Midterm Details

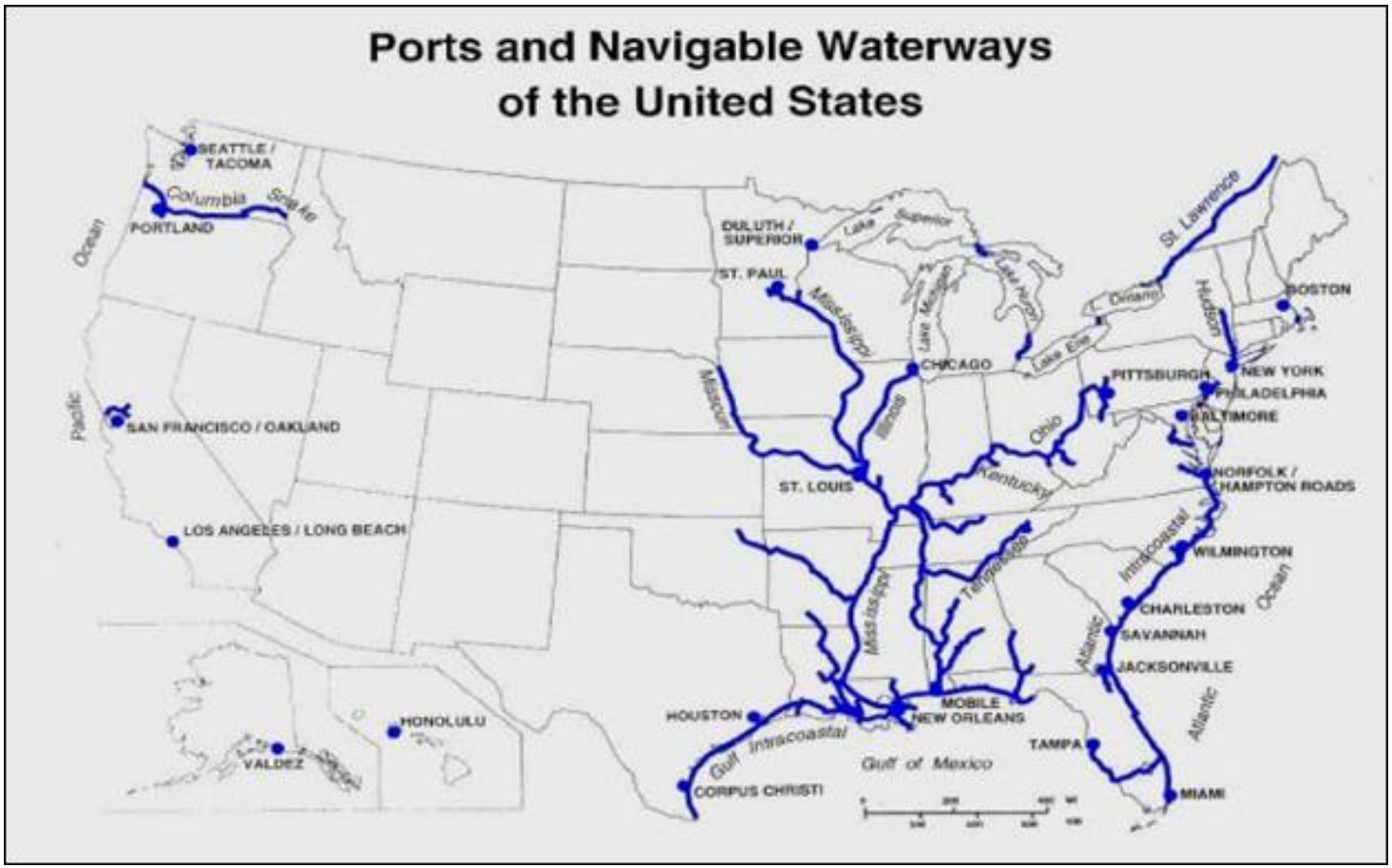
- You'll get your referee reports back at the end of class (I'll make some general comments right now)
- The top number is your score out of 10 on the summary section, the second number is your score out of 10 on the critiques, the third number is just your total score out of 20
- You'll get midterms back on Tuesday
- The second referee report is due November 2 (on "A Nation of Immigrants: Assimilation and Economic Outcomes in the Age of Mass Migration" by Abramitzky, Boustan and Eriksson)

The Transportation Revolution

Transportation in the Early Nineteenth Century

- One of the big benefits the United States retained from British mercantalist policies was well developed ocean transportation
- Inland transportation was pretty much limited to navigable rivers (roads were terrible)
- What this meant was that port cities were in a position to thrive and grow right from the start
- For economic growth in the interior, better transportation would need to be developed to connect people living in the interior to markets

Transportation in the Early Nineteenth Century



Transportation in the Early Nineteenth Century

Transportation Costs, 1815

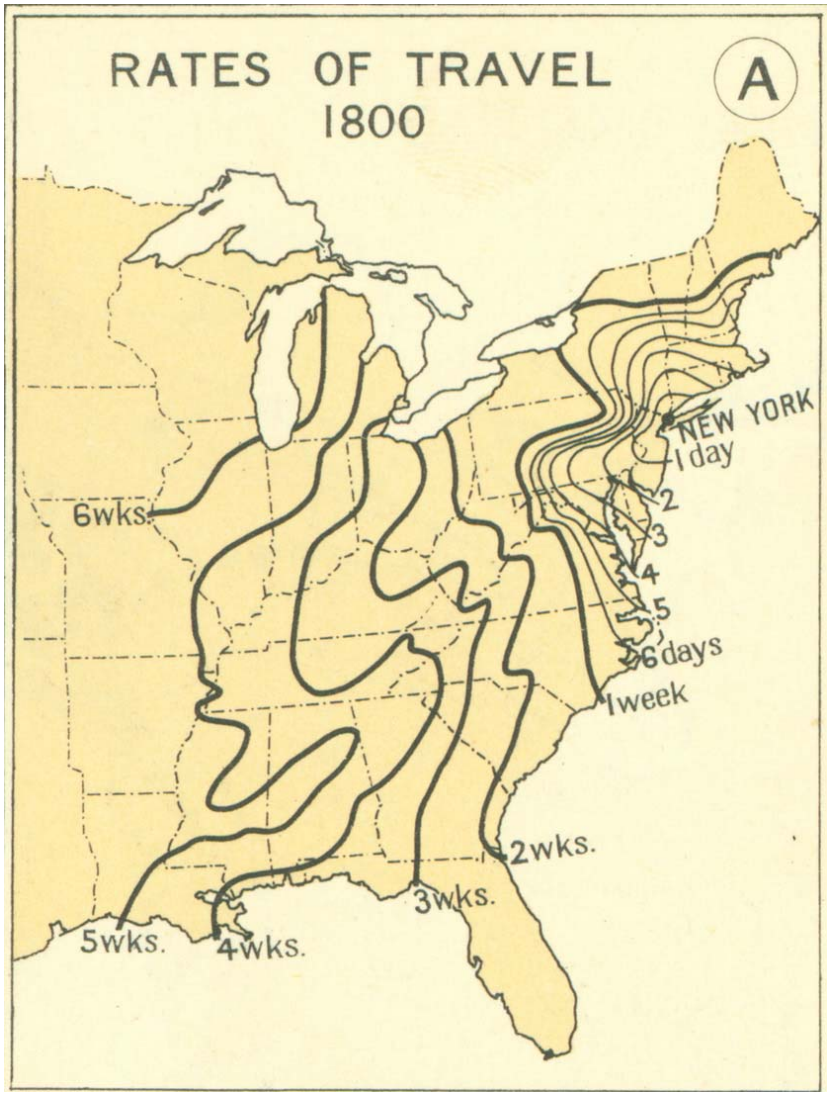
Mode of Transportation	Cost per Ton-Mile
Road	$0.30
River, Upstream	$0.06
River, Downstream	$0.01
Ocean	<$0.01

The Evolution of Travel Times

Maximum Shipping Distance in Miles Before Shipping Costs are Prohibitive, 1815

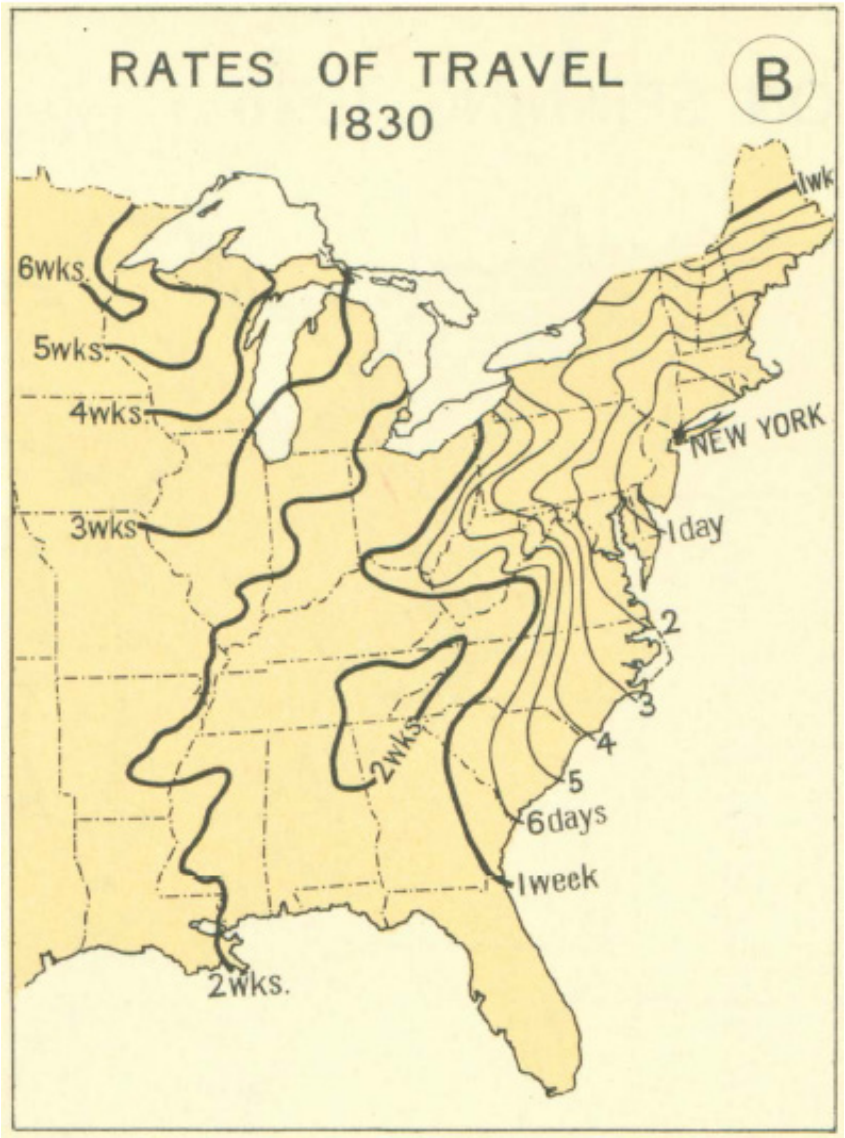
Commodity	Road	River, Upstream	River, Downstream	Ocean
Farm Products				
Corn	40	200	910	1180
Wheat	80	410	1900	2300
Flour	130	670	3080	4000
Tobacco	300	1500	6920	9000
Butter	780	3900	18080	23500
Cotton	870	4330	20000	Anywhere
Tea	3000	15000	Anywhere	Anywhere
Manufactured Products				
Pig iron	90	460	2120	2760
Iron bar	230	1170	5380	6990
Nails	420	2080	9620	12510

The Evolution of Travel Times



From "Atlas of the Historical Geography of the United States" by Charles Paulin, 1932

The Evolution of Travel Times



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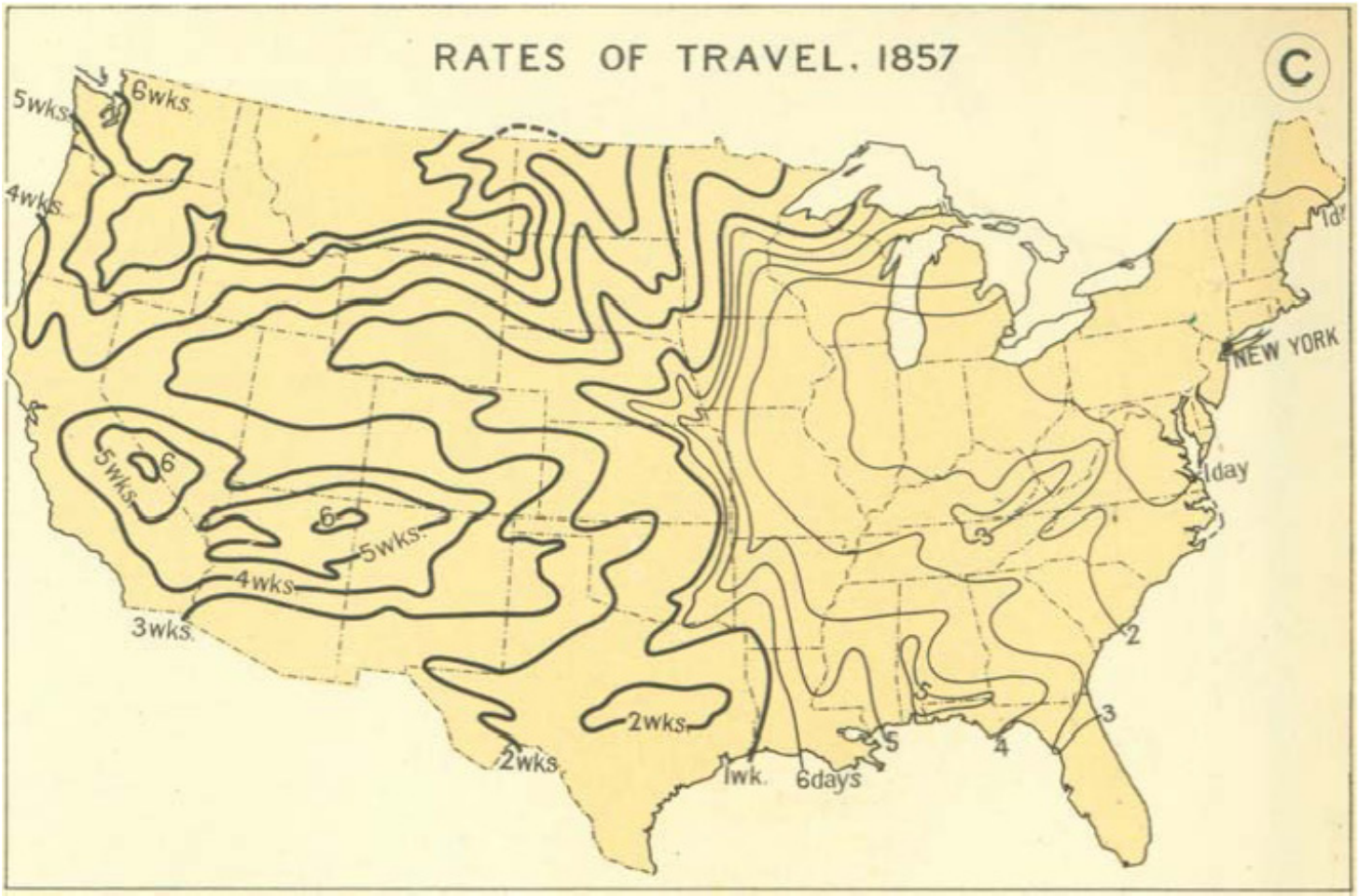

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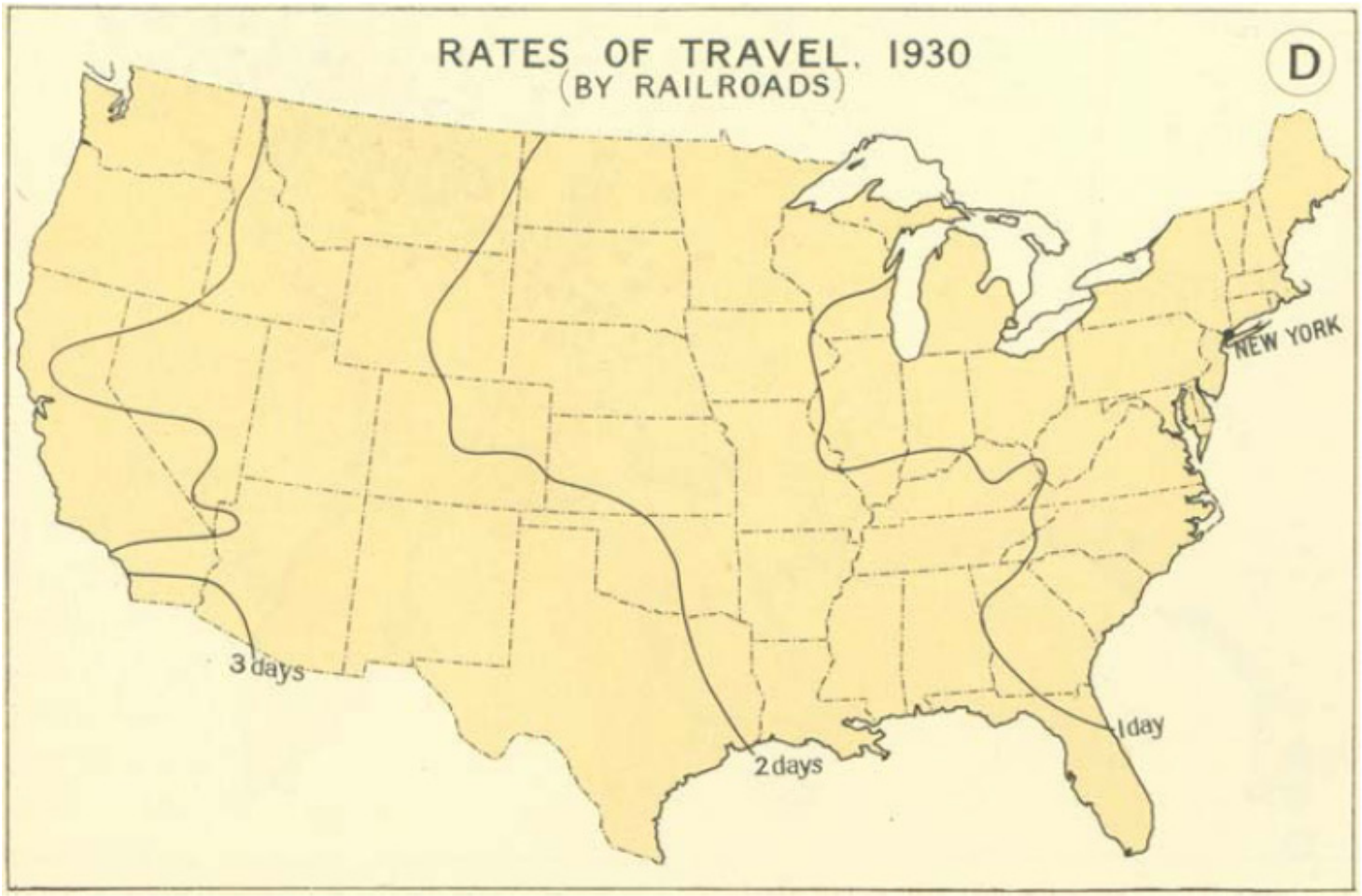

