includes those within the historical USA and allows flexibility for researchers to select specific regions of interest. Additionally, this approach enables estimation of freight transport costs in unorganized territories, shedding light on the economic challenges faced by settlers during westward expansion. For brevity, we present results for counties in states already part of the Union.

3.1.4 *Limitations.* There are a few limitations that need to be recognized. First, there is no economies of scale or congestion effect in freight transport. We do not include different railway gauges, which require additional costs to modify railway cars, locomotives, and tracks (Rogers Taylor and New 1956). Second, since we focus on the average transport costs, we assume away the seasonal variation of the freight rates on waterborne transport. Third, even though we incorporate the direction-specific freight rates on rivers, the freight rates might be direction-specific on railways too due to back-haul transport. Overall, we expect that the county-to-county transport costs will be robust to the inclusion of these additional costs, especially over large distances. It is the transport costs over short distances that might be affected but even there, we do not expect that any extra cost on railways or seasonal spike on waterway freight rates would make wagon transport a preferred choice for the cost of wagon transport is larger by an order of magnitude. This methodology does not include journey time. Canal boats, typically pulled by mules or horses, moved at a slow pace, averaging between 2 and 3 miles per hour while steamboats on major rivers could reach the speed between about 6 and 10 miles per hour (Hunter 1949, p. 490; New York State Assembly 1838, p. 18). The speed of rail transport depended on the terrain, the grade of the railroads, and the locomotive power, but the available data suggest that the rail speed of freight was between 10 and 12 miles per hour while the passenger rail could travel over 20 miles per hour (Hunter 1949, p. 490; von Gerstner 1842–3, p. 369). Incorporating travel times would further refine the county-pair transport costs and substantiate the advantage of railroads over canals and rivers.

4. Antebellum transport cost and market access

In this section, we present the new dataset. Our focus will be market access, decomposition of transport cost changes in 1820–1860 between the extensive and intensive margin, and counterfactuals. Before that, we will first look at changes in the transport cost by transport mode. Table 3 reports the average cost of freight transport along cost-minimal route in

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Table 3. *Average cost of freight transport along cost-minimal route, USA 1820–1860 (cents per 100 miles in $US 2,000).*

	1820	1830	1840	1850	1860	1820–1860
All transport modes	1.54	0.79	0.62	0.54	0.53	−65.9%
Canals		0.57	0.32	0.24	0.27	−52.3%
Railroads			1.72	0.79	0.54	−68.3%
Navigable rivers	0.27	0.24	0.19	0.18	0.15	−45.9%
Coastal and lake shipping	0.20	0.06	0.09	0.06	0.07	−63.2%
Wagons	8.18	5.52	5.33	4.62	4.70	−42.5%

Source: See text for details on data sources. *Note:* USA does not include western territories.

1820–1860 by transport mode and shows a substantial reduction in the county-pair freight costs of almost 66 percent. Railroads were the transport mode with the largest decrease—more than 68 percent—followed by coastal and lake shipping with 63.2 percent and canal with 52.3 percent decrease. These are all substantial reductions in transport costs that offer quantitative support for and substantiate Goodrich (1961, p. 228): "... there can be little doubt that the canals played a major role in sharply reducing the general level of overland transport costs." Wagon transport costs experienced the smallest decline, but even there the magnitude was almost 43 percent. Table A7 in the Appendix provides further breakdown by regions. Antebellum transportation advances manifest themselves not only in the changes in the transport costs but also in which transport modes were being used. Table 4 shows the percentage of length (in miles) traveled along the cost-minimal route by transport mode in 1820–1860 within regions. We see that in 1820, waterway transport—be it navigable rivers, the Great Lakes, or coastal shipping—were the most preferred cost-minimizing transport mode. Since then, their importance declined as canals and railroads were gaining importance, but there were important regional differences. Rivers are the crucial transport mode by a wide margin in East South Central and by a smaller margin in East North Central throughout the antebellum era, indicating that the Mississippi River, Ohio River, and their tributaries were still important despite the canal and railroad building. Coastal shipping was the dominant transport route in the South Atlantic region throughout the antebellum years from the cost-minimizing perspective, same as in New England, though there only until 1850, after which railroads became the preferred mode. The Middle Atlantic is the region in which first canals and then railroads are more preferred than navigable rivers or the Great Lakes, reflecting the dense nature of the canal and railroad network in this region. Table 4 also demonstrates the rapid increase in railroad importance between 1850 and 1860. There is one caveat we need to be mindful of. Our calculations do not consider the time it takes to transport freight on different transport modes. Since railroads delivered goods faster than canal boats and steamships on rivers, lakes, and along the coast, it is likely that accounting for transportation time would increase the share of railroad routes.

4.1.1 *Extensive versus intensive margin.* Changes in transportation cost between 1820 and 1860 reflect both the construction of new transport modes, such as canals and railways, and freight rate changes. The freight rates charged by steamboats, canal, and railway companies reflected, among others, technological and organizational advances made by them in the

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Table 4. *Percentage of length traveled along cost-minimal route (%), within regions 1820–1860.*

	1820	1830	1840	1850	1860
	Panel A: New England				
Roads 1820–1860	29.7	17.2	14.9	14.0	11.7
Rivers 1820–1860	16.7	22.4	19.8	7.2	6.6
Coastal shipping and lakes 1820–1860	53.1	52.5	52.9	42.6	37.8
Canals 1830–1860		6.8	10.1	1.8	1.5
Railroads 1840–1860			0.6	33.1	41.4
	Panel B: Middle Atlantic				
Roads 1820–1860	22.9	8.5	6.5	6.6	6.6
Rivers 1820–1860	34.2	39.0	20.1	17.9	9.0
Coastal shipping and lakes 1820–1860	42.7	37.8	31.2	27.7	5.3
Canals 1830–1860		14.3	40.5	41.0	18.8
Railroads 1840–1860			0.7	5.7	60.0
	Panel C: East North Central				
Roads 1820–1860	25.8	10.9	7.0	6.3	5.2
Rivers 1820–1860	33.1	54.4	62.8	54.6	35.6
Great Lakes 1820–1860	41.1	28.1	21.9	25.8	25.2
Canals 1830–1860		6.5	8.0	11.2	4.7
Railroads 1840–1860			0.1	1.9	29.1
	Panel E: South Atlantic				
Roads 1820–1860	15.9	10.1	7.0	6.3	4.4
Rivers 1820–1860	29.5	36.9	41.2	34.6	24.2
Coastal shipping 1820–1860	54.4	52.4	49.2	50.6	48.3
Canals 1830–1860		0.3	1.2	0.8	0.8
Railroads 1840–1860			1.1	7.4	21.8
	Panel F: East South Central				
Roads 1820–1860	18.6	11.1	5.5	5.5	4.4
Rivers 1820–1860	69.1	77.9	86.4	83.7	73.8
Coastal shipping 1820–1860	11.9	10.5	6.8	9.2	7.2
Canals 1830–1860		0.1	0.1	0.1	0.1
Railroads 1840–1860			0.7	1.1	14.1