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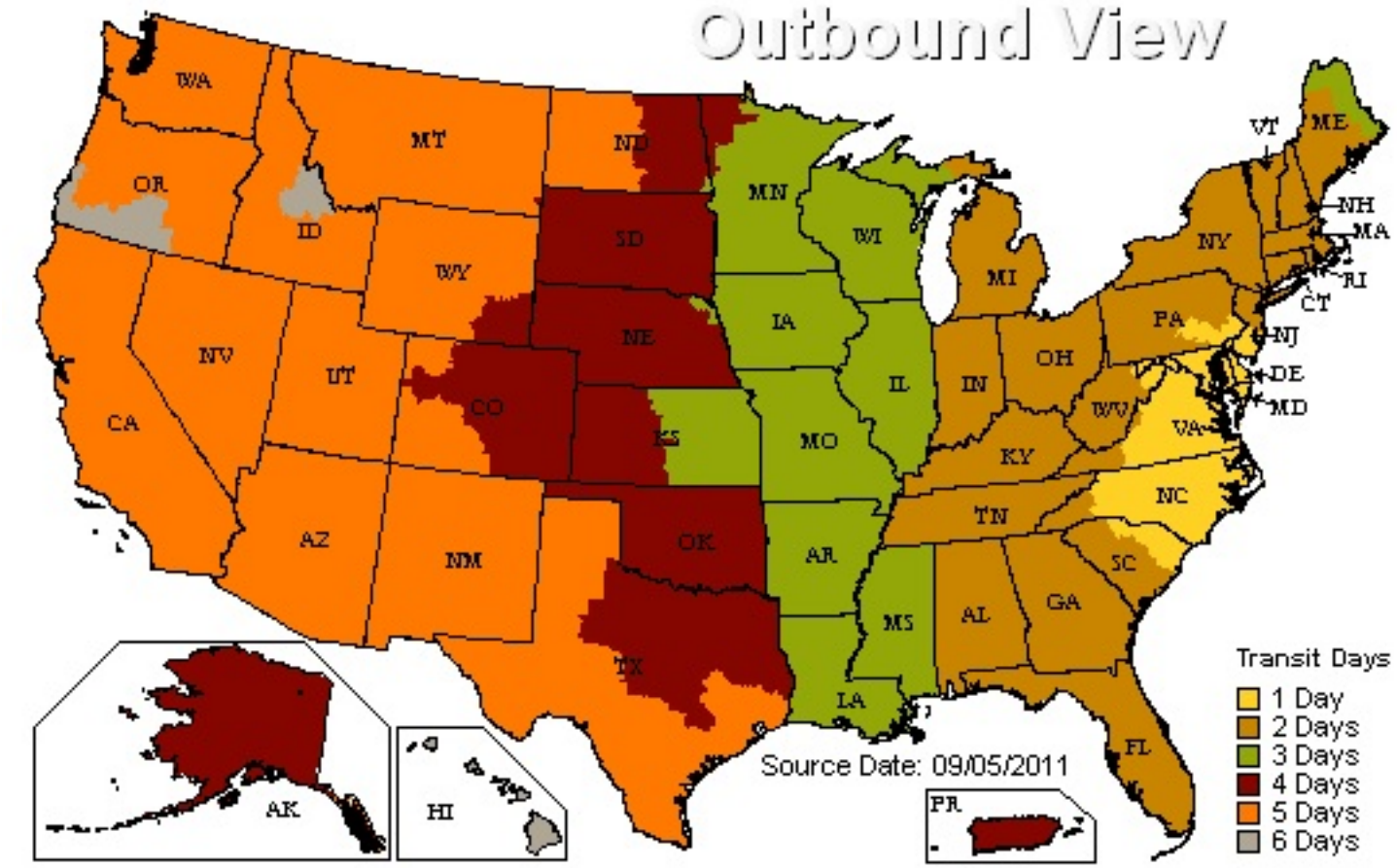
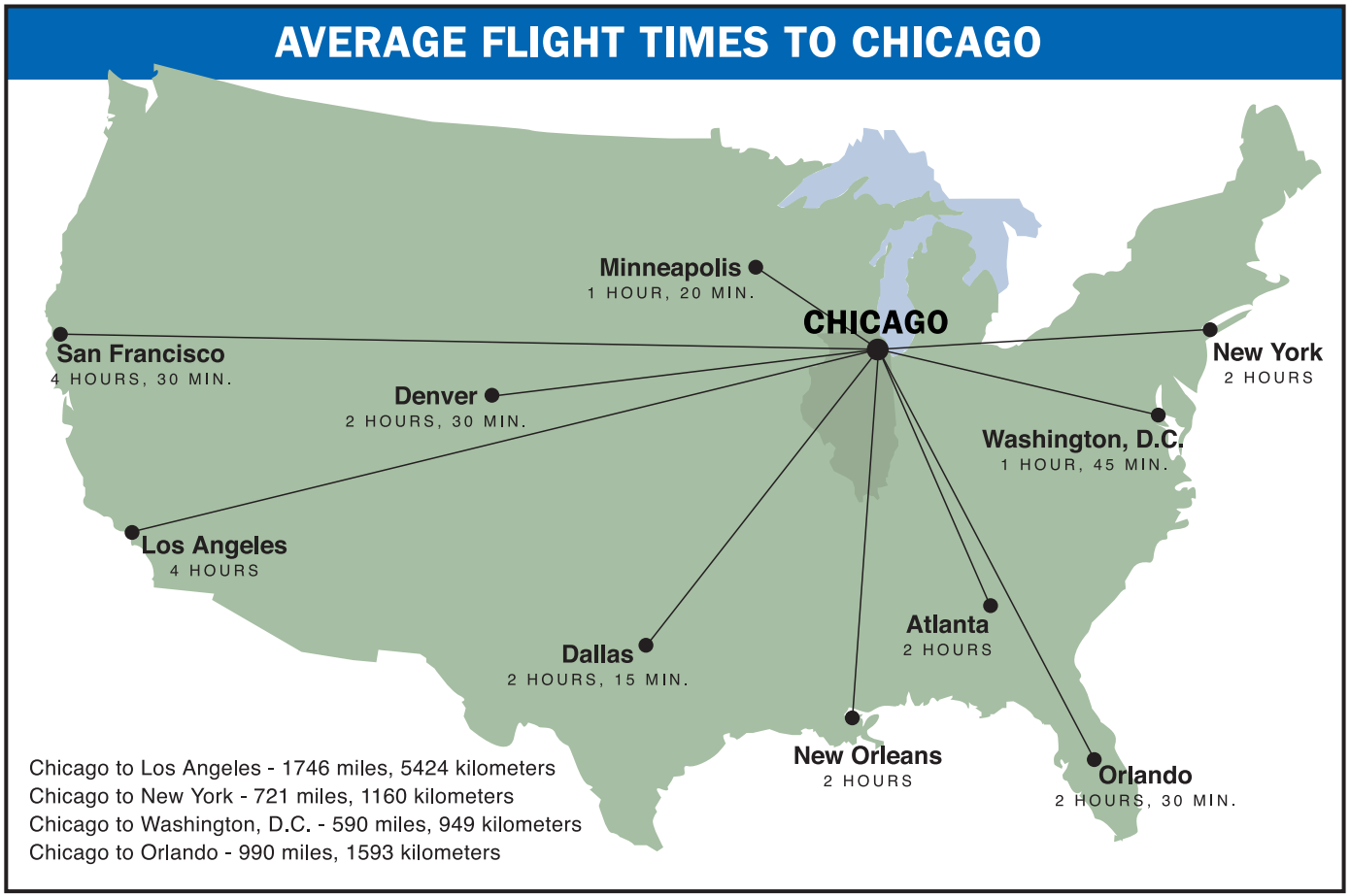


UPS Ground transit times from Williamsburg, VA

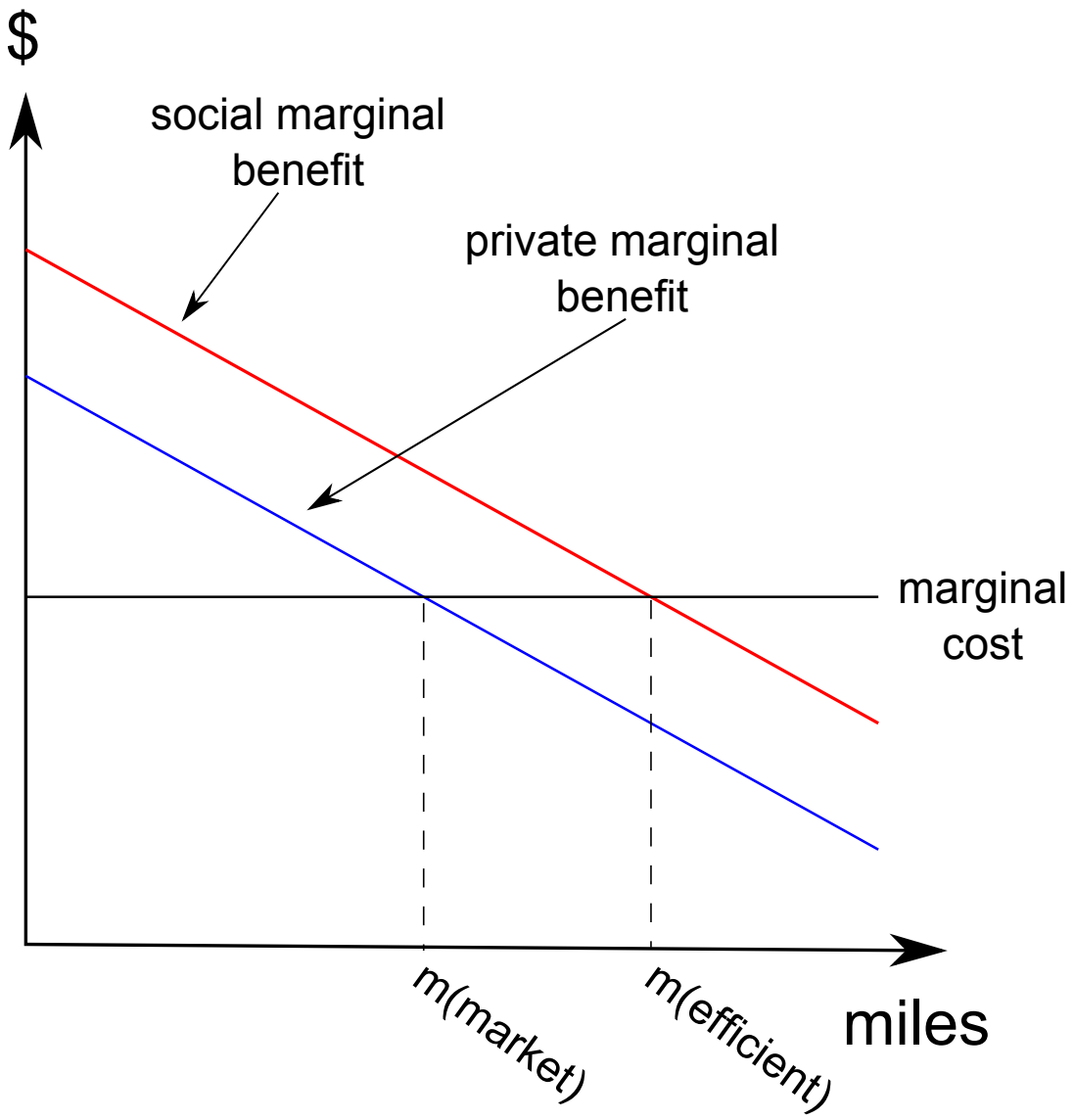
The Evolution of Travel Times



Problems With Developing Transportation

- Transportation without private control leads to a free-rider problem
- Transportation with private control has a couple of problems of its own:
  - Private companies may not be able to acquire the parcels of land needed for a useful transportation system
  - If a privately controlled transportation system can be built, monopoly power will lead to socially inefficient outcomes
  - Even if competitively priced, transportation may be underprovided
- Transportation systems have serious scale issues (it's difficult to start small)

Problems With Developing Transportation



Plan for Studying the Transportation Revolution

- We are going to trace the history of each major transportation advance (roads, canals, steamboats, railroads)
- For each form of transportation, we'll consider the following questions:
  - How was expansion funded?
  - Was it a private or public endeavor?
  - What were the private returns to investment?
  - What were the social returns?
  - How did it reshape the economy?

Roads

Roads

Excerpts from a 1918 publication of the North Carolina Good Roads Association on the reasons for state highways:

- ...the success of the agricultural, industrial, economic and social life of our State depends largely upon transportation...
- ...highways contructed and maintained by the State mean equal rights to all, special priveleges to none...
- ...more and better roads can be built and properly maintained by the State than through hundreds of local units...
- ...every individual in the State of North Carolina will benefit directly or indirectly from a system of public roads and, therefore, should contribute towards their construction...

A Timeline of Road Construction

- 1792-1845: Turnpike Era
- 1847-1853: Plank Road Boom
- 1850-1902: Toll Roads in the West
- 1880-1916: Good Roads Movement
- 1956- : Interstate Highway System

A Timeline of Road Construction

The Call

SAN FRANCISCO BICYCLE RIDERS AS DISCIPLES OF PROGRESS.

Enthusiastic Outpouring of Devotees of the Wheel Who Are Determined on Improving the City's Thoroughfares—Fully One Hundred Thousand Spectators Viewed the Parade.

Roads

- Roads were really, really bad (mudpits, deep ruts, rocks, tree stumps, etc.)
- Maintenance of roads presents classic free rider problems
- An early solution, when roads were maintained by town governments, was a road labor tax
- It became clear that state and local governments weren't up to the task of providing better roads
- An alternative was the private provision of roads: turnpikes

Roads

Excerpt from the compiled Nebraska state statutes:

SEC. 79. [**Allowance for work.**]—The overseer shall allow all persons who may appear in pursuance to such notice and offering to pay their labor tax and three-fourths [of] their road tax in labor, under his direction, the sum of $1.50 for every day he shall actually work eight hours on such road, $1.50 for each yoke of oxen, and $1.50 for each span of horses he shall furnish agreeably to the requirements of the overseer; and for such labor performed the overseer shall give to such person a certificate, which certificate shall be received by the county treasurer in discharge of the labor tax and three-fourths of the road tax of such person as aforesaid. The one-fourth of the road tax shall be paid in cash; *Provided*, That any person who is a resident of the district not notified by the overseer to labor upon the roads as hereinbefore provided, shall be discharged from the payment of said labor tax and three-fourths [of] said road tax.

The Growth of Turnpikes

Turnpikes as a percentage of all business incorporations, 1800-1830

State	All Incorporations	Turnpike Incorporations	Turnpikes as a % of all incorporations
New York	993	339	34
Pennsylvania	428	199	46
New Jersey	190	47	25
Maryland	194	54	28
Connecticut	234	77	33
Rhode Island	127	34	27
Massachusetts and Maine	880	104	12
New Hampshire	304	51	17
Vermont	177	41	23
Total	3527	946	27

The Growth of Turnpikes

Cumulative Turnpike Investment (1800-1830) as % of 1830 GDP

State	Cumulative Turnpike Investment	Turnpike Investment as a % of 1830 GDP
Maine	35,000	0.16
New Hampshire	575,100	2.11
Vermont	484,000	3.37
Massachusetts	4,200,000	7.41
Rhode Island	140,000	1.54
Connecticut	1,036,160	4.68
New Jersey	1,100,000	4.79
New York	9,000,000	7.06
Pennsylvania	6,400,000	6.67
Maryland	1,500,000	3.85
Total	24,470,260	6.15

How Turnpikes Worked

- Most were financed through private stock subscription and structured to pay dividends
- The initial sale of stock provided the funds to build the turnpike, toll receipts would then cover operating expenses
- In practice, little was left over to pay dividends
- The lack of profits is a little misleading
- The social returns were greater than the private returns and many investors cited civic duty as an important reason for the investment

Government Efficiency vs Private Sector Efficiency

A Comparison of Private and Public Ventures

	Pittsburgh Pike	National Road
Route	Pittsburgh to Harrisburg	Maryland to West Virginia to Midwest
Cost per mile	$4,805	$13,455
Maintenance Financing	tolls	government outlays
Result	cut freight rates in half between Pittsburgh and Philadelphia	never completed

Problems with Turnpikes

- Turnpikes faced some controversy
- People feared owners abusing monopoly power and objected to paying for something that used to be free
- To keep the public happy, legislators wrote restrictions into turnpike charters
- Examples of these restrictions:
  - Toll gates could be spaced no closer than a specified minimum distance
  - Exemptions from toll payment for particular people
  - Toll and penalty increases required petitioning the legislature
- Even with better roads, land transport was still costly compared to water transport

The End of Toll Roads

- Despite the regulations, many private toll roads were chartered and in use throughout the 19th century
- They were often more successful than government efforts to expand roads
- In the late 1800s, sentiment turned against toll roads
- State and federal governments developed anti-toll road policies
- The network of private toll roads had disappeared by 1920

The Transportation Revolution

The End of Tollroads

The Extent of Private Toll Roads

Toll Road Movements	Incorporations	% Successful in Building Road	Roads Built and Operated	Average Road Length	Toll Road Miles Operated
Turnpikes Incorporated from 1792 to 1845	1562	55	859	18	15000
Plank Roads Incorporated from 1845 to 1860	1388	65	902	10	9000
Toll Roads in the West Incorporated from 1850 to 1902	1127	40	450	15	7000
Other	1000	50	500	16	8000
Total	5000-5600	48-60	2500-3200	12-16 miles	30000-52000

Roads - Not Much of a Revolution

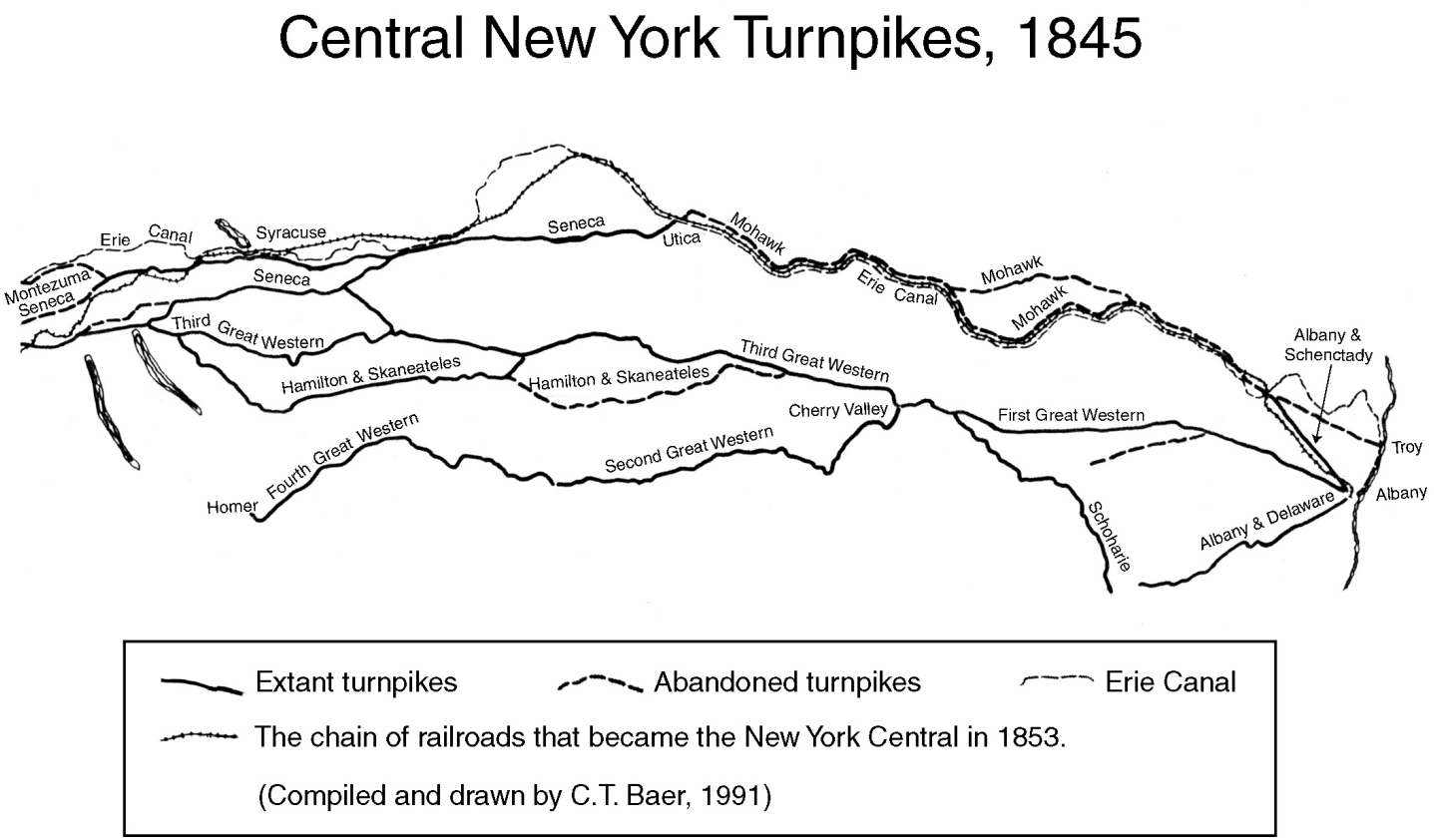
- Large investments were made in turnpikes, mainly in the mid-Atlantic states and New England
- While not all that profitable for the investors, the roads did cut travel costs in half
- Turnpikes were typically private endeavors with a slight public twist to them
- Governments were typically unable to finance and maintain roads or were very inefficient at it
- Road transportation still remained costly: it was slow and took up manpower and animal power for an extended period of time
- Roads weren't going to be the transportation revolution the economy was looking for

Transportation in the Early Nineteenth Century

Transportation Costs, 1815

Mode of Transportation	Cost per Ton-Mile
Road	$0.30
River, Upstream	$0.06
River, Downstream	$0.01
Ocean	<$0.01

Map of Central New York Turnpikes, 1845



The Construction of Canals

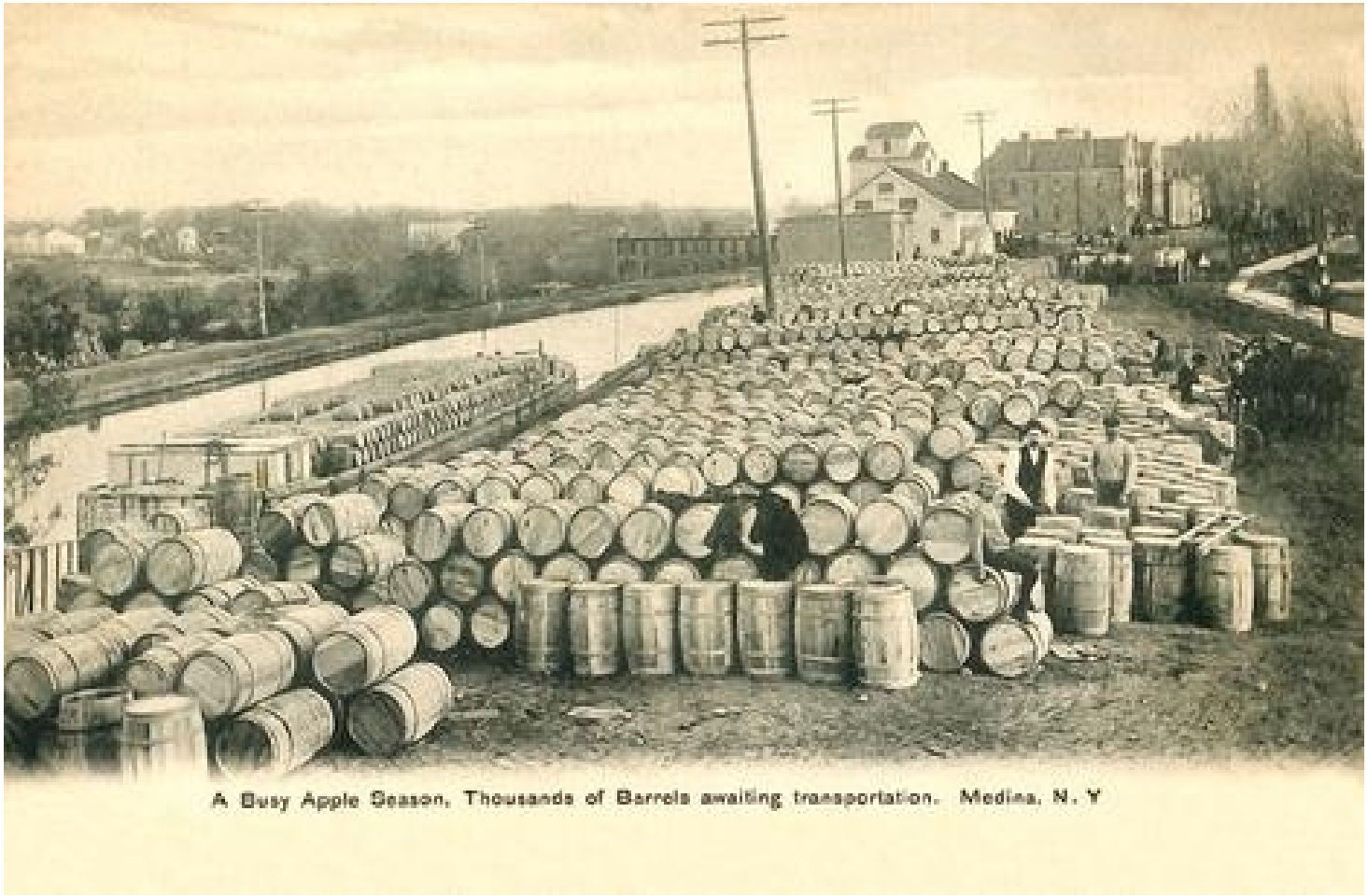
- Canals solved many of the problems with roads
- They could be built to cover similar stretches of land but benefited from using boats rather than wagons
- Canal technology was well developed:
  - Canals have been around since 4000 B.C.
  - By 609, China had completed the Grand Canal, over 1,000 miles of water transport
  - Were being built extensively in England in the 1700s as a result of the Industrial Revolution
- So canals seemed like a pretty good solution to transportation issues

Problems with Canal Construction

- Canals seem like a great idea, but their construction presents a few issues
- Roads were being built 10 or 15 miles at a time, this doesn't work for canals
- To be useful, canals had to be big projects; big projects cost a lot of money and raise big route planning issues
- This moved them into the realm of a very large public works project
- Once that happens, issues of politics, bureaucracy, waste and corruption arise

Case Study: The Erie Canal

The Erie Canal



Why focus on the Erie Canal?

- Engerman and Sokoloff (2004) on the governance of the building of the Erie Canal
- They want to study how much corruption there was in the antebellum economy
- Concerned with the issue of whether low corruption, secure property rights are a precondition for growth and whether corruption increases or decreases as an economy grows
- The Erie Canal was one of the biggest public works projects before the Civil War
- It had major effects on the shape of the economy and transportation networks
- It can be fairly easily compared to modern public works projects

History of the Erie Canal

- Politics were central to canal creation:
  - Canals were typically funded and operated by the government
  - Being on the canal path led to big economic gains
  - If financed through taxes, burden is shared by entire state
- Politics is evident in route choice: went to Erie rather than Ontario, making it much longer than necessary
- Why? Kept trade from getting diverted to Canada, would increase land values in western NY

History of the Erie Canal - The Politics of the Canal

- Mid-Hudson valley farmers opposed the project
- Strong opposition from people in New York City
- Canal was only approved by a narrow margin
- Getting the necessary votes required logrolling
- Unlike bank charters, it didn't seem that votes were obtained through bribes

History of the Erie Canal - The Politics of the Canal

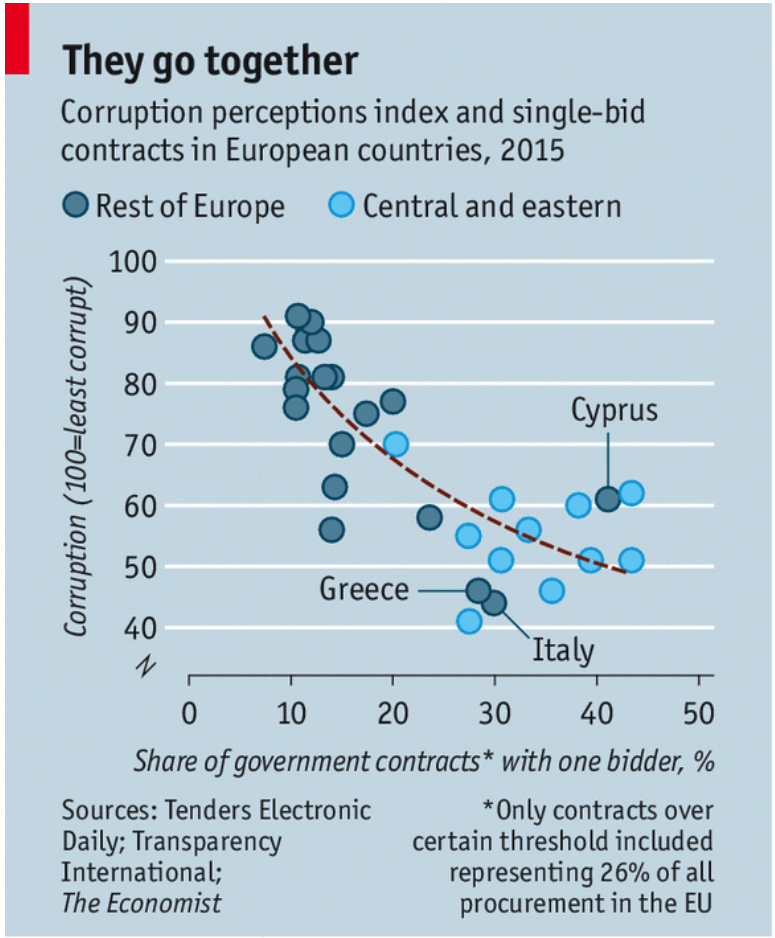
- Ultimately, the legislation to build the canal gets passed
- It is to be funded entirely by the state (federal funding fell through)
- Money for construction would be borrowed on the credit of the state
- It would be paid off through a Canal Fund
- Money for the Canal Fund would come from canal tolls, a tax on salt, duties on auctioned goods, taxes on steamboat passengers and a real estate tax on land within 25 miles of the canal

History of the Erie Canal - The Construction of the Canal

- Where concerns of corruption and fraud arose were in the construction of the canal
- Construction was contracted out to private firms and individuals
- In modern times, this means big contracts potentially going to friends and family or firms with a lot of lobbying behind them

History of the Erie Canal - The Construction of the Canal

History of the Erie Canal - The Construction of the Canal



History of the Erie Canal - The Construction of the Canal

- Things were different then: contracts were split up into small chunks and the quality of work was easily observed and compared to well-known standards
- Small contracts meant small gains from corrupt practices
- Overall result: canal gets constructed at a cost 46 percent higher than estimated costs

Erie Canal Cost Overruns in Context

Actual Expenditures to Projected Costs on Major Public Works

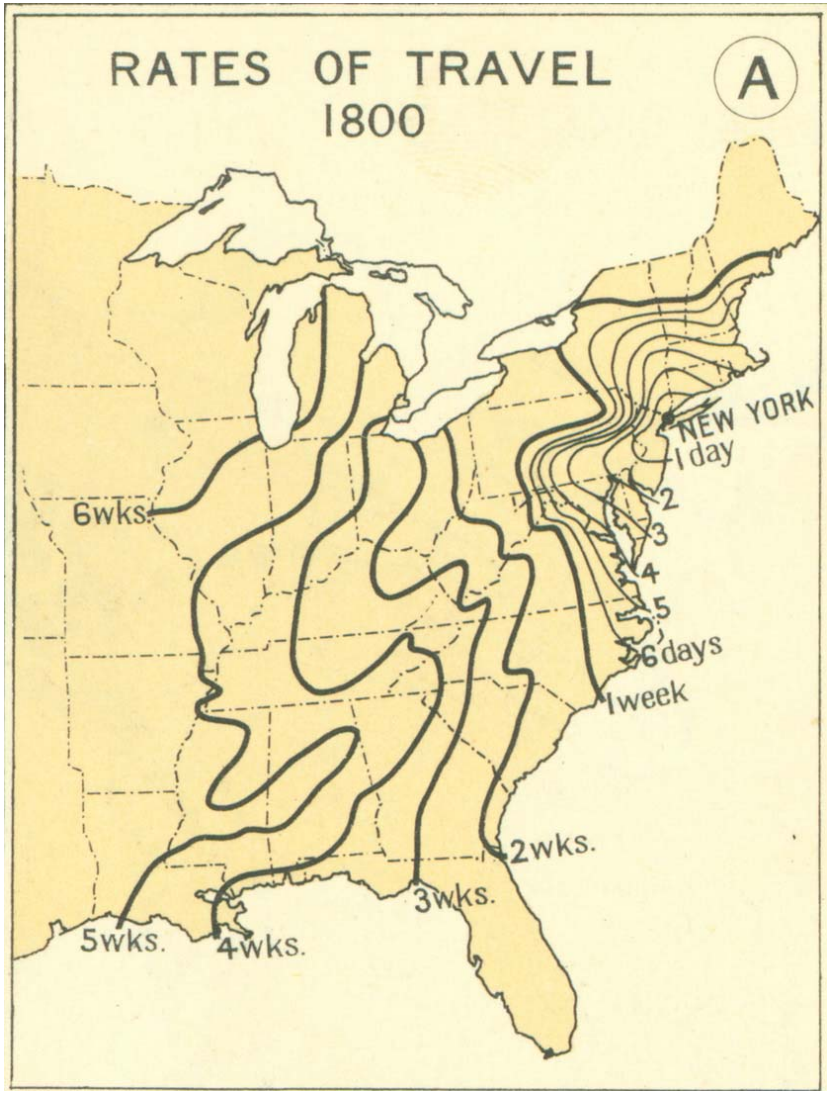
Years	Public Works	Projected Cost (current US $ millions)	Actual Expenditures (current US $ million)	Ratio of Actual to Projected Costs
1817-1825	Erie Canal	5.75	8.4	1.46
1835-1862	Enlargment of Erie Canal	12.42	30	2.42
1883-1926	Mississippi River Levee Line	11.45	229	20
1902-1913	Panama Canal	145	298	2.06
1931-1936	Hoover Dam	48.89	54.7	1.12
1952-1953	Interstate Highways	25	477.5	19.1
1966-1975	Louisiana Superdome	35	163	4.66
1971-1975	Renovation of Yankee Stadium	24	100	4.17
1991-2004	The Big Dig	2800	14600	5.21