Source: See text for details on data sources. *Note:* The row sums do not add up to exactly 100 because of rounding.

antebellum decades (Chandler Jr. 1977; Fishlow 2000; Usselman 2002; Vance 1995).[25] We view the construction of the canals and railways as an *extensive margin* of county-to-county transport cost decline and the changes in the freight rates charged to deliver goods as an *intensive margin*. We focus on the transport cost changes between 1820 and 1860: between the year with no systematic canal network and no railways and the year just before the Civil War. We can apportion the transport cost changes between these two effects with the following decomposition:

$$\Delta(TC) = [(TI_{1860} \times FR_{1860}) - (TI_{1820} \times FR_{1860})] + [(TI_{1820} \times FR_{1860}) - (TI_{1820} \times FR_{1820})], \quad (1)$$

[25] The importance of other factors than the transportation infrastructure is discussed in Fishlow (1965, 2000), Haites et al. (1975).

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where *TI* denotes the transportation infrastructure consisting of all modes of transportation that existed in 1820 or 1860 and *FR* stands for "freight rates" in 1820 or 1860. We will call the first bracket on the right-hand side as "transportation infrastructure effect" or "extensive margin," and the second as "freight rate effect" or "intensive margin."

Table 5 reports the results of the county-pair transport cost decomposition when we consider transporting freight from any county to any other county between 1820 and 1860. The table is split into two vertical panels: "Transport costs Δ1820–1860," which presents the data entering the decomposition, and "Decomposition," which reports the results. Row (1) shows the results for the entire USA. We see that the average county-pair costs declined by 22.3 cents. Of these, the changes in the transportation infrastructure account for 30.2 percent and the changes in the freight rates for 69.8 percent. The regional breakdown, reported in rows (2)–(6), shows that the changes in transportation infrastructure (such as canal and railway construction) account for over 30 percent of the transport cost decline with the rest of the decline being due to freight rate declines. The contribution of the transport infrastructure might be seen low, considering the extent of canal and railroad construction. However, we need to keep in mind that canal building was confined to a few states in the Northeast and the railroad expansion was sluggish in the South and Southwest. On the other hand, freight rates on rivers, lakes, and coastal shipping declined substantially between 1820 and 1860 (e.g., Mississippi freight rates declined by almost 70 percent and coastal shipping by 61 percent, see Table A1). This means that transporting freight to the regions where canals and railroads were not the dominant transport mode was cheap even without the canal or railroad network, hence the larger contribution of the intensive than extensive margin. Indeed, Table 4 shows that especially in New England and South Atlantic, coastal shipping was a very important transport mode even in 1860 and river transport was dominant in East South Central. This can be also seen when we consider county-pair transport costs only within regions, as we do in Table A8 in the Appendix. There, the changes in the transportation infrastructure account for about 42.2 percent and 39 percent in transport infrastructure-–heavy regions of Middle Atlantic and East North Central, respectively. Another possibility why we find a larger contribution of freight rates rather than transport infrastructure is that our calculation overestimates the former one. This is because our calculation does not consider time it takes to transport freight on different transport modes. Since railroads delivered goods faster than steamships on rivers, lakes, and along the coast, the contribution of the new infrastructure was likely higher than our calculations would suggest.

4.1.2 *Counterfactuals.* We have established the overall quantitative importance of the transportation infrastructure in the previous section. To determine how much canals, railways, or both, contributed to the decrease of county-pair transportation costs, we perform a counterfactual analysis. Specifically, we construct county-pair transport costs in three different counterfactual scenarios: (1) no canals were built, (2) no railways were built, and (3) no canal and no railways were built. We then calculate the percentage difference between the "actual" costs and the "counterfactual" costs to assess the impact of canal and railway building on transport costs.

Table 6 presents the counterfactual calculations for the USA and its regions, which included only states officially part of the union. The regional county-pair costs are the cost of transporting freight from a county in region i to the rest of the USA. Starting with scenario 1—no canals—in Panel A and E we see that the largest effect in 1830 was in the Middle Atlantic region, and it stayed that way until 1860. The magnitude was not trivial—without

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Table 5. *Decomposition of the changes in the average county-pair transport costs (cents per ton in $US 2,000) between 1820 and 1860.*

		Transport Costs Δ 1820–1860				Decomposition			
	From a county in the US region to the rest of the USA	Year 1820	Year 1860	1820 transp infrastructure with 1860 freight rates	Δ 1820–1860	Transport system effect	Freight rate effect	Transport system effect (%)	Freight rate effect (%)
(1)	United States	32.8	10.6	17.3	−22.3	−6.7	−15.5	30.2	69.8
(2)	New England	24.7	7.7	12.7	−17.0	−5.0	−12.0	29.6	70.4
(3)	Middle Atlantic	26.0	6.9	13.5	−19.0	−6.6	−12.4	34.6	65.4
(4)	East North Central	26.6	6.8	14.0	−19.7	−7.2	−12.6	36.2	63.8
(5)	South Atlantic	26.2	8.0	13.6	−18.2	−5.6	−12.6	31.0	69.0
(6)	East South Central	25.4	7.2	13.5	−18.1	−6.2	−11.9	34.2	65.8

Source: See the text for details on the data sources.

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Table 6. *Actual and counterfactual average county-pair freight cost by regions (cents per ton in $US 2,000) 1820–1860.*

From a county in the US region to the rest of the USA	1830	1840	1850	1860	1830	1840	1850	1860
Panel A: counterfactual: no canals					Panel E: percentage difference: Panel A vs. Panel D			
New England	13.5	11.4	8.6	7.8	11.5%	13.0%	4.0%	1.6%
Middle Atlantic	14.6	11.8	9.3	7.4	16.3%	30.3%	18.0%	7.1%
East North Central	14.1	11.0	8.9	7.1	14.9%	18.2%	13.1%	3.7%
South Atlantic	14.2	11.3	9.3	8.1	5.4%	6.3%	3.9%	1.6%
East South Central	13.6	10.0	8.5	7.4	4.5%	6.7%	5.2%	2.7%
USA	18.2	14.3	12.0	10.7	4.6%	6.1%	4.2%	1.7%
Panel B: counterfactual: no railways					Panel F: percentage difference: Panel B vs. Panel D			
New England		10.1	8.7	8.7		0.6%	6.1%	13.1%
Middle Atlantic		9.1	8.1	7.8		1.1%	3.1%	12.8%
East North Central		9.3	8.1	7.7		0.8%	3.0%	12.0%
South Atlantic		10.8	9.4	9.2		1.5%	5.1%	14.5%
East South Central		9.6	8.5	8.3		2.6%	4.6%	14.5%
USA		13.6	11.8	11.3		0.8%	2.2%	7.1%
Panel C: counterfactual: no canals, no railways					Panel G: percentage difference: Panel C vs. Panel D			
New England		11.7	9.9	10.0		16.2%	20.5%	30.3%
Middle Atlantic		12.5	10.7	10.6		38.2%	36.1%	53.5%
East North Central		11.2	9.9	9.6		21.3%	26.4%	40.7%
South Atlantic		11.6	10.1	9.9		9.6%	13.2%	24.3%
East South Central		10.4	9.3	9.1		11.5%	14.0%	25.2%
USA		14.6	12.7	12.3		8.3%	9.9%	16.1%
Panel D: actual freight costs								
New England	12.1	10.1	8.2	7.7				
Middle Atlantic	12.5	9.0	7.8	6.9				
East North Central	12.2	9.3	7.8	6.8				
South Atlantic	13.5	10.6	8.9	8.0				
East South Central	13.0	9.3	8.1	7.2				
USA	17.4	13.5	11.6	10.6				