The Results of the Erie Canal

- The Erie Canal was a huge success
- It easily paid for itself and the social gains were huge
- It altered the status of New York City and the counties along the canal
- It led to additional canal construction (both from competitors and because of promises made during voting)
- These additional canals typically didn't see the success of the Erie but many still had reasonably high social returns

Map of Canals in the United States, 1825

The Effect of Canals on Travel Times



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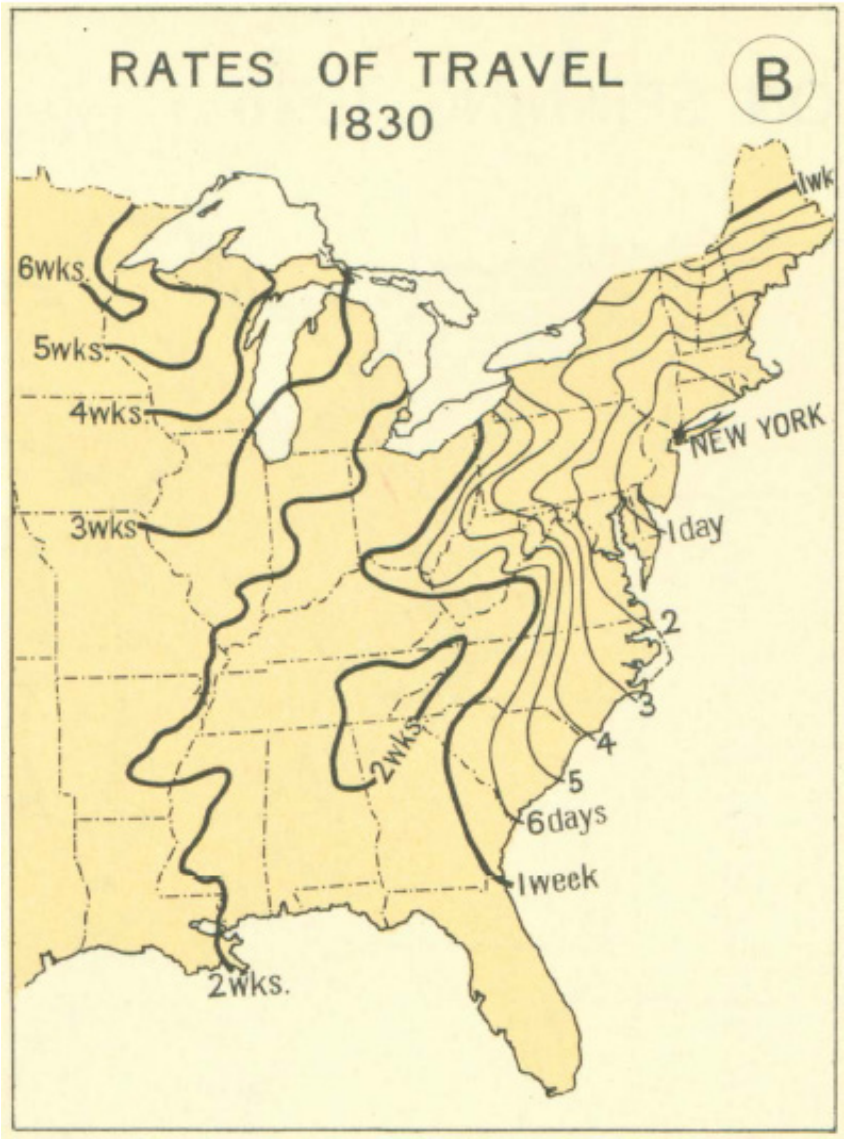
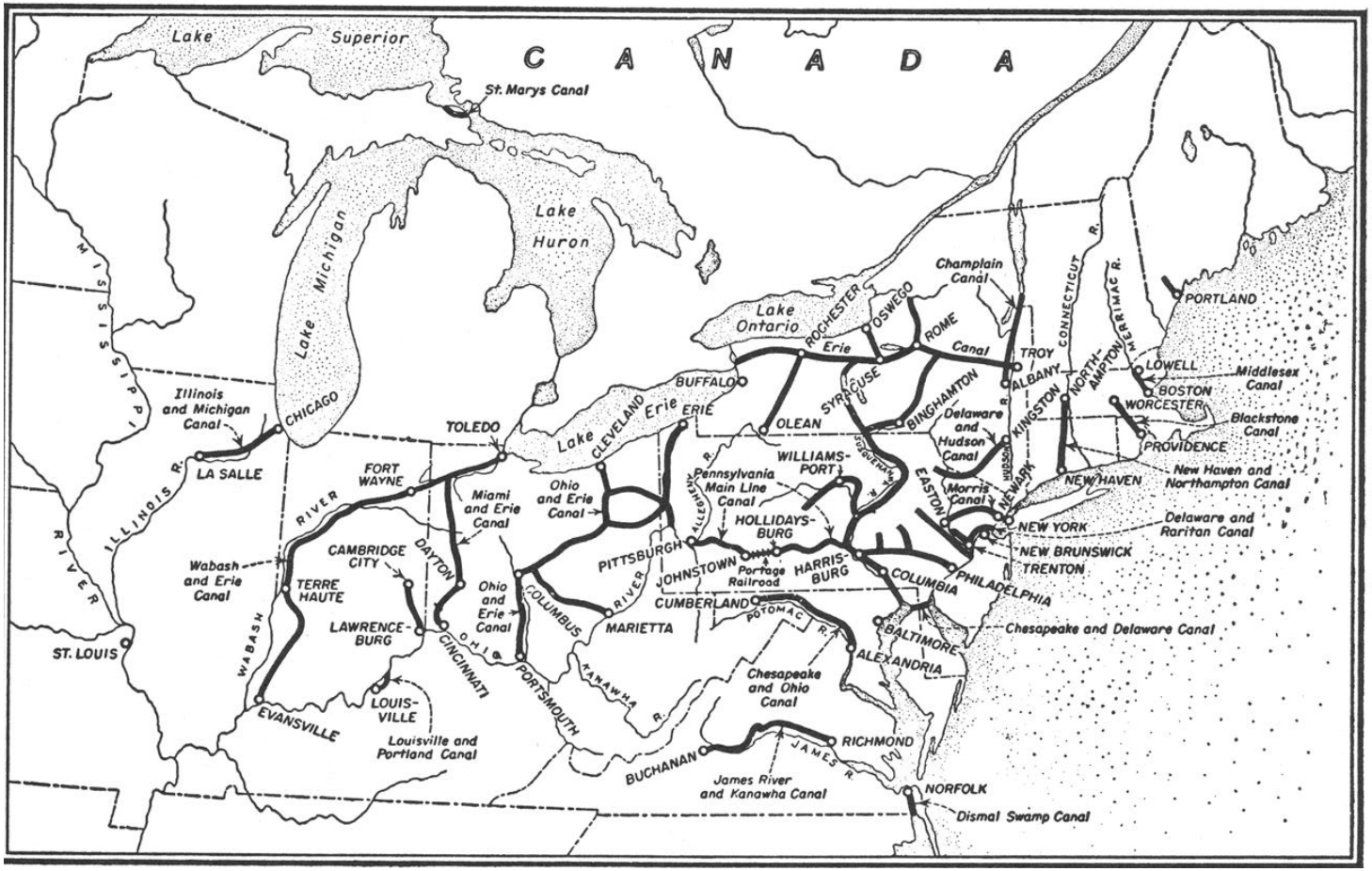


A Brief Summary of the Canal Era

- Canal building occurred in three major waves:
  - 1815-1834 - construction of the New York and Pennsylvania systems
  - 1834-1844 - construction in the Midwest
  - 1844-1860 - feeder lines into existing network
- Commercially, the results were quite different for each phase:
  - 1815-1834 - large private returns and social returns
  - 1834-1844 - generally unprofitable but probably good social returns
  - 1844-1860 - financial disaster for both state governments and private investors

The Canal System by 1860



The Canal System by 1860

The Canal System Over Time

Expansion of Canals and Railroads

Year	Canal Mileage	Railroad Mileage
1820	150	0
1830	1277	73
1840	3326	3328
1850	3698	8879
1860	4000+	30636

Lessons in Public Good Provision From the Canal Era

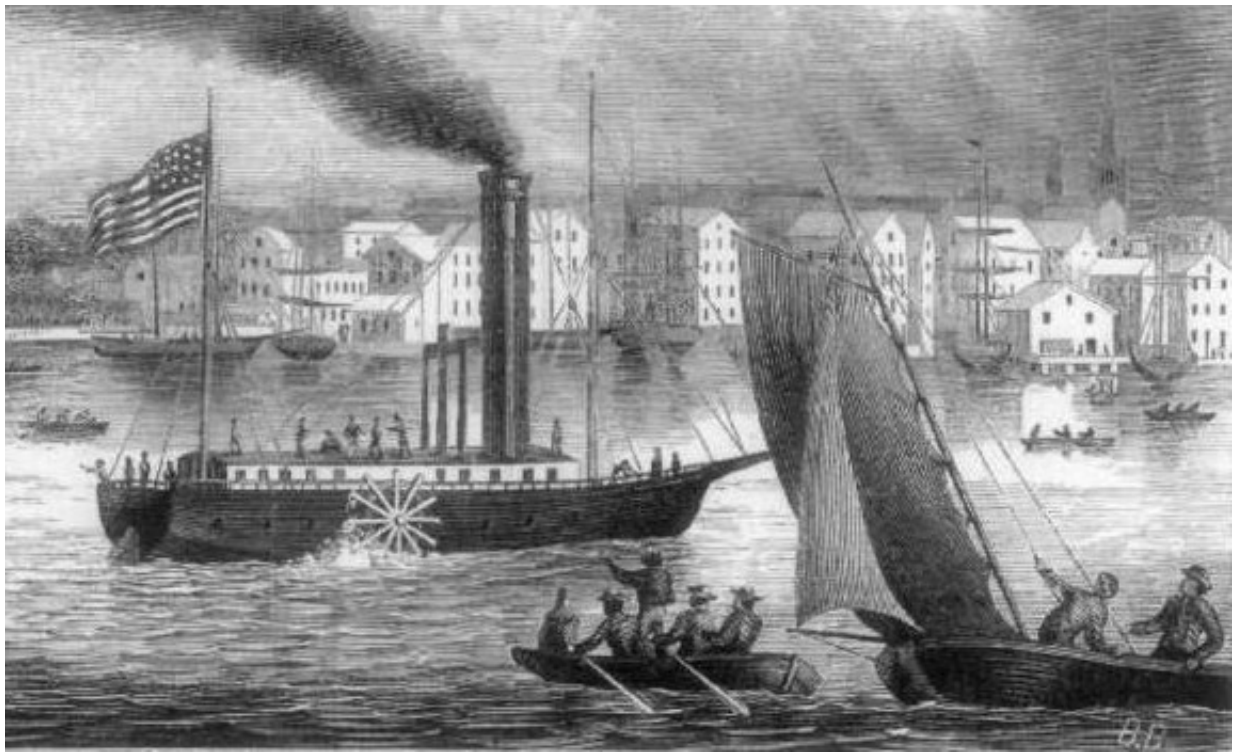
- Canals did fundamentally change the transportation network, linking the Midwest to the East
- Particularly for the early canal projects, there were huge social gains that justified the large public expenditures
- However, public provision of canals didn't stay efficient throughout the whole period
- By the end of the period, public debt was being accumulated for questionable social returns

The Economic Impact of Canals

- Canals cut the cost of shipping from 20 cents per ton-mile in 1810 to as little as 1 cent per ton-mile by the end of the era
- Trade through the North (primarily through the Erie Canal) became almost as large as trade through the Mississippi by 1860
- Even once railroads were built, canals remained in operation (a combination of low operating costs and cheaper shipping of high-bulk commodities)
- The government support of large canal projects led to two important developments for the future economy:
  - Congress began to use land grants to promote canal construction
  - The huge costs led to the growth of bond markets and links to foreign capital markets

Evolutions in River Transport

Evolutions in River Transport



Evolutions in River Transport

The morning I left New York, there were not perhaps thirty persons in the city who believed that the boat would ever move one mile an hour, or be of the least utility, and while we were putting off from the wharf, which was crowded with spectators, I heard a number of sarcastic remarks. This is the way in which ignorant men compliment what they call philosophers and projectors. Having employed much time, money and zeal in accomplishing this work, it gives me, as it will you, great pleasure to see it fully answer my expectations. – Robert Fulton

Evolutions in River Transport

Some imagined it to be a sea-monster, while others did not hesitate to express their belief that it was a sign of the approaching judgment. What seemed strange in the vessel was the substitution of lofty and straight black smoke-pipes, rising from the deck, instead of the gracefully tapered masts that commonly stood on the vessels navigating the stream, and, in place of the spars and rigging, the curious play of the working-beam and pistons, and the slow turning and splashing of the huge and naked paddle-wheels, met the astonished gaze. The dense clouds of smoke, as they rose wave upon wave, added still more to the wonderment of the rustics. – Poughkeepsie resident

Productivity Gains in Steamboats

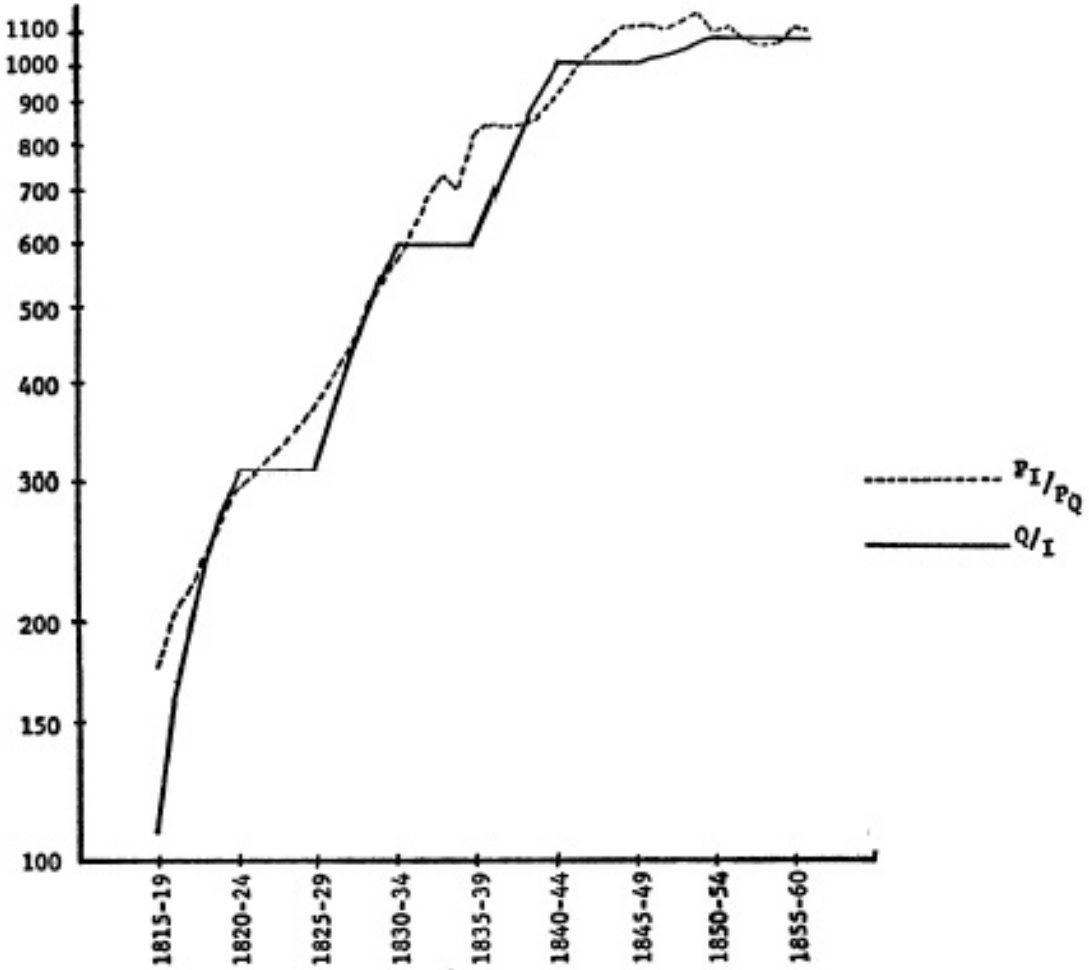


FIGURE 1

FIVE YEAR MOVING AVERAGES OF INDEXES OF STEAMBOAT TOTAL PRODUCTIVITY

Productivity Gains in Steamboats

Inputs of an Average Steamboat on the Louisville-New Orleans Route, 1815-1860

Period	Ship Size (tons)	Ratio of Carrying Capacity to Size	Capital Input per Ton	Labor Input per Ton	Fuel Input per Ton	Insurance per Ton
1815-19	220	0.5	0.17	0.22	1.53	5.09
1820-29	290	0.8	0.11	0.13	1.06	1.26
1830-39	310	1	0.08	0.09	0.77	0.53
1840-49	310	1.6	0.07	0.07	0.55	0.21
1850-60	360	1.75	0.07	0.07	0.58	0.2

The Role of the Government in River Transport

- River travel presented a slight wrinkle for the government's role in transportation improvements
- Constitutionality of federal involvement in internal improvements was hotly debated
- Beyond constitutionality, opposition and support for federal involvement differed greatly across the country
- River transport was unique in that navigable rivers were under federal control (they were the interstate federal highways of the day)
- It was up to the federal government to improve rivers (states couldn't collect taxes on river transport) but the government was often hindered by an anti-big government sentiment