Source: See the text for details on the data sources. *Note:* The USA includes only states officially admitted to the Union.

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canals, the county-pair transport costs in this region would have been more than 16 percent higher in 1830 and 30 percent higher in 1840. The canal's importance petered out after that, unsurprisingly given the rise of railroads. The effect of canals in the other regions reflect the density of the canal network with the lowest in the southern regions. Examining scenario 2—no railways—in Panel B and F, we see that in all five regions, in 1840 and 1850, the contribution was modest, in the range 0.6 percent–2.6 percent and 3 percent–6.1 percent, respectively, but increased to a range of 12 percent–14.5 percent by 1860, reflecting the slow start of railway construction and its rapid increase in the 1850s. Scenario 3 in Panel C and G—no canals and no railway—represents the "complete" counterfactual because it considers the newly constructed modes of transport together, thus accounting for their interconnectedness. We see that the effect of canals and railways together is now substantial in the Northeast and Midwest ranging between 16 percent and 38 percent between 1840 and between 30 percent and 54 percent in 1860. This contrasts with the southern regions where the contribution of the canals and railways is much lower: in 1840, it is between 9.6 percent and 11 percent and between 24 percent and 25 percent in 1860. This difference is partly because the length of railway network in the southern region was not as advanced as in the northeast and partly because of very few canals being built in this region.

This counterfactual calculation assumes that the transportation network is exogenous, meaning that removing part of it does not affect the rest. It is a partial, not general equilibrium analysis. The latter requires a general equilibrium model of transport network formation in which a counterfactual analysis of removing part of the network, for example canals, would lead to a reconfiguration of the rest of the network. Swisher (2017) offers a general equilibrium model in which he endogenizes transport network formation and examines the effect of a counterfactual removal of either the canal network or railroad network on output, though not on transport costs. Nagy (2023) also builds a general equilibrium model and performs a counterfactual analysis in which he studies the impact of removing railroads on transport costs, city formation, growth, and output. He finds that in a scenario without railroads, the transport costs would increase by 1 percent in 1840, 3 percent in 1850, and 8.2 percent in 1860, which are only slightly higher than our findings of 0.8 percent, 2.2 percent, and 7.1 percent, respectively.

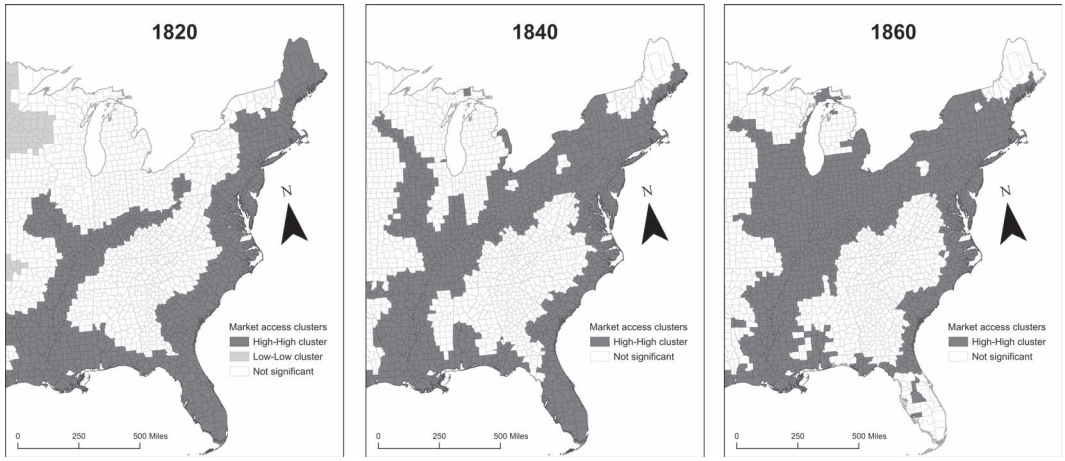
4.1.3 *Market access.* We use market access measure to show a spatial aspect of antebellum transportation network. We use the approach of Donaldson and Hornbeck (2016) and with the parameters from Hornbeck and Rotemberg (2024) where $MA_i = \sum_j Pop_j \tau_{ij}^{-\theta}$ defines the market access of county i, Pop_j is the population of county j, $\tau_{ij}^{-\theta}$ is trade cost function, and θ is trade elasticity parameter.[26] The parameter τ_{ij}, also called "iceberg trade cost" is defined as $\left(\tau_{ij} = 1 + t_{ij}/P\right)$ where t_{ij} is the transport cost between county i and j and P is the average price per ton of transported goods. We use the parameters from Hornbeck and Rotemberg (2024), who estimated the value of 3.05 for θ and 38.7 for P.[27]

To assess the occurrence and type of spatial dependency at the overall level in market access values, we calculated Global Moran's indicator (Moran 1948) in 1820, 1840, and 1860. This measure tells us whether market access values are distributed randomly, clustered, or

[26] Literature also uses a term "market potential".

[27] We have conducted a robustness check on the value of P. Table A11 in Appendix shows that a different value of P has a mechanical effect on the values of marker access. Specifically, a larger value of P (48.7) increases the log of market access, though only marginally.

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Map 5. Market access clusters using regional freight rates 1820, 1840, 1860. *Source:* See the text for details on data sources. *Note:* A high–high cluster occurs where counties with relatively high market access are surrounded by other counties with similarly high market access. For a county to be in high–high cluster, the similarity between its market access and that of its neighbors (which here are defined as the nearest eight counties to the county of interest) is significantly greater than would be expected if market access was distributed randomly. The threshold for significance was determined by applying a False Discovery Rate correction to a 95 percent confidence level.

dispersed. The resulting positive and significant Global Moran's indicators are indicative of spatial dependency in the form of clustering: across all years, counties with similar market access tend to occur close together. The contribution of individual counties to this clustering is illustrated by calculating the Local Moran's indicator (Anselin 1995) for each county, identifying certain counties as part of significant high–high or low–low clusters (when a county with relatively high or low market access is surrounded by other counties with similarly high or low market access). For a county to be in high–high cluster, the similarity between its market access and that of its neighbors (which here are defined as the nearest eight counties to the county of interest) is significantly greater than would be expected if market access was distributed randomly. We show the Local Moran's indicator overlaid with the transportation network in Map 5.[28]

While market access exhibited a clustered distribution in all years, the location of the clusters of high market access change from 1820 to 1860. In 1820 these clusters are concentrated around the Ohio, Mississippi Rivers, and Atlantic coast. In 1860, the clustering of high market access extends across the Midwest, north of the Ohio River to the Great Lakes, remained high along the Mississippi River, while the extent of the cluster along the Atlantic coast is reduced. We also present maps with market access in 1820, 1840, and 1850 in Appendix, Map A3, in a comparable map layout as in Zimran (2020).[29] The patterns

[28] For the cluster analysis using local Moran's I, the threshold for significance was calculated by applying a False Discovery Rate correction to a 95% confidence level (Caldas de Castro and Singer, 2006).

[29] In Zimran (2020), these market access maps are in Appendix, figure A.3.

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are broadly similar to Zimran (2020), although in our case, market access in 1840 and 1850 seems to be higher in the Middle Atlantic, which is driven by the fact that, in addition to time-varying transport network, we use time and region-varying freight rates that were declining substantially in the antebellum decades.

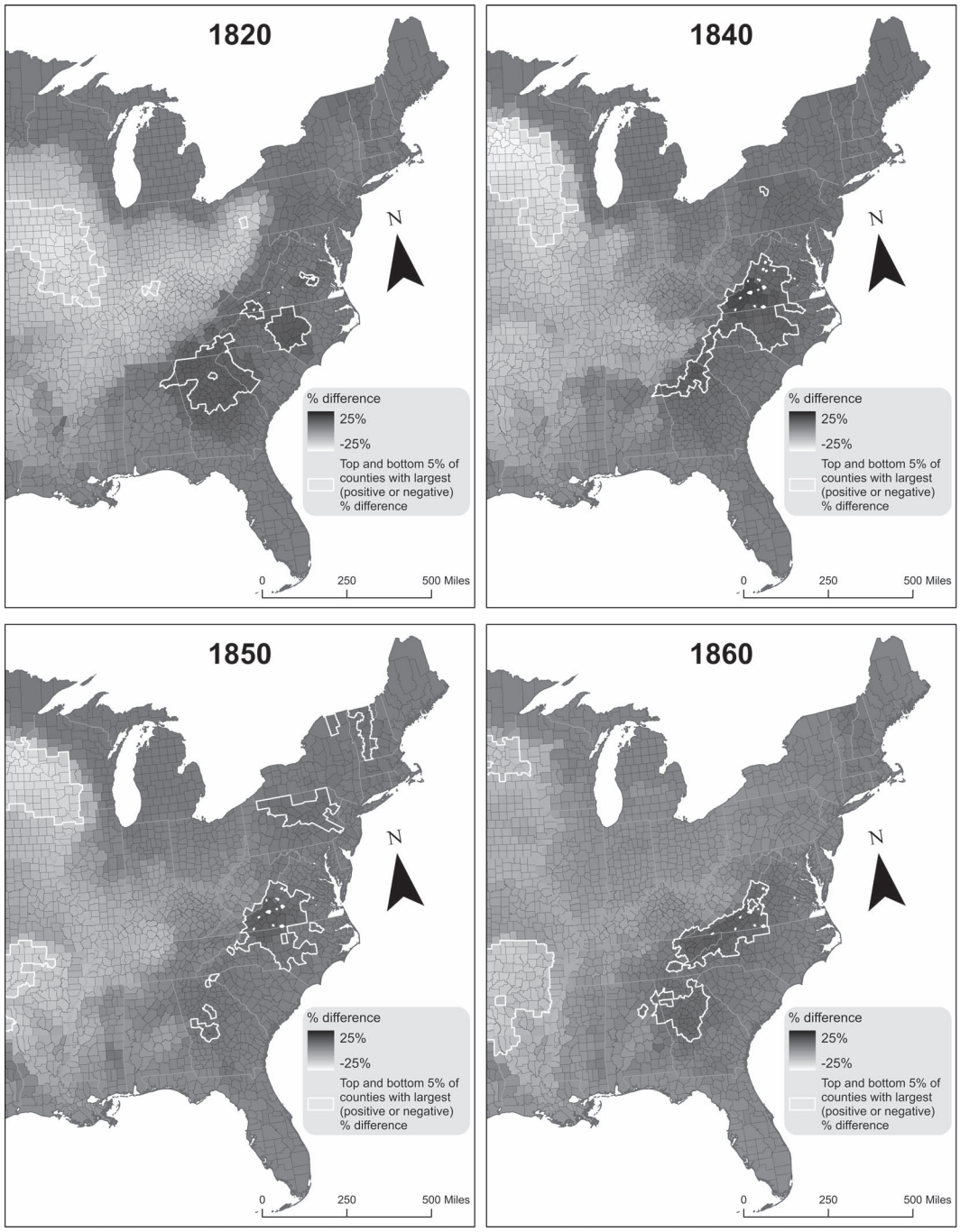
Earlier in the paper, we have examined the importance of changes in the freight rates between 1820 and 1860 relative to the changes in the transportation network. Here we will look at the importance of region- and direction-specific freight rates in a cross-sectional setting. We do it by comparing market access calculated with the US weighted average modal freight rates with the market access calculated using region- and direction-specific freight rates—we call it "market access difference."[30] We will also examine the importance of rivers, canals, and railroads, respectively, by applying the same comparison framework, but instead of using US weighted average for all transport modes, we use the average for rivers, canals, and railroads in turn. The formula for market access presented earlier tells us that the freight rates enter the market access calculation inversely through the parameter t_{ij}, which is the transport cost between county i and j calculated with freight rates and Dijkstra algorithm. Since it is a cross-sectional comparison in which the county population is the same whether we calculate market access with regional freight rates or US weighted averages, this parameter determines the magnitude of the market access difference. The results are presented in a set of maps. By the nature of averaging, there will be cases when US average freight rates will be higher than region- and direction-specific freight rates, and vice versa. As a result, market access calculated with the average freight rates will be higher in some areas and lower in others than market access calculated with region- and direction-specific freight rates.

Map 6 illustrates the percentage difference in market access calculated using US weighted average freight rates versus region- and direction-specific freight rates for 1820, 1840, 1850, and 1860, with differences ranging from −25 percent to 25 percent. Positive values indicate higher market access with US average rates, while negative values show lower access compared to region- and direction-specific rates. The spatial distribution highlights significant patterns: counties along navigable rivers, particularly the Mississippi, exhibit the largest negative differences. Here, US average freight rates, higher than downstream river rates, increase transport costs along river flows, reducing market access. Conversely, the largest positive differences appear in the South, where river freight rates exceed the US average, boosting market access when calculated with the national average. This dynamic underscores the critical role of navigable rivers in shaping market access. In all years, counties with the most significant positive or negative differences are consistently located along these rivers, reflecting the influence of region and direction specific freight rate variations on regional economic connectivity and accessibility during this period.