Announcements

- Very good job on the midterms
- Expect the final to be similar, maybe a little bit more difficult
- Note that the final will not be cumulative
- Next big thing is the second referee report, due Nov. 2nd (on "A Nation of Immigrants: Assimilation and Economic Outcomes in the Age of Mass Migration" by Abramitzky, Boustan and Eriksson)

Announcements

Upcoming readings:

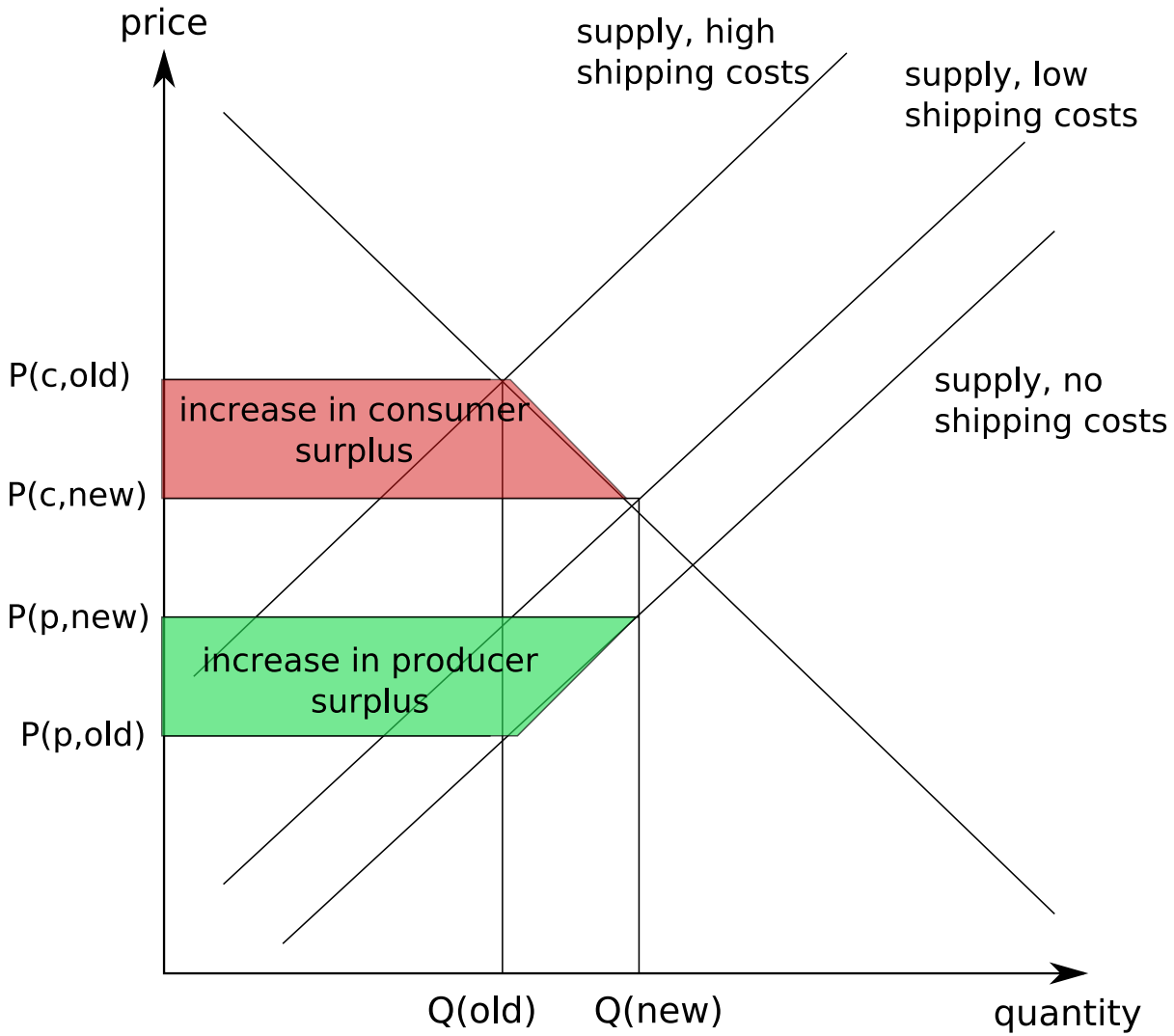
- Donaldson and Hornbeck (2006) on railroads (skip the model section)
- Galenson (1981) on indentured servitude
- Logan (2018) on Reconstruction

Questions are up for Donaldson and Hornbeck and Galenson, questions for Logan will be up by the weekend

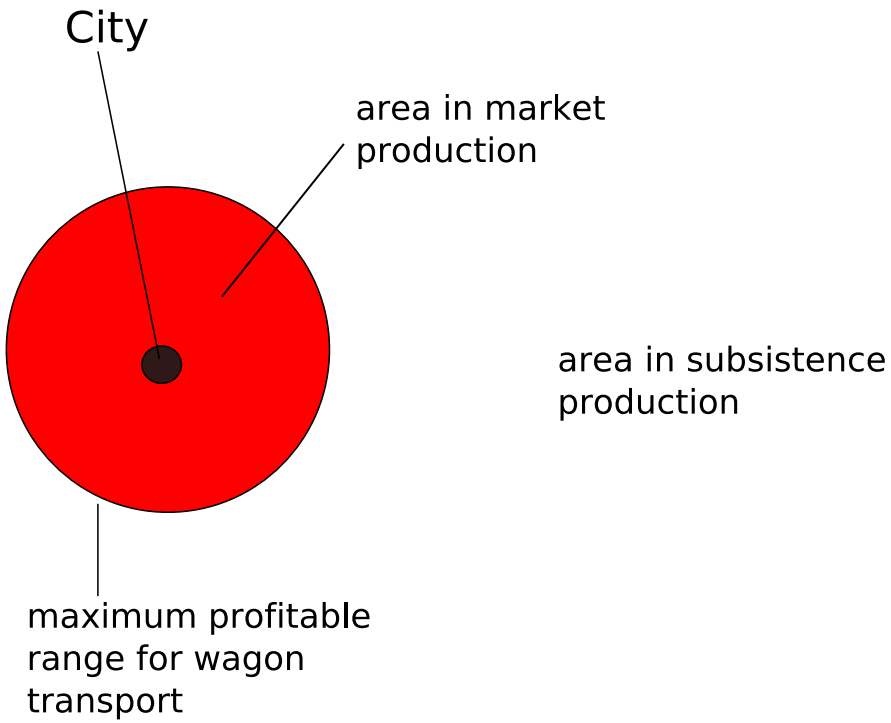
Who Benefited From Transportation Improvements?

- We've seen that many of the transportation improvements led to major reductions in shipping costs but didn't necessarily lead to big profits for investors
- If transportation improvements were so important but profits weren't huge, where were these big social returns going?
- They were going to a few different groups:
  - **Investors**: some investors did see decent returns
  - **Producers**: expanded access to markets meant greater demand, better transportation meant higher net prices received
  - **Consumers**: expanded access to markets meant greater supply, better transportation meant lower net priced paid
  - **Landowners**: land linked to transportation network increased in value

Gains in Surplus From Lower Shipping Costs



Market Size and Land Values



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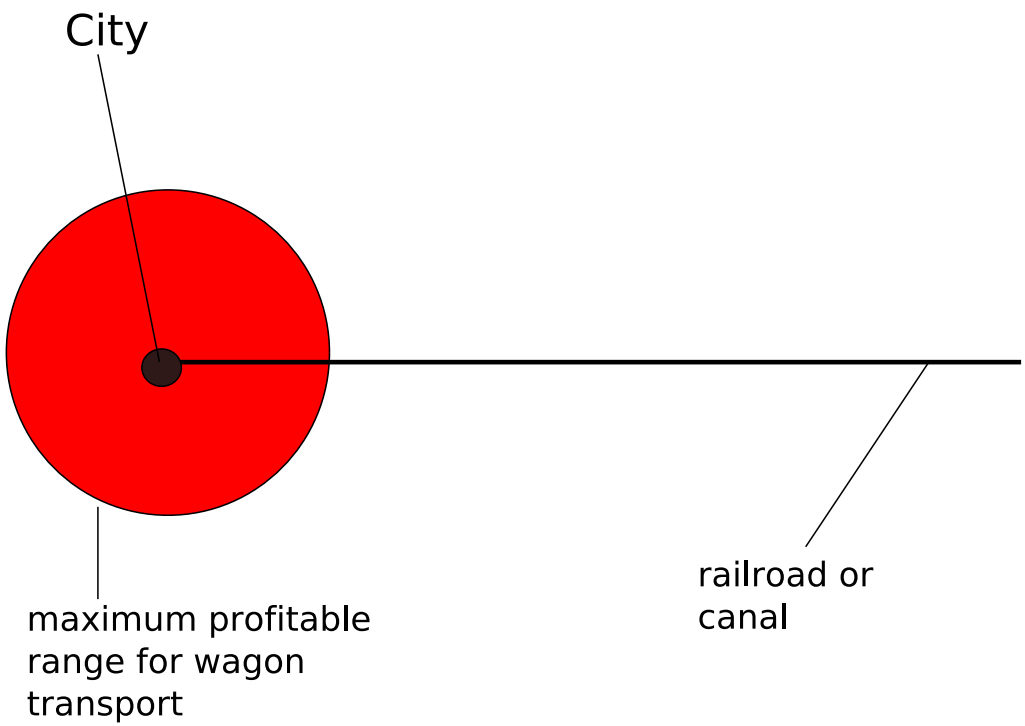

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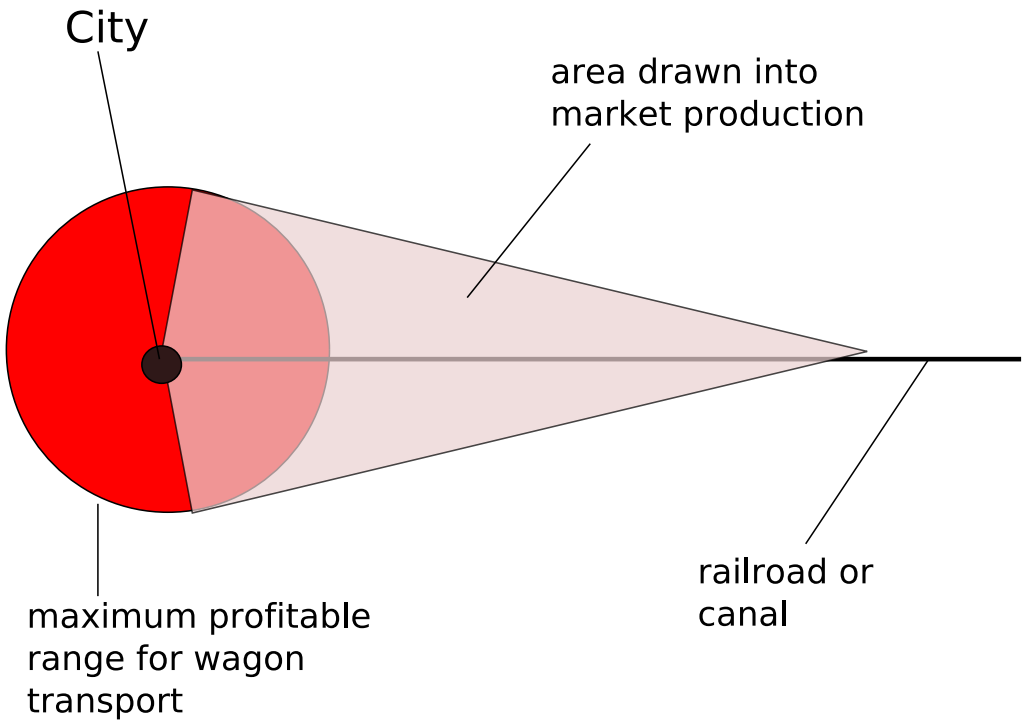
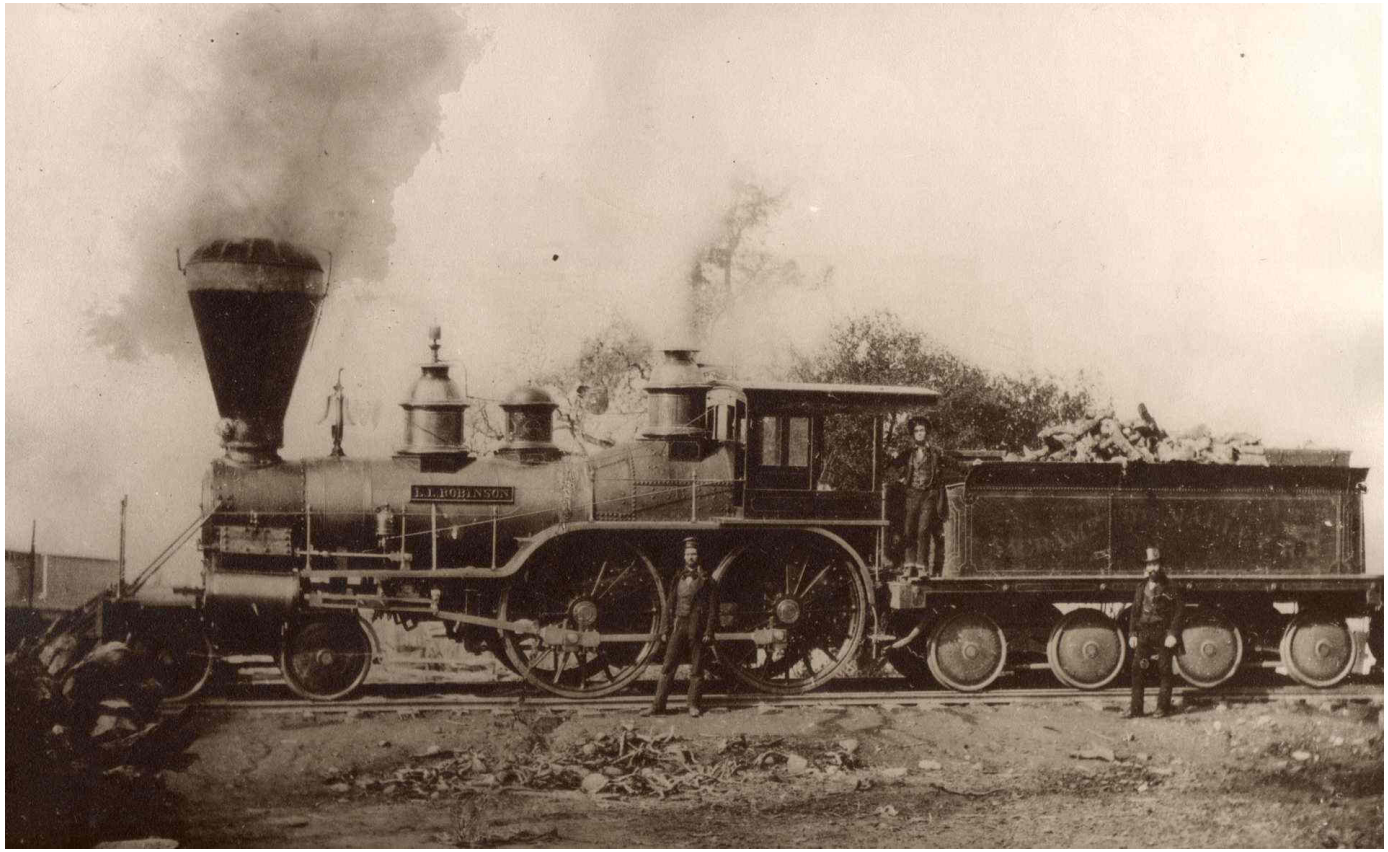
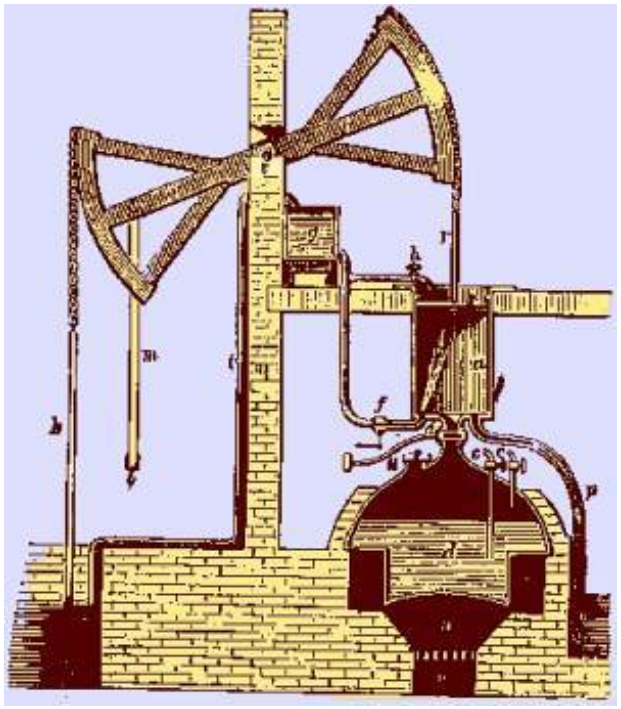