Next, we focus on differences between US average freight rates and region- and direction-specific rates for rivers, canals, and railroads, respectively. The most significant differences, ranging from −25 percent to 25 percent, occur with navigable rivers (Map A4), particularly along the Mississippi and Ohio Rivers, where downstream freight rates are much lower than the US average, leading to higher market access when using region-specific rates. This makes navigable rivers the primary driver of market access disparities, as confirmed by similarities with Map 6. For canals (Map A5), market access differences are smaller, between −2 percent and 2 percent, reflecting competitive and uniform canal freight rates across regions. Counties in upstate New York and eastern Ohio show higher market access with region-specific canal

[30] The weights are the length of the transport mode over which the freight rates apply.

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Map 6. Difference between market access calculated using US average freight rates and market access calculated using regional freight rates. *Source:* See the text for details on data sources. *Note:* Positive percentage difference values mean that the US average freight rates overestimate market access. Negative percentage differences values mean that the US average freight rates underestimate market access.

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rates, while those in Pennsylvania, western Ohio, Indiana, and Illinois benefit from US average rates. Railroad rate differences (Map A6) range from −8 percent to 8 percent, with limited impact in 1840–1850 due to slow rail network expansion. By 1860, rapid rail growth results in positive market access differences in the South, where region-specific rail rates are higher, and negative differences in the Middle Atlantic and Midwest where railroad freight rates are lower. Map A7 in Appendix uses the same methodology as in Map 6 and reveals that using US average freight rates obscure high market access clusters along the middle Mississippi River, where direction-specific rates were among the lowest, highlighting the critical role of navigable rivers in shaping economic connectivity during this period.

5. Applications of the dataset

Scholars have been examining the effects of the antebellum transportation on various socio-economic outcomes.[31] Our dataset allows us to substantiate numerous hypotheses ranging from the location of manufacturing sector, agricultural performance, or domestic trade. While beyond the scope of the paper to fully examine the socio-economic effects of antebellum transport, we illustrate the application of our data set by looking at a relationship between antebellum transport and land values, and then we discuss several avenues of research using our dataset.

5.1 Land values

Expansion of canals and railroads led scholars to investigate a connection between the newly emerging transport routes and the value of land, land being one of the main assets of western expansion and means for economic and social advancement. Fishlow (1965, p. 40) writes: "Between 1850 and 1860 total land in farms increased from 294 to 407 million acres; valuation of farmlands and buildings showed a more than proportionate rise from $3.1 billion to $6.4 million. One important cause of this dramatic increase in land values was the transportation revolution of the 1850s." Our dataset allows us to quantitatively examine this claim. We use county-level total value of agricultural land drawn from the US Censuses of Agriculture and Population (Haines 2010). Conceptually we will follow the methodology of Donaldson and Hornbeck (2016), who investigate the effects of railroad expansion in the postbellum decades on the land values. To capture the multimodality of transport network and the complementary nature of canals and railroads, we use market access measure discussed earlier in the paper.

Our empirical strategy is to regress the log value of agricultural land in county i and year t on log market access (MA_{it}), county-level controls (X_{it}), county fixed-effect (δ_i), state-year fixed effect (δ_{st}), and a cubic polynomial of county latitude and longitude interacted with year fixed effect ($f(x_i, y_i,)\ \delta_t$):

$$\ln(\text{Land Value}_{it}) = \beta \ln(\text{MA}_{it}) + X_{it} + \delta_i + \delta_{st} + f(x_i, y_i)\,\delta_t + \varepsilon_{it}. \quad (2)$$

To estimate equation (2), we follow the approach of Donaldson and Hornbeck (2016) who notice that in case of two periods (in our case 1850 and 1860), it is equivalent to estimate equation (2) in differences.[32] It is also more convenient to discuss a relationship between

[31] For example, Fishlow (1965), Clark (1966), Pred (1980), Nagy (2023).
[32] Donaldson and Hornbeck (2016), p. 883.

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the changes in log land values to changes in market access, and it is closer to the spirit of quote in the previous paragraph from Fishlow (1965). Standard errors are clustered at state-level, and the regressions are weighted by the land value of counties in 1850 to account for outliers. County-level controls in the vector (X_{it}) contain time and county varying measures of the physical presence of the transport network which we will examine in turn. These include categorical measures of the presence of a navigable river, canal, or railroad as well as the length (in miles) of the navigable river, canal or railroad. We will use, respectively, two measures of market access: one calculated with time-, region, and direction-specific freight rates, and the other with U.S. average freight rate.

Table 7 reports the estimates of equation (2).[33] There are two panels: Panel A includes the results when market access is measured with time-, region-, and direction-specific freight rates, and Panel B presents the results when the market access is measured with US average freight rates. Column (1) in Panel A contains the baseline results. We see that the market access is highly statistically significant and has a large impact: a 1 percent increase in market access increases land values by approximately 0.9 percent. Column (2) reports an unweighted estimate that is of lower statistical significance, but the magnitude is higher: 1.509 versus 0.902. We prefer the latter one because weighting by 1850 land values reduces the influence of outliers: for example, counties with very low land value in 1850 would experience a large percent increase in land values between 1850 and 1860.

Columns (3)–(10) report the estimate when controlling for the physical presence of the transport network in own county. We use both categorical measures and length-measures in turn: columns (3)–(6) include the former and columns (7)–(10) the latter. Categorical measures control for the situation when a county gains a physical presence of either a canal, railroad line, or a navigable river between 1850 and 1860. Length-measures control not only for the situation when the county gains the physical presence of the network, but also whether this network expanded in the county (e.g., longer portions of navigable river, additional railroad line, or a canal feeder). The estimates of market access are similar and highly statistically significant, though their magnitude is slightly lower when using categorical controls than when using length-based controls.

Panel B reports the impact of the market access when measured using US average freight rates. The baseline result is highly statistically significant and a 1 percent increase in market access leads to about 0.96 percent increase in land value. The unweighted estimate is not significant, and the estimate is larger than the weighted one. The qualitative pattern of the estimates when controlling for the physical presence of the network is similar to that in Panel A. Overall, we can summarize that the impact of market access on land values is quantitatively important and, on average, the estimated impact is around 0.9 percent among the estimates weighted by 1850 land values. If we compare these estimates with the ones in Panel A, market access calculated with US average freight rate exhibits slightly higher impact on land values than the market access calculated with time-, region-, and direction-specific freight rates.[34]

Probably the main empirical concern is that the market access is endogenous. Panel data specification allows us to control for unobserved county and state-year fixed effects. Furthermore, controlling for the physical presence of the transport network in own county

[33] There are fewer counties than 2,656 because of missing historical data on counties' land values.

[34] We have conducted a robustness check for Panel A in which we used $P = 48.7$ instead of $P = 38.7$ (P is average value of shipment and enters the calculation of market access). The results are presented in Table A12 in the Appendix and show that the impact of market access is larger than in the original estimates. It is because the market access is larger when P = 48.7 as parameter P enters inversely the market access formula.

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Table 7. *Estimates of the impact of market access on agricultural land value.*

	Log value of agricultural land									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Panel A: market access calculated with time-, region-, and direction-specific freight rates									
Log market access	0.902***	1.549**	0.801**	0.822***	0.891***	0.683**	1.056***	0.833***	0.905***	0.986***
	(0.307)	(0.748)	(0.328)	(0.278)	(0.303)	(0.297)	(0.336)	(0.283)	(0.306)	(0.326)
Controls for:										
Any river	No	No	Yes	No	No	Yes	No	No	No	No
Any canal	No	No	No	Yes	No	Yes	No	No	No	No
Any railroad	No	No	No	No	Yes	Yes	No	No	No	No
River length	No	No	No	No	No	No	Yes	No	No	Yes
Canal length	No	No	No	No	No	No	No	Yes	No	Yes
Railroad length	No	No	No	No	No	No	No	No	Yes	Yes
Weighted regression	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of counties	1,924	1,924	1,924	1,924	1,924	1,924	1,924	1,924	1,924	1,924
R-squared	0.557	0.505	0.558	0.559	0.558	0.561	0.559	0.559	0.557	0.561
	Panel B: market access calculated with average US freight rates									
Log market access	0.963***	2.909	0.882***	0.894***	0.957***	0.788**	1.108***	0.905***	0.967***	1.048***
	(0.302)	(1.766)	(0.317)	(0.306)	(0.297)	(0.323)	(0.316)	(0.301)	(0.301)	(0.323)
Controls for:										
Any river	No	No	Yes	No	No	Yes	No	No	No	No
Any canal	No	No	No	Yes	No	Yes	No	No	No	No
Any railroad	No	No	No	No	Yes	Yes	No	No	No	No
River length	No	No	No	No	No	No	Yes	No	No	Yes
Canal length	No	No	No	No	No	No	No	Yes	No	Yes
Railroad length	No	No	No	No	No	No	No	No	Yes	Yes
Weighted regression	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,924	1,924	1,924	1,924	1,924	1,924	1,924	1,924	1,924	1,924
R-squared	0.558	0.510	0.559	0.560	0.559	0.562	0.560	0.560	0.558	0.562

Source: See text for details on data sources. *Notes:* Column (1) reports the results from the baseline specification of equation (2) with no controls in the vector X. Column (2) reports the estimates without regression weights. Columns (3)–(6) include dummies for each transport mode respectively and then together. Columns (7)–(10) reports the results when the length of transport mode is controlled for. Weighted regression specification uses 1850 counties' land value. SEs reported in parentheses are clustered by state. $^{**}P < .05$. $^{***}P < .01$.

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might alleviate some of these concerns as well. Nonetheless, the construction of canals and railroads might have happened in the counties where the land values were experiencing a relative increase, or the regional freight rates that enter market access calculation reflected local demand for transportation services driven by the supply of agricultural products, which, in turn, affected the value of agricultural land. Therefore, we need an instrumental variable estimator with an instrument that offers a plausible exogenous variation of the market access. It is beyond the scope of this paper to fully examine it; hence we interpret the results as conditional correlations. Still, these results lend support to Fishlow's (1965, p. 40) claim and offer a "first-look" quantitative impact of the "transportation revolution" on land values. In addition, the results are qualitatively in line with those of Donaldson and Hornbeck (2016), who estimated the impact of market access on land values between 1870 and 1890. Future research could explore the causal relationship between market access and land values by employing, for instance, the instrumental variable approach of Borusyak and Hull (2023), which leverages a counterfactual transport network, or Faber (2014), which utilizes a minimum-spanning tree network.

5.2 Further research

Our dataset enables the exploration of further hypotheses about the economic development of the antebellum USA. Fishlow (1965, pp. 198–199) advances hypotheses about the role of expectations and speculation about the land values and the role of anticipatory settlement before the railroads spread westward. Furthermore, he examined competition between canals and railroads and the reasons why railroads were the wining transport technology, something that our dataset can address by analyzing the mode-specific transport cost. Donaldson and Hornbeck (2016) conducted a counterfactual analysis in which they examined the impact of removing railroads on land values. Similar analysis can be conducted for the antebellum canals and railroads.[35] Potential implications of such as counterfactual is that land values would have been lower without canals and railroads. Scholars have also seen the advent of canals and railways as one of the main factors that led to the redirection of the domestic trade from the "Midwest–southeast" corridor with New Orleans as the major port to the "west–east" corridor with the Great Lakes, canals, and later railways as the main modes of transportation.[36] Our dataset allows us to examine the effects of canals and railroads on the costs of transport between the west, New Orleans, and New York City and substantiate their importance in the changes of domestic trade patterns. The location of manufacturing activities has been also a long-lasting interest of historians, historical geographers, and economic historians.[37] Meyer (1983) hypothesizes that high transport costs in the antebellum era actually fostered regional industrialization by keeping regional markets separate. This lack of integration allowed New England, the Middle Atlantic, and the Midwest to develop specialized manufacturing independently without facing tough competition from other regions. It was only after the Civil War, as transport costs fell and these regions became interconnected, that they merged to form the cohesive Manufacturing Belt. Our dataset enables us to test this hypothesis and enhance our understanding of antebellum manufacturing location patterns.

[35] We are grateful to an anonymous referee for this suggestion.
[36] Pred (1980), Fishlow (1965), chapter 7, Goodrich (1961, pp. 227–234).
[37] For example, Goodrich (1961, pp. 235–238), Fishlow (1965), chapter 6, Pred (1980), Klein and Crafts (2012).

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6. Conclusion

We have constructed a new dataset of county-to-county minimal transport costs for every decade between 1820 and 1860. Our dataset introduces a digitized network of turnpikes and other roads, as well as time-, region-, and direction-specific freight rates. The former expands the existing digitized transport modes, while the latter allows to examine the intensive margin of the transport cost changes. We have conducted numerous calculations including counterfactuals, explored the differences between market access calculated using our method and market access calculated using US average modal freight rates. Lastly, we have offered a first look at the relationship between market access and land values in the antebellum decades.

Our guiding principles were to get closer to the historical reality, and future research can incorporate further refinements. For example, transport speed also influenced freight rates and although water transport was cheaper than rail, its slower pace disadvantaged time-sensitive agricultural products. Future research can also incorporate precise location of river ports and the importance of coastal ports.