Railroads and the American Economy



Brief History of the Locomotive



1712 - Thomas Newcomen invents the first commercially successful steam engine

Brief History of the Locomotive

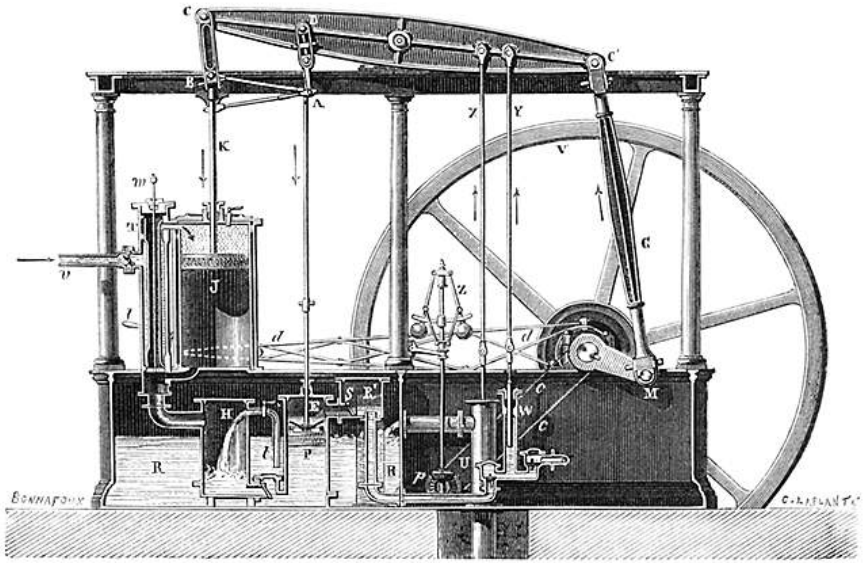
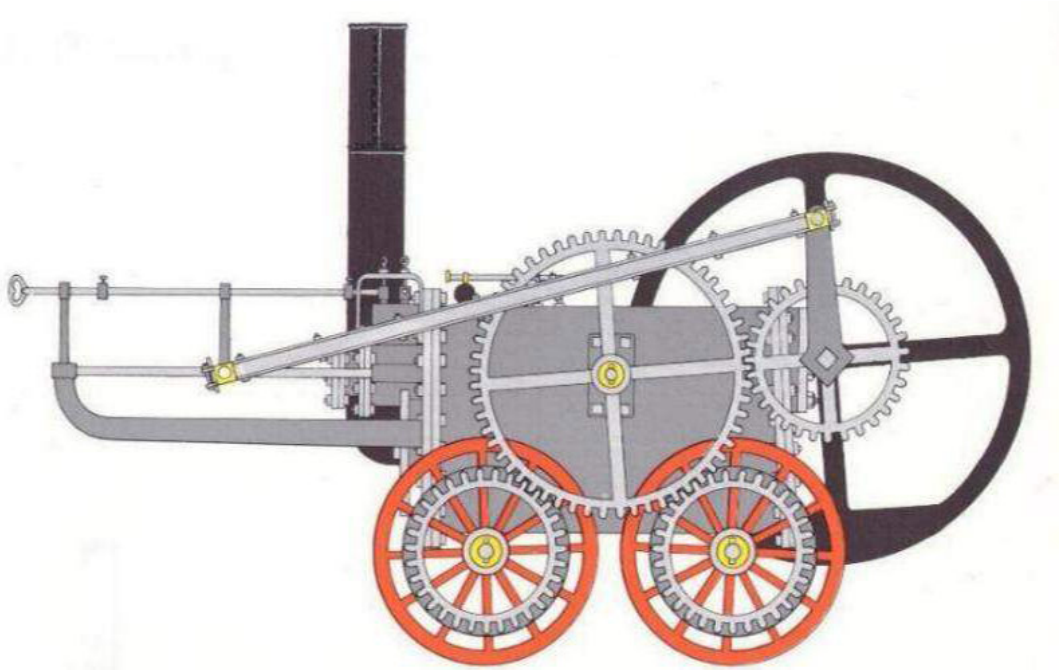


Fig. 59. — Machine à balancier de Watt.

v. Tuyau de prise de vapeur; T, tiroir; J, cylindre; H, condenseur; PE pompe d'épuisement; WY pompe alimentaire de la chaudière UX pompe d'alimentation de la bâche R; *p* Z régulateur; *dd* excentrique; ABCD parallélogramme; GM bielle et manivelle; V volant.

1765 - James Watt invents a substantially more efficient steam engine

Brief History of the Locomotive



1804 - Richard Trevithick builds the first full scale steam rail locomotive using new high pressure steam technology

Brief History of American Railroads

1830 - South Carolina Railroad is introduced as the first successful steam railway in the US

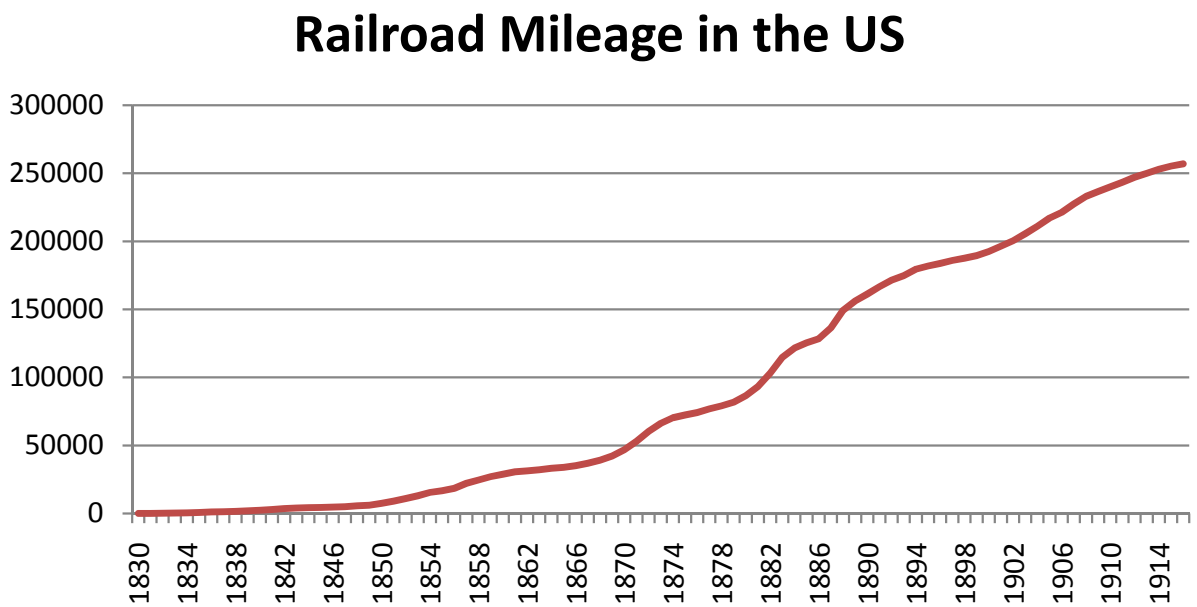
Brief History of American Railroads

1869 - Transcontinental Railroad is completed

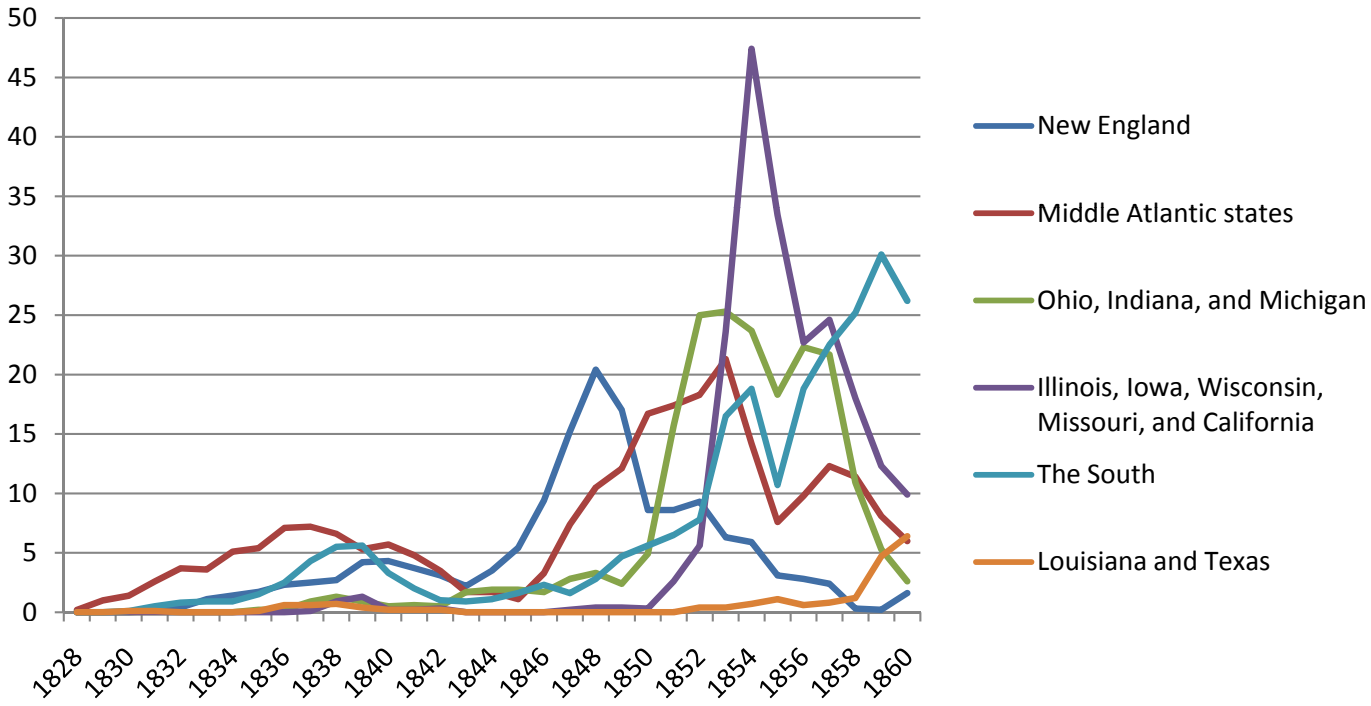
Brief History of American Railroads

1957 - Last run of the Norfolk and Western 611 locomotive

Brief History of American Railroads

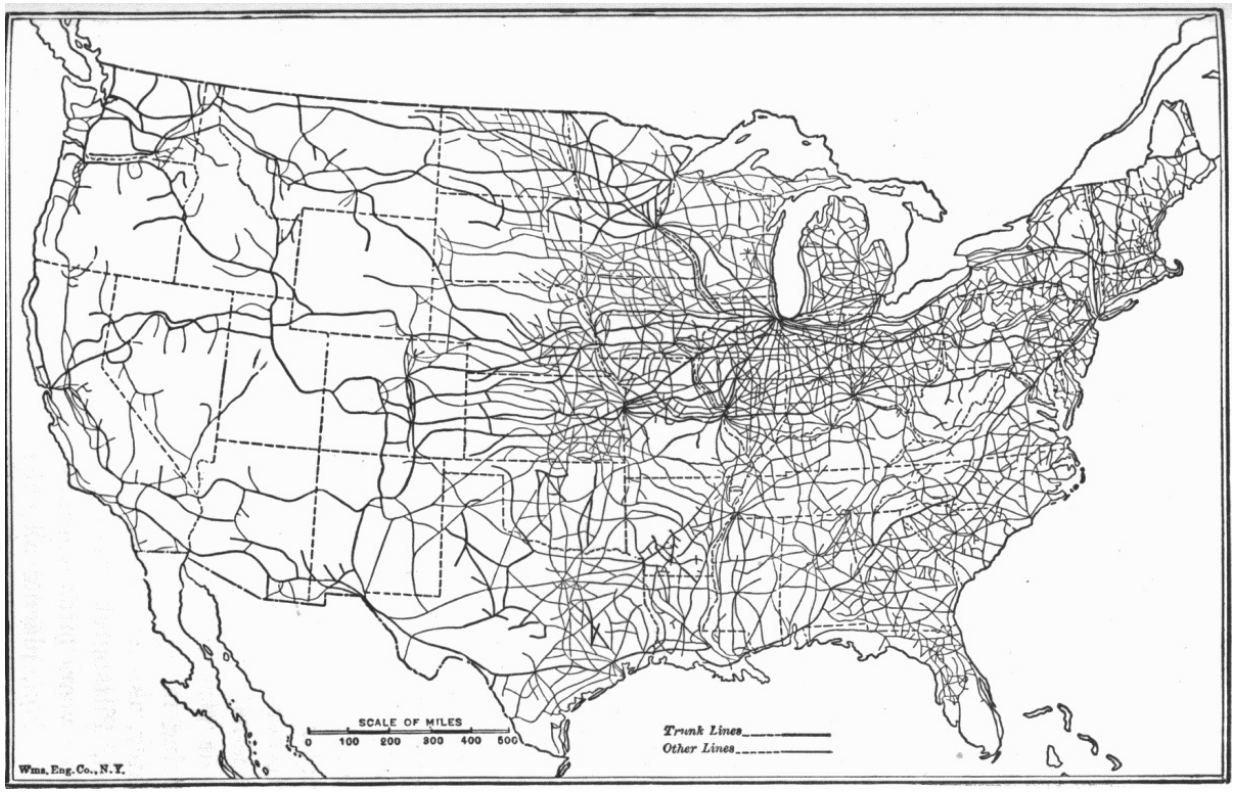


Railroad Investment by Region, 1828-1860



Vertical axis is measured in millions of current dollars.

Railroad Network by 1918



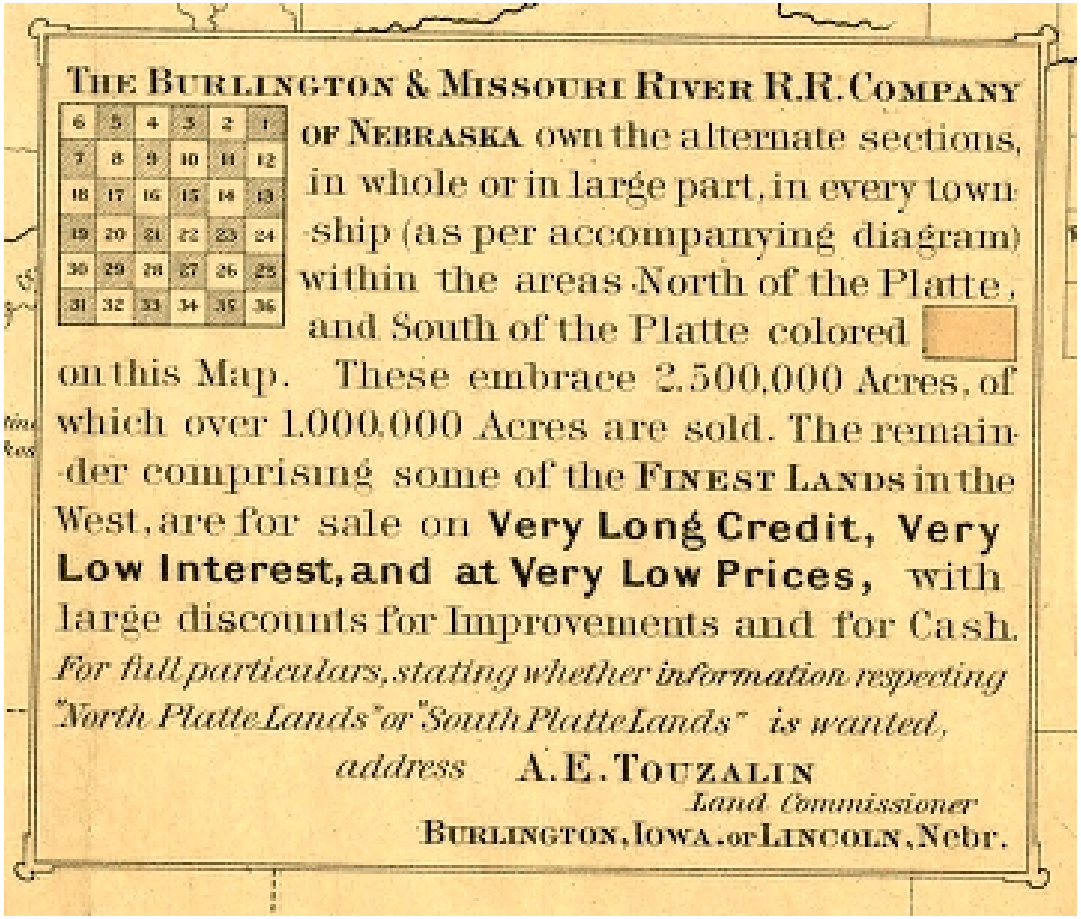
Economic Issues in the Building of Railroads

- Incentives to collude and delay construction until demand is greater
- Poorly developed capital markets
- Gap between private and social benefits (an issue both in whether to build and what to charge)
- Uncertainty over profitability

Land Grants as a Solution

- Land grants offered a solution to some of these issues with the efficient provision of railroads
- Land grants were plots of land given by the federal government to the railroad company, the railroad company could then sell the land
- Land was typically given in alternating squares, with the federal government retaining every other square
- At the heart of land grant logic was the idea that the land would be valuable when the railroad is built

Land Grants as a Solution



Land Grants as a Solution

Union Pacific Lands – every other section of area in green = 4.85 million acres.
Burlington & Missouri – every other section of brown area = 2.5 million acres.
Additional state and federal grants to other railroad companies totalled around 820,000 acres.

States with the Most Acres in Federal Land Grants

Federal land grants used by railroads by state: 1850-1871

State	Acres
Montana	14,736,919
California	11,585,393
North Dakota	10,697,490
Minnesota	9,953,008
Washington	9,582,878
Kansas	8,234,013
Arizona	7,695,203
Nebraska	7,272,623
Wyoming	5,749,051
Nevada	5,086,283

Land Grants as a Solution

How did land grants potentially solve the issues of underprovision of rail services?