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Supplementary material

Supplementary material is available at *European Review of Economic History* online.

Conflicts of interest

None declared.

Data availability

The data and methods underlying this article are available in the article and in its online supplementary material.

References

Aldrich, N.W., R.P. Falkner, and C.C. McCain 1893. *Wholesale Prices, Wages, and Transportation: Report by Mr. Aldrich, from the Committee on Finance, March 3, 1893 (No. 1394)*. Washington: US Government Printing Office.

Alvarez-Palau, E.J., D. Bogart, M. Satchell, and L. Shaw-Taylor 2025. "Transport and Urban Growth in the First Industrial Revolution." *The Economic Journal* **135**:1191–228.

Alvarez-Palau, E.J., and J. Martí-Henneberg 2020. "Shaping the Common Ground: State-Building, the Railway Network, and Regional Development in Finland." *Journal of Interdisciplinary History* **51**:267–96.

Annual Report of the State Engineer and Surveyor on the Canals of the State of New York, 1853–54. Charles van Benthuysen, Printer to the Legislature: Albany.

Anselin, L. 1995. "Local Indicators of Spatial Association—LISA." *Geographical Analysis* **27**:93–115.

Downloaded from https://academic.oup.com/ereh/advance-article/doi/10.1093/ereh/heag001/8644323 by guest on 13 April 2026

Atack, J. 2015. *Historical Geographic Information Systems (GIS) database of Steamboat-Navigated Rivers During the Nineteenth Century in the United States*, https://my.vanderbilt.edu/jeremyatack/data-downloads/.
Atack, J. 2016. "Historical Geographic Information Systems (GIS) Database of U.S. Railroads for 1820–1860, https://my.vanderbilt.edu/jeremyatack/data-downloads/
Atack, J. 2017. *Historical Geographic Information Systems (GIS) Database of Nineteenth Century U.S*: Canals, https://my.vanderbilt.edu/jeremyatack/data-downloads/
Atack, Jeremy, and Peter Passell 1994. *A New Economic View of American History*, 2nd edn. W.W. Norton & Company: New York.
Baldwin, L.D. 1941. *The Keelboat Age on Western Waters*. Pittsburgh: University of Pittsburgh Press.
Berger, T. 2019. "Railroads and Rural Industrialization: Evidence from a Historical Policy Experiment." *Explorations in Economic History* **74**:101277.
Binder, J.J. 2011. "The Transportation Revolution and Antebellum Sectional Disagreement." *Social Science History* **35**:19–57.
Bogart, D. 2005. "Turnpike Trusts and the Transportation Revolution in 18th Century England." *Explorations in Economic History* **42**:479–508.
Bogart, D. 2007. "Neighbors, Networks, and the Development of Transport Systems: Explaining the Diffusion of Turnpike Trusts in Eighteenth-Century England." *Journal of Urban Economics* **61**:238–62.
Bogart, D. 2009. "Turnpike Trusts and Property Income: New Evidence on the Effects of Transport Improvements and Legislation in Eighteenth-Century England." *The Economic History Review* **62**:128–52.
Borusyak, K., and P. Hull 2023. "Nonrandom Exposure to Exogenous Shocks." *Econometrica* **91**:2155–85.
Caldas de Castro, M., and B.H. Singer 2006. "Controlling the False Discovery Rate: a New Application to Account for Multiple and Dependent Tests in Local Statistics of Spatial Association." *Geographical Analysis* **38**:180–208.
Carter, S.B., S.S. Gartner, M.R. Haines, A.L. Olmstead, R. Sutch, and G. Wright (Eds.) 2006. *Historical Statistics of the United States: Millennial Edition*. New York: Cambridge University Press.
Chandler, A.D. Jr. 1977. *The Visible Hand*. Massachusetts: Harvard University Press, Cambridge.
Clark, J.G. 1966. *The Grain Trade in the Old Northwest*. Urbana: The University of Illinois Press.
Crafts, N., and A. Klein 2014. "Geography and Intra-National Home Bias: US Domestic Trade in 1949 and 2007." *Journal of Economic Geography* **15**:477–97.
Dixon, F.H. 1909. *A Traffic History of the Mississippi River System (No. 11)*. Washington: US Government Printing Office.
Donaldson, D., and R. Hornbeck 2016. "Railroads and American Economic Growth: a "Market Access" Approach." *The Quarterly Journal of Economics* **131**:799–858.
Eckert, F., A. Gvirtz, J. Liang, and M. Peters 2020. *A Method to Construct Geographical Crosswalks with an Application to US Counties since 1790 (No. w26770)*. Cambridge, Massachusetts: National Bureau of Economic Research.
Esteban-Oliver, G., and J. Martí-Henneberg 2024. "The Spanish Railway Network, 1848–2023." *Revista de Historia Economica-Journal of Iberian and Latin American Economic History* **42**:153–69.
Faber, B. 2014. "Trade Integration, Market Size, and Industrialization: Evidence from China's National Trunk Highway System." *Review of Economic Studies* **81**:1046–70.
Fishlow, A. 1965. *American Railroads and the Transformation of the Ante-Bellum Economy*. Cambridge, Massachusetts: Harvard University Press.
Fishlow, A. 2000. "Internal Transportation in the Nineteenth and Early Twentieth Centuries". In *The Cambridge Economic History of the United States*, edited by S.L. Engerman, and R.E. Gallman, pp. 543–642. Cambridge University Press: Cambridge Economic History of the United States.
Fogel, R.W. 1964. *Railroads and American Economic Growth*. Baltimore: The Johns Hopkins Press.
von Gerstner, F.A.R. 1842–3. *Early American Railroads: Franz Anton Ritter von Gerstner's 'Die innern Communicationen'1842-1843*. Stanford, California: Stanford University Press.

Downloaded from https://academic.oup.com/ereh/advance-article/doi/10.1093/ereh/heag001/8644323 by guest on 13 April 2026

Goodrich, C., J. Rubin, H.J. Cranmer, and H.H. Segal 1961. *Canals and American Economic Development*. New York: Columbia University Press.
Gross, D.P. 2020. "Collusive Investments in Technological Compatibility: Lessons from US Railroads in the Late 19th Century." *Management Science* **66**:5683–700.
Haines, M.R., and Inter-university Consortium for Political and Social Research 2010. *Historical, Demographic, Economic, and Social Data: The United States, 1790-2002*. Ann Arbor, MI: Inter-university Consortium for Political and Social Research. https://doi.org/10.3886/ICPSR02896.v3
Haites, E.F., J. Mak, and G.M. Walton 1975. *Western River Transportation: The Era of Early Internal Development, 1810–1860*. Baltimore: The Johns Hopkins University Press.
Hall, J. 1848. *The West: Its Commerce and Navigation*. Cincinnati: HW Derby & Company.
Harrison, J.M. 2023. "Exploring 200 Years of US Commodity Market Integration: a Structural Time Series Model Approach." *Explorations in Economic History* **88**:101514.
Hornbeck, R., and M. Rotemberg 2024. "Growth off the Rails: Aggregate Productivity Growth in Distorted Economies. Forthcoming in the." *Journal of Political Economy* **132**:3547–602.
Hornung, E. 2015. "Railroads and Growth in Prussia." *Journal of the European Economic Association* **13**:699–736.
Howe, D.W. 2007. *What Hath God Wrought: The Transformation of America, 1815–1848*. Oxford: Oxford University Press.
Hunter, L.C. 1949. *Steamboats on the Western Rivers*. Cambridge, Massachusetts: Harvard University Press.
Jacks, D.S. 2005. "Intra-and International Commodity Market Integration in the Atlantic Economy, 1800–1913." *Explorations in Economic History* **42**:381–413.
Jacks, D.S. 2006. "What Drove 19th Century Commodity Market Integration?" *Explorations in Economic History* **43**:383–412.
Jaremski, M. 2012. "Estimating Antebellum Passenger Costs: a Hub-and-Spoke Approach." *Historical Methods: A Journal of Quantitative and Interdisciplinary History* **45**:93–101.
Jarvis, A., H.I. Reuter, A. Nelson, and E. Guevara 2008. "Hole-Filled Seamless SRTM Data V4.", http://srtm.csi.cgiar.org.
Jaworski, T., E.O. Kimbrough, and N. Saito 2024. *How Important Are Cultural Frictions for Internal Migration? Evidence from the Nineteenth Century United States (No. w33192)*. Cambridge, Massachusetts: National Bureau of Economic Research.
Klein, A., and N. Crafts 2012. "Making Sense of the Manufacturing Belt: Determinants of U.S. Industrial Location, 1880–1920." *Journal of Economic Geography* **12**:775–807.
Klein, D.B., and J. Majewski 1992. "Economy, Community, and Law: the Turnpike Movement in New York, 1797–1845." *Law & Society Review* **26**:469–512.
Klovland, J.T. 2008. "The Construction of Ocean Freight Rate Indices for the Mid-Nineteenth Century." *International Journal of Maritime History* **20**:1–26.
Larkin, J. 1988. *The Reshaping of Everyday Life, 1790–1840*. New York: Harper Perennial.
Larson, J.L. 2001. *Internal Improvement: National Public Works and the Promise of Popular Government in the Early United States*. Chapel Hill and London: University of North Carolina Press.
Mahoney, T.R. 1990. *River Towns in the Great West: The Structure of Provincial Urbanization in the American Midwest, 1820–1870*. New York: Cambridge University Press.
Meyer, D.R. 1983. "Emergence of the American Manufacturing Belt: an Interpretation." *Journal of Historical Geography* **9**:145–74.
Minicucci, S. 2004. "Internal Improvements and the Union, 1790–1860." *Studies in American Political Development* **18**:160–85.
Moran, P.A. 1948. "The Interpretation of Statistical Maps." *Journal of the Royal Statistical Society. Series B (Methodological)* **10**:243–51.
Nagy, D.K. 2023. "Hinterlands, City Formation and Growth: Evidence from the US Westward Expansion." *Review of Economic Studies* **90**:3238–81.
National Atlas of the United States. 1970. https://maps.lib.utexas.edu/maps/united_states

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New York State Assembly 1838. *Documents of the Assembly of the State of New York, Sixty-First Session (Vol. 2), Report on February 18, 1838*. E. Croswell: Albany, NY.
Newcomb, H.T., and E.G. Ward Jr. 1901. *Changes in the Rates of Charge for Railway and Other Transportation Services*. Government Printing Office: Washington.
Pontarollo, N., and R. Ricciuti 2020. "Railways and Manufacturing Productivity in Italy after Unification." *Journal of Regional Science* **60**:775–800.
Pred, A. 1980. *Urban Growth and City-Systems in the United States, 1840–1860*. Cambridge, Massachusetts: Harvard University Press.
Raitz, K., and N. O'Malley 2007. "Local-scale Turnpike Roads in Nineteenth-century Kentucky." *Journal of Historical Geography* **33**:1–23.
Ransom, R.L. 1964. "Canals and Development: a Discussion of the Issues." *The American Economic Review* **54**:365–76.
Ransom, R.L. 1967. "Interregional Canals and Economic Specialization in the Antebellum United States." *Explorations in Economic History* **5**:12–35.
Report on the Canals of the United States by T.C. Purdy 1883. "1880 Census: Volume 4". In *Report on the Agencies of Transportation in the United States, including the Statistics of Railroads, Steam Navigation, Canals, Telegraphs, and Telephones*. Government Printing Office: Washington.
Ringwalt, J.L. 1888. *Development of Transportation Systems in the United States: Comprising a Comprehensive Description of the Leading Features of Advancement, from the Colonial Era to the Present Time, in Water Channels, Roads, Turnpikes, Canals, Railways, Vessels, Vehicles, Cars and Locomotives*. Pub. by the Author, Railway World Office.: Philadelphia.
Rogers, Taylor, G., and I.D. Neu 1956. *The American Railroad Network, 1861–1890*. Urbana and Chicago: University of Illinois Press.
Scheiber, H.N. 1969. *The Ohio Canal Era: A Case Study of Government and the Economy, 1820–1861*. Athens, Ohio: The Ohio University Press.
Sellers, C. 1994. *The Market Revolution: Jacksonian America, 1815–1846*. Oxford: Oxford University Press.
Shaw, R.E. 1984. "Canals in the Early Republic: A Review of Recent Literature." *Journal of the Early Republic* **4**:117–42.
Slaughter, M.J. 2001. "Does Trade Liberalization Converge Factor Prices? Evidence from the Antebellum Transportation Revolution." *Journal of International Trade & Economic Development* **10**:339–62.
Swisher IV, S.N. 2017. "Reassessing Railroads and Growth: Accounting for Transport Network Endogeneity." Unpublished manuscript.
Taylor, G.R. 1957. *The Transportation Revolution, 1815–60*. New York: Holt, Rinehart and Winston.
Taylor, A. 2021. *American Republics: A Continental History of the United States, 1783–1850*. New York: WW Norton & Company.
Twelfth Census of the United States Taken in the Year 1900 n.d., Part 1, Volume 1: Population, U.S. Census Office, Washington.
Usselman, S.W. 2002. *Regulating Railroad Innovation: Business, Technology, and Politics in America, 1840–1920*. New York: Cambridge University Press.
Vance, J.E. 1995. *The North American Railroad: its Origin, Evolution, and Geography*. Baltimore: The Johns Hopkins University Press.
Vitaliano, D.F. 2016. "Benefits and Costs of the Erie Canal: a New View." *Eastern Economic Journal* **42**:581–93.
Zimran, A. 2020. "Transportation and Health in the Antebellum United States, 1820–1847." *The Journal of Economic History* **80**:670–709.

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