- As far as poor capital markets, sales of land could directly underwrite construction costs and companies could rely on mortgage markets rather than bond and equity markets
- For enticing companies to build railroads, land grants offered the private companies a share of the capital gains on land from railroad access
- Land grants did not shelter investors from risk (if the railroad failed, the land grants are of little value)
- In practice, none of the above made a strong case for land grants

Returns to Railroad Investment

Returns to Railroad Investment and the Opportunity Cost of Capital

System	Private Return (without government aid)	Opportunity Cost of Capital
Central Pacific	10.6	9
Union Pacific	11.6	9
Texas and Pacific	2.2	7.7
Santa Fe	6.1	7.9
Northern Pacific	6.3	7.9
Great Northern	8.7	6.3

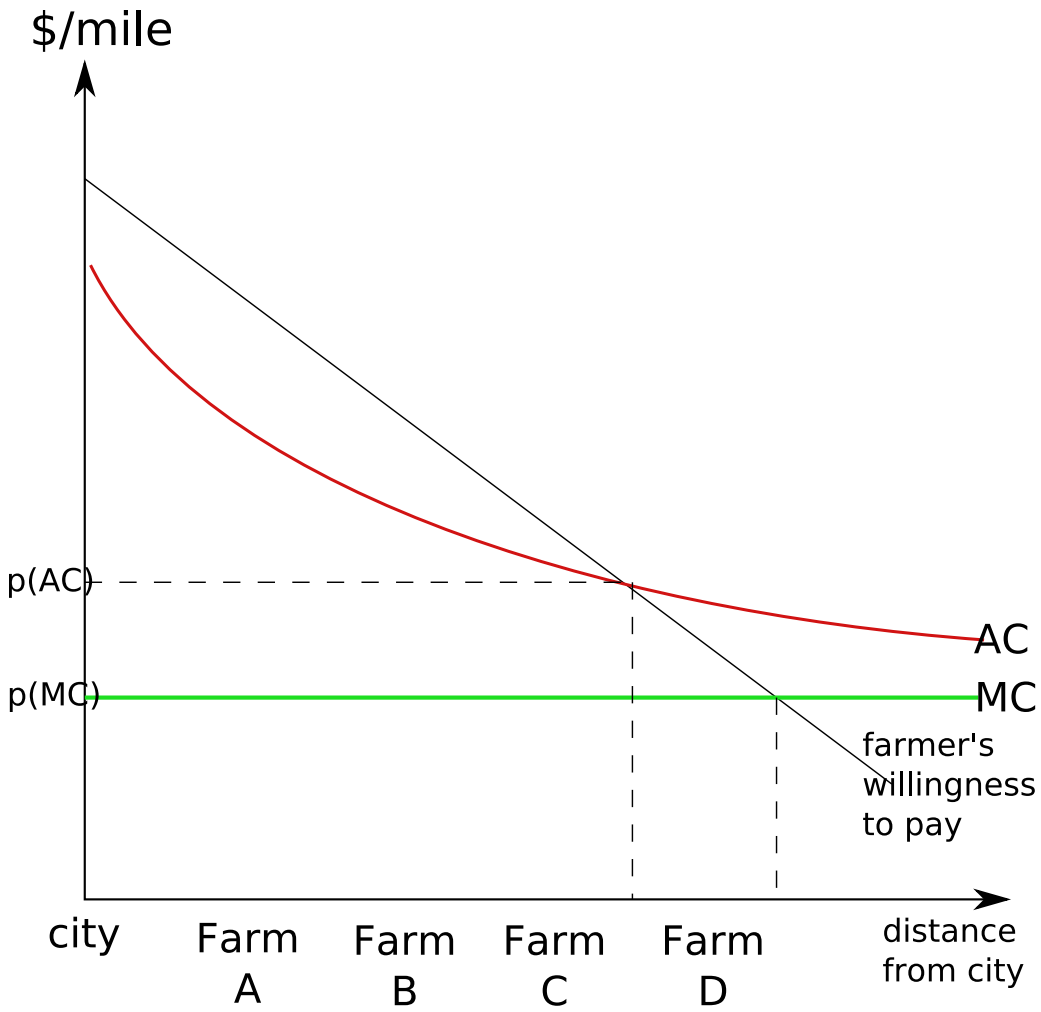
Were Land Grants Needed?

- It looks like land grants weren't needed
  - Private companies were able to finance most construction without land grants
  - Land grants didn't help mitigate risk
  - The private returns were often larger than the opportunity cost of capital
- So is there another justification of land grants?
- Yes, land grants help promote efficient pricing once railroads are built

Average Cost vs. Marginal Cost Pricing

- Railroads have huge initial costs to get built
- Once built the marginal costs are very low
- If a railroad company wants to break even, they will charge a price equal to their average costs
- From a social efficiency standpoint, this price is too high
- Land grants offer an interesting solution to this problem:
  - Land value depends on the cost of transportation
  - If railroads own land, increasing prices lowers the value of their land
  - Railroads have an incentive to keep prices low

Average Cost vs. Marginal Cost Pricing



Average Cost Pricing

- To break even, railroads need to charge average cost which depends on how many people use the railroad
- In equilibrium, Farms A, B and C use the railroad and the price (equal to the average cost) is P(AC)
- Farm D does not use the railroad because his marginal benefit is below the price
- If they could contract separately, if would be beneficial to both the railroad and Farm D to use the railroad at any price between P(AC) and P(MC) but this isn't possible if the railroad has to charge a single price
- End result: railroad breaks even; Farms A, B and C now sell to the market increasing their land values; Farm D sees no change and still engages in subsistence production

Marginal Cost Pricing

- Charging marginal costs means that any farm whose benefit from the railroad is greater than the actual costs of shipping that farm's product will get to use the railroad
- Farms A, B, C and D all use the railroad and the price (equal to the marginal cost) is P(MC)
- Every farm for which the total surplus of using the railroad is positive uses the railroad, making P(MC) socially efficient
- End result: railroad loses money; Farms A, B, C and D now sell to the market increasing their land values

Marginal Cost Pricing with Land Grants

- Every farm for which the total surplus of using the railroad is positive uses the railroad (making P(MC) socially efficient)
- The railroad owns the land and charges the farmers rent based on how profitable the land is
- End result: railroad makes money; Farms A, B, C and D now sell to the market increasing their land values, farmers get charged rent equal to this increase in land values meaning they break even
- Total surplus is the same as the marginal cost pricing case without land grants, the surplus is just distributed differently

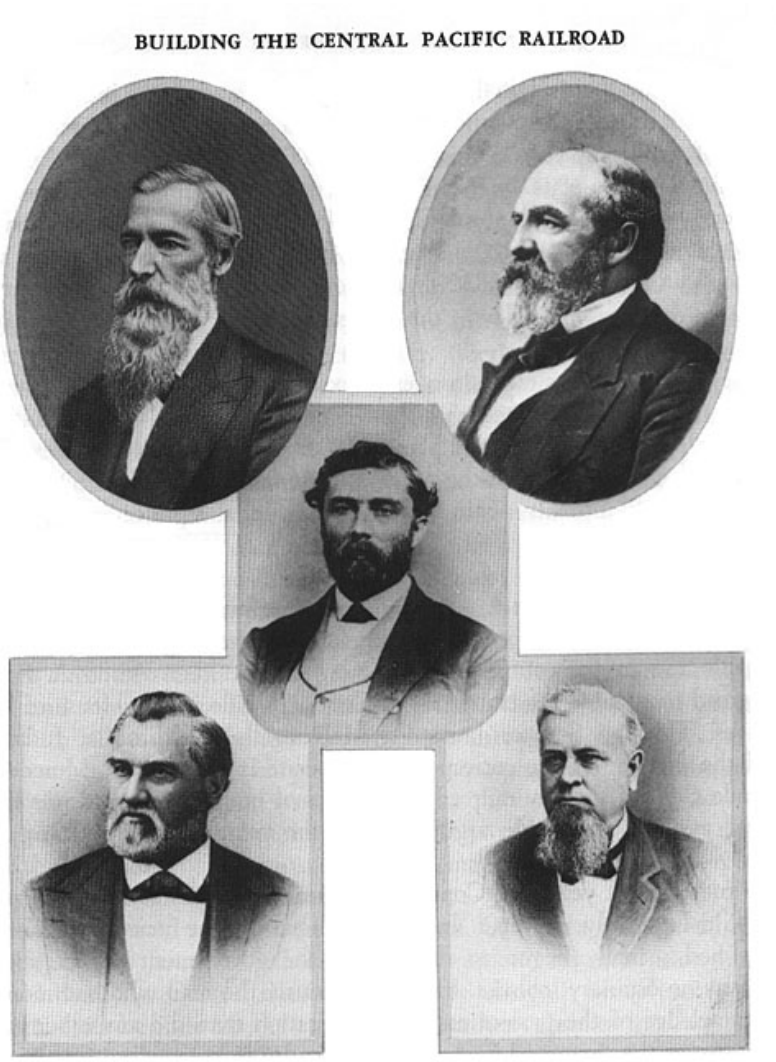
Summary of Land Grants in Theory

- Land grants were considered a solution to several potential problems that would cause an underprovision of railroads
- Poor capital markets: land grants gave railroad companies an asset that could be converted to cash or give them access to the mortgage markets
- Insufficient private returns to build railroads: land grants increased the private returns to railroad construction by letting the investors share in the increase in land values caused by the railroad
- Inefficient pricing: land grants gave railroads an incentive to maximize total surplus by pricing at marginal cost rather than some higher price (average cost, monopoly price)

Summary of Land Grants in Practice

- Poor capital markets weren't a huge problem, railroads managed to raise plenty of capital without land grants
- The private returns to many railroads were high relative to alternative investments
- The marginal cost pricing argument depended on railroads retaining ownership of land and on the proper functioning of the land rental market
- Overall, the value of land grants is very questionable
- There were often seen as essentially a gift from the government to railroad companies serving no purpose other than boosting railroad profits

Railroads, Public Money and Private Gains



Mark Hopkins, Collis P. Huntington, Theodore Judah, Leland Stanford, Charles Crocker. (Courtesy of the Bancroft Library)

Railroads, Monopolies and Private Gains

Top Ten Wealthiest Americans

Name	Wealth (2007 dollars)	Industry
John D. Rockefeller	$192 billion	Standard Oil
Cornelius Vanderbilt	$143 billion	steamboats, railroads
John Jacob Astor	$116 billion	furs, real estate
Stephen Girard	$83 billion	shipping, banking
Bill Gates	$82 billion	Microsoft
Andrew Carnegie	$75 billion	steel, railroads
A.T. Stewart	$70 billion	department stores
Frederick Weyerhaeuser	$68 billion	lumber
Jay Gould	$67 billion	railroads
Stephen Van Rensselaer	$64 billion	inherited land

Measuring the Social Returns to Railroads

- There are two classic books on the social savings of the railroads
- Albert Fishlow, *American Railroads and the Transformation of the Ante-Bellum Economy*, 1965
- Robert Fogel, *Railroads and American Economic Growth: Essays in Econometric History*, 1964
- While published at roughly the same time, they reach very different conclusions about the social savings of the railroads
- Fishlow takes a fairly direct approach: multiply the cost savings per-mile by the amount of travel taking place
- Fishlow's result: savings from the railroad were about 4 percent of GDP in 1859 and as much as 15 percent of GDP around 1900

Fogel's Estimation of Social Savings

- Fogel sees things as much more complicated
- Some land that is in use with railroads would not be in use without railroads
- Transportation issues from market to market are very different than from farm to market
- Transportation networks wouldn't have remained stagnant in the absence of railroads

Announcements

https://www.elections.virginia.gov/voter-outreach/voting-info-tool.html

Announcements

- No class or office hours on Tuesday, November 6th since I will be at the polls
- Don't forget about the second referee report, due Nov. 2nd (on "A Nation of Immigrants: Assimilation and Economic Outcomes in the Age of Mass Migration" by Abramitzky, Boustan and Eriksson)
- Readings for the upcoming lectures:
  - Galenson (1981) on indentured servitude
  - Logan (2018) on Reconstruction

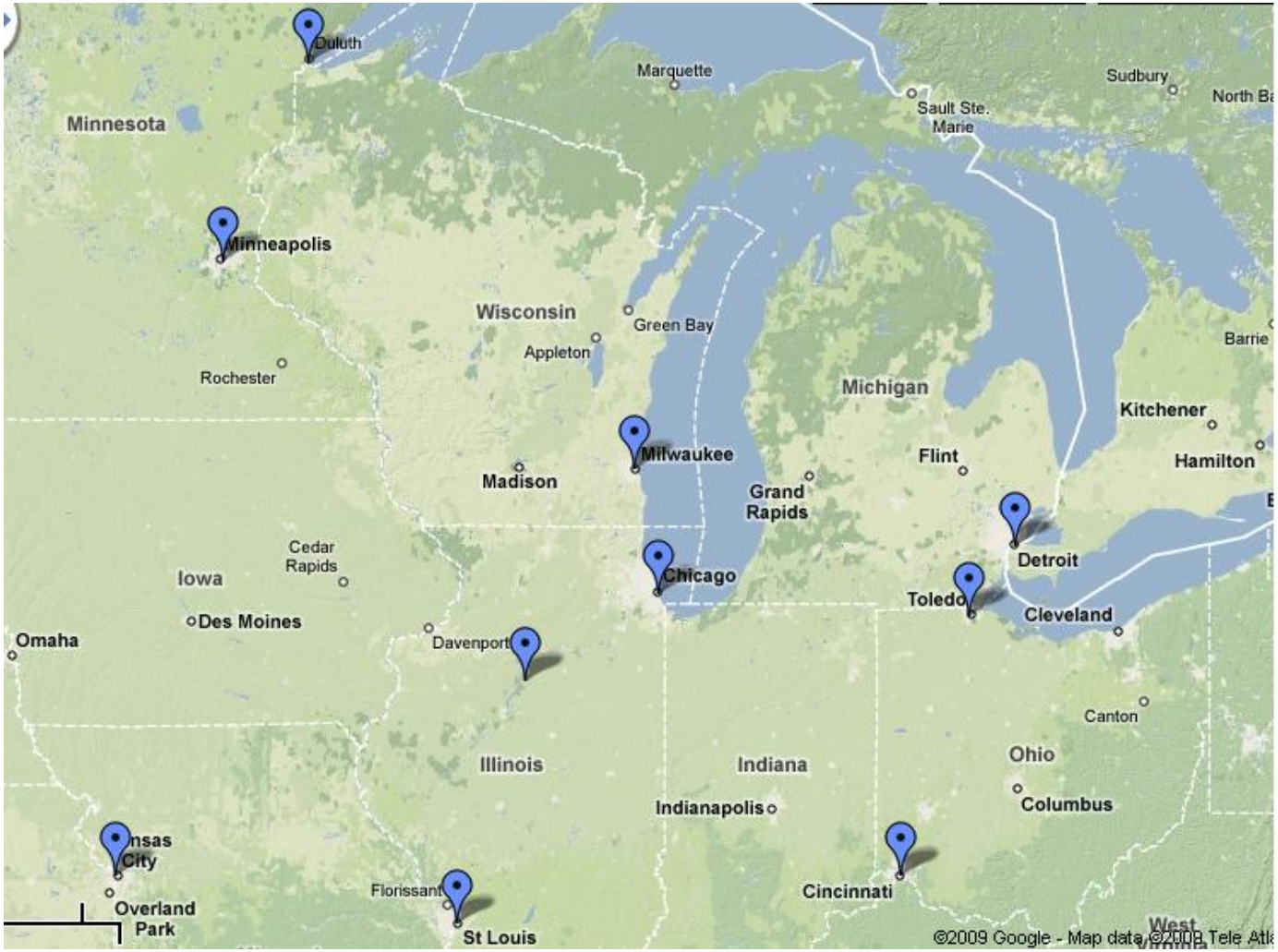
Fogel's Estimation of Social Savings

- Recall Fishlow's basic calculation: saving = (non-railroad costs - railroad costs) x total amount of shipping
- Fogel sees things as much more complicated
- Some land that is in use with railroads would not be in use without railroads (inflates savings)
- Transportation issues from market to market are very different than from farm to market
- Transportation networks wouldn't have remained stagnant in the absence of railroads (also inflates savings)

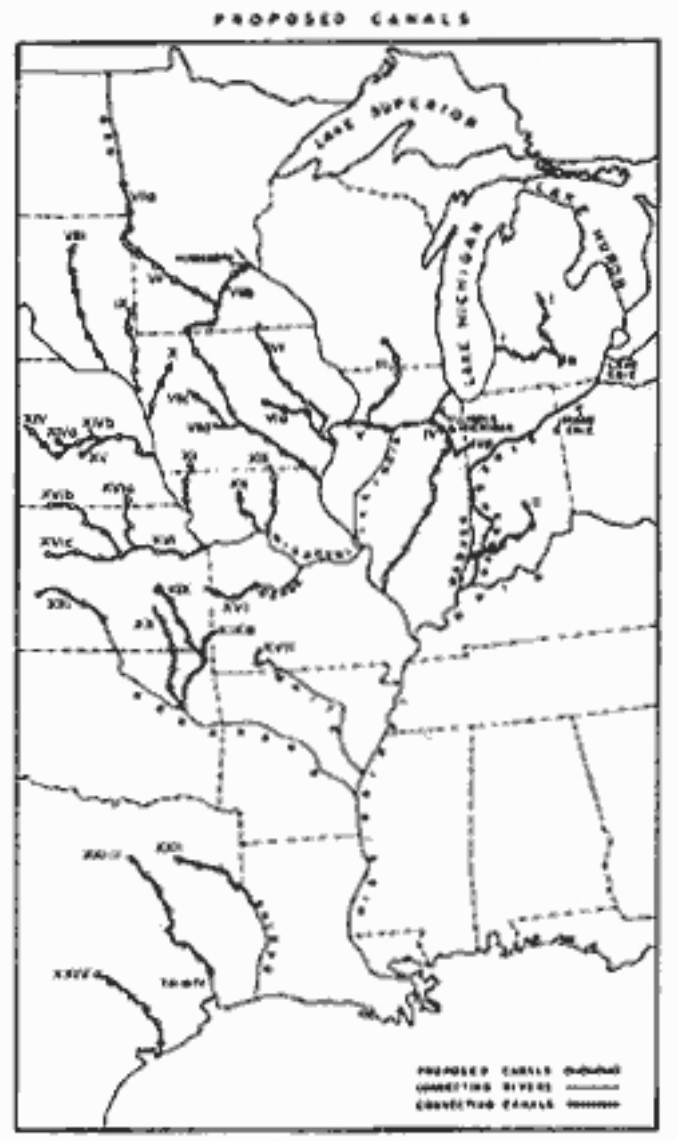
Fogel's Estimation of Social Savings

- Fogel breaks down the social savings into two distinct sources:
  - Savings on interregional distribution of products
  - Savings on intraregional distribution of products
- Interregional distribution is the shipment of products from primary markets in the Midwest to secondary markets typically on the East Coast
- Intraregional distribution is the transportation of products from the farms to the primary markets

Primary Markets and Interregional Distribution



Fogel's Proposed Canals



Fogel's Proposed Canals

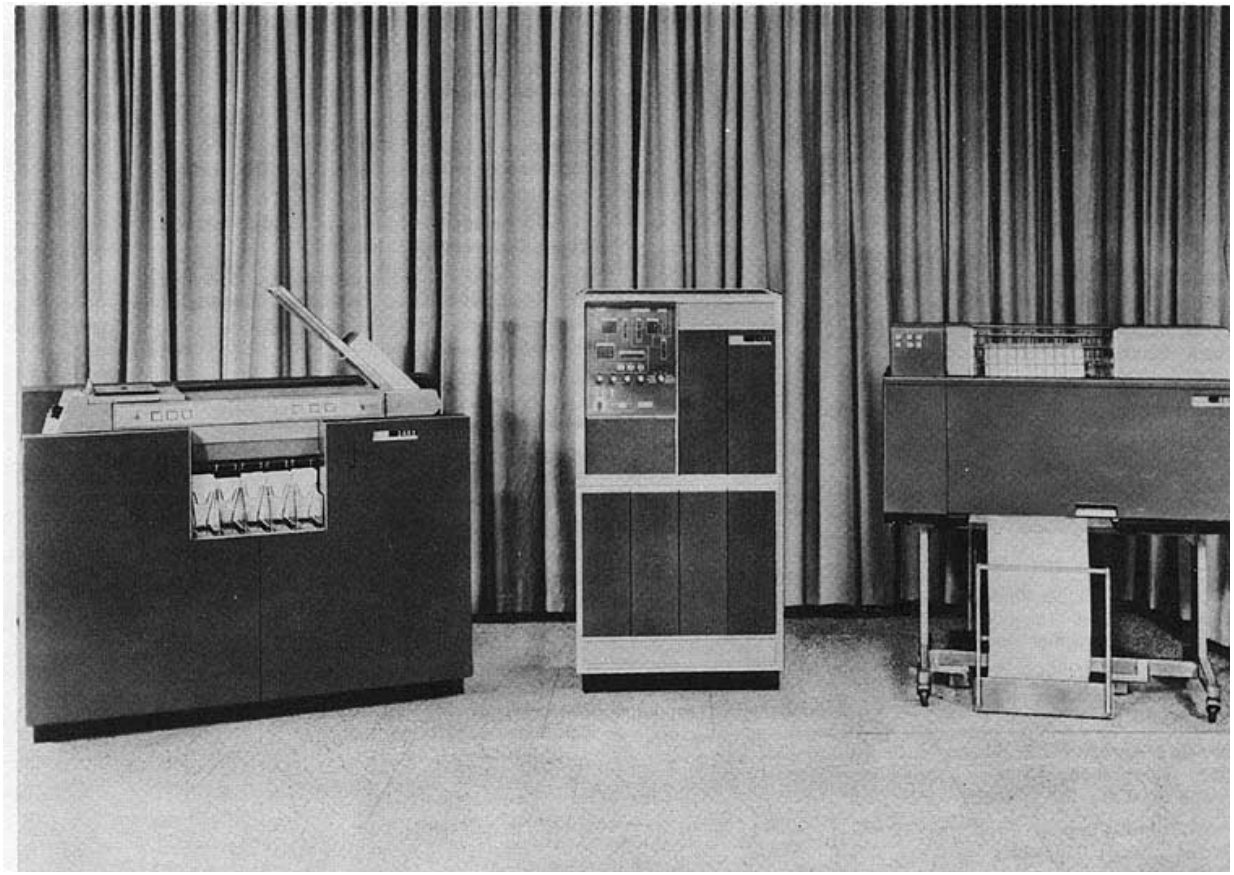
Fogel's Conclusions

- Railroads weren't as huge as people thought
- The savings on interregional transportation were small (there were good water transportation networks)
- The important savings were in intraregional transportation
- Some of the savings are overstated if you don't consider the canals that could have developed
- Fogel comes up with social savings about a third of the size of Fishlow's savings

Donaldson and Hornbeck

- Donaldson and Hornbeck are going to revisit Fogel with the benefit of better data
- How does the nineteenth century change just by going from the 1960s to the 2010s?
- While history itself doesn't change, the theory and data we have to study it do
- Donaldson and Hornbeck are going to make contributions on both these fronts

Donaldson and Hornbeck

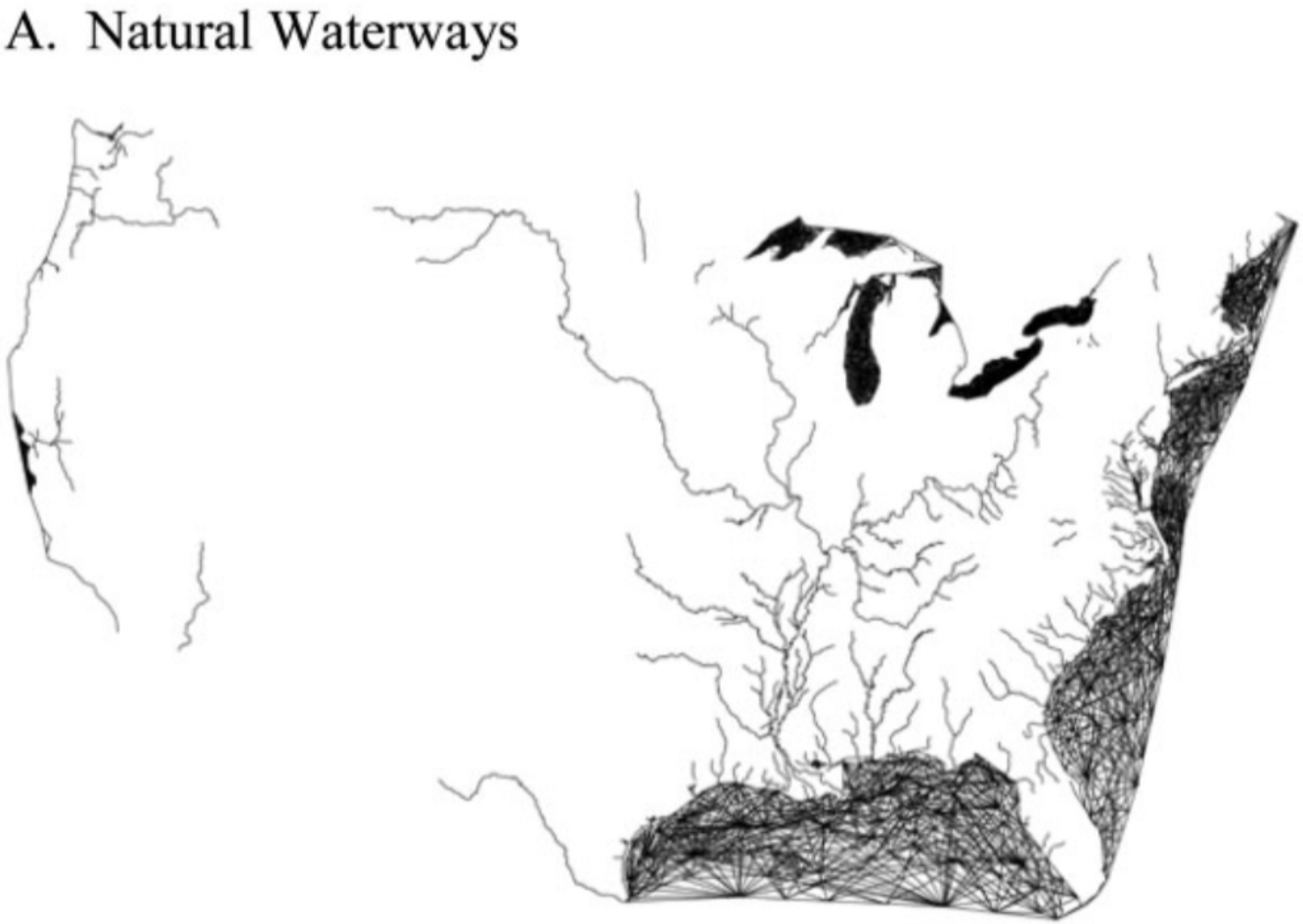


The IBM 1401: introduced in 1959, weights 5 tons, has 16 kB of memory, 10 million times slower than a cell phone, rented for $21,000 a month in today's dollars

Donaldson and Hornbeck

The Center for Geospatial Analysis

Donaldson and Hornbeck



Donaldson and Hornbeck

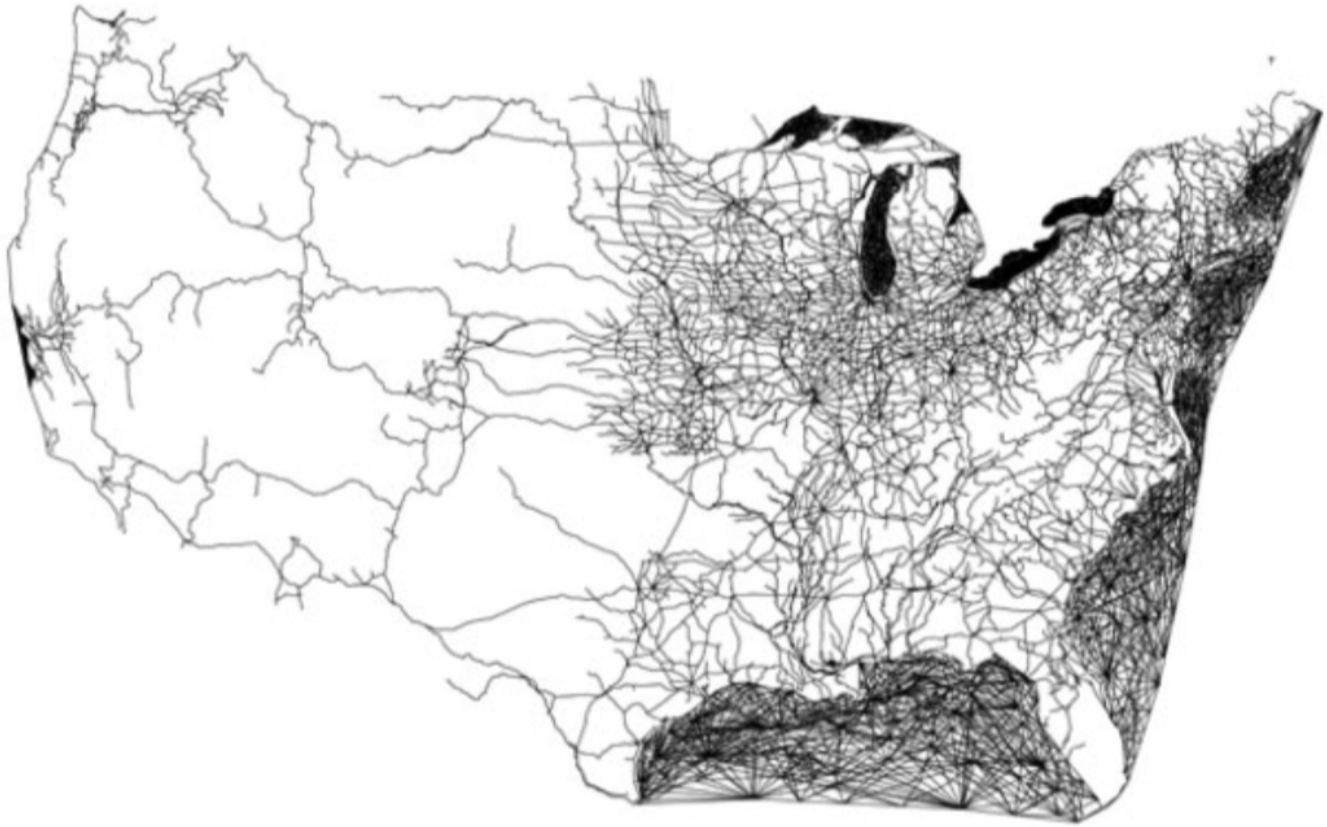
B. Natural Waterways and Canals

Donaldson and Hornbeck

C. Natural Waterways, Canals, and 1870 Railroads

Donaldson and Hornbeck

D. Natural Waterways, Canals, and 1890 Railroads



Donaldson and Hornbeck

$$MA_o \approx \sum_d \tau_{od}^{-\theta} N_d$$

- MA_o: market access for county o
- τ_{od}: trade costs between counties o and d
- θ: trade elasticity
- N_d: population in county d

Donaldson and Hornbeck

- So we've got two big changes (as well as some others)
- Donaldson and Hornbeck have access to much better data (and much, much better computers)
- They are also going to switch from thinking about railroad access as an independent variable to market access as an independent variable
- Why aren't railroad access and market access the same thing?
- What do they find?

Donaldson and Hornbeck

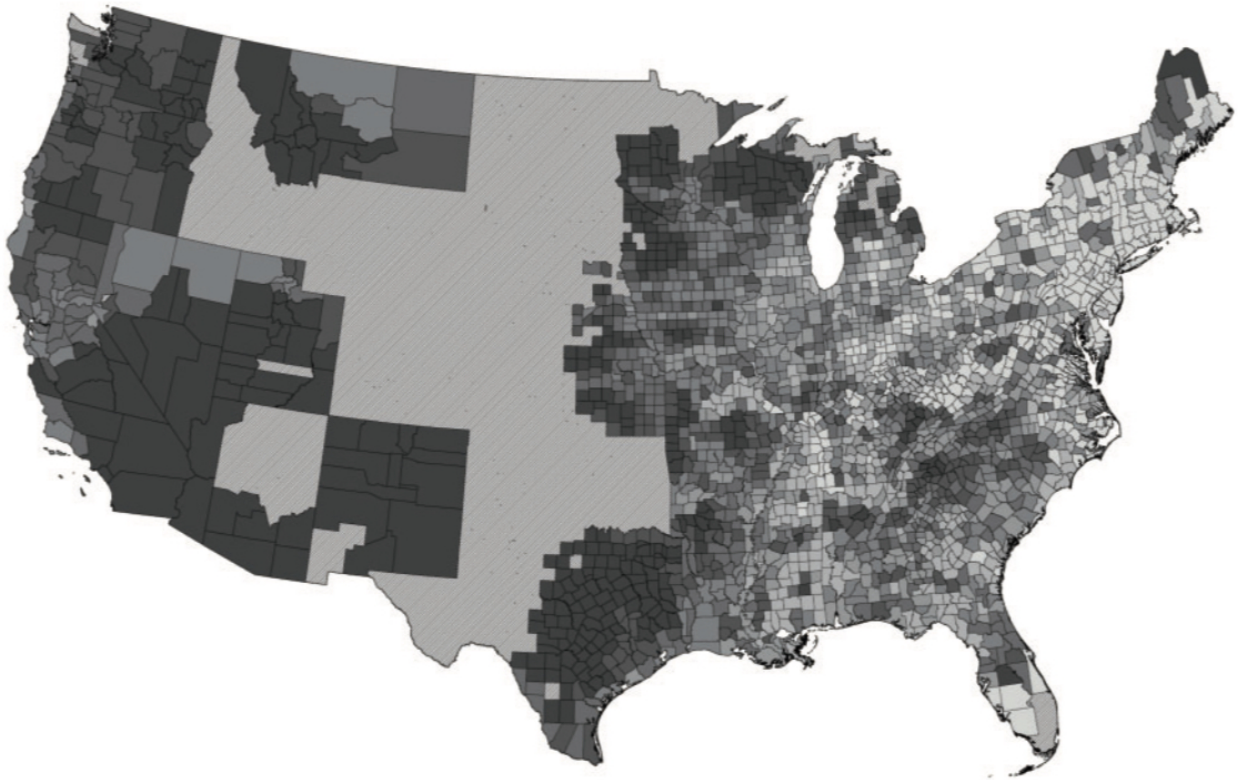


FIGURE III

Calculated Changes in Log Market Access from 1870 to 1890, by County

This map shows the 2,327 sample counties, shaded according to their calculated change in market access from 1870 to 1890. Counties are divided into seven groups (with an equal number of counties per group), and darker shades denote larger increases in market access. The seven groupings correspond to log changes of: greater than 1.60 (darkest), 1.60 to 1.06, 1.06 to 0.83, 0.83 to 0.73, 0.73 to 0.66, 0.66 to 0.61, and smaller than 0.61 (lightest). nonsample regions are shown hatched.

Donaldson and Hornbeck

IMPACT OF MARKET ACCESS: ROBUSTNESS TO CONTROLS FOR LOCAL RAILROADS

	Log Value of Agricultural Land				
	(1)	(2)	(3)	(4)	(5)
Log market access	0.511	0.434	0.431	0.343	0.276
	(0.065)	(0.064)	(0.082)	(0.080)	(0.075)
Controls for:					
Any railroad	No	Yes	Yes	Yes	Yes
Railroad length	No	No	Yes	Yes	Yes
Railroads within nearby buffer	No	No	No	Yes	Yes
Railroads within further buffers	No	No	No	No	Yes
Number of counties	2,327	2,327	2,327	2,327	2,327
R-squared	0.625	0.627	0.632	0.640	0.653

Donaldson and Hornbeck

COUNTERFACTUAL IMPACTS ON LAND VALUE, ALLOWING FOR POPULATION REALLOCATION

	Percent Decline in Land Value without Railroads
Baseline counterfactual without railroads in 1890	60.2 (4.2)
Changes in the distribution of population (holding total population constant)	
1. Assuming the population distribution from 1870	59.1 (4.1)
2. Assuming the population distribution from 1850	59.3 (4.1)
3. Assuming the population distribution from 1830	60.1 (4.0)
4. Assigning the model-predicted counterfactual distribution of population	56.6 (4.0)
Changes in the distribution and total level of population (holding worker utility constant)	
5. Model-predicted estimate, allowing for changes in the level and distribution of population	58.4
Changes in the distribution of population and worker utility (holding total population constant)	
6. Model-predicted estimate, allowing for changes in worker utility and the distribution of population	19.0

Donaldson and Hornbeck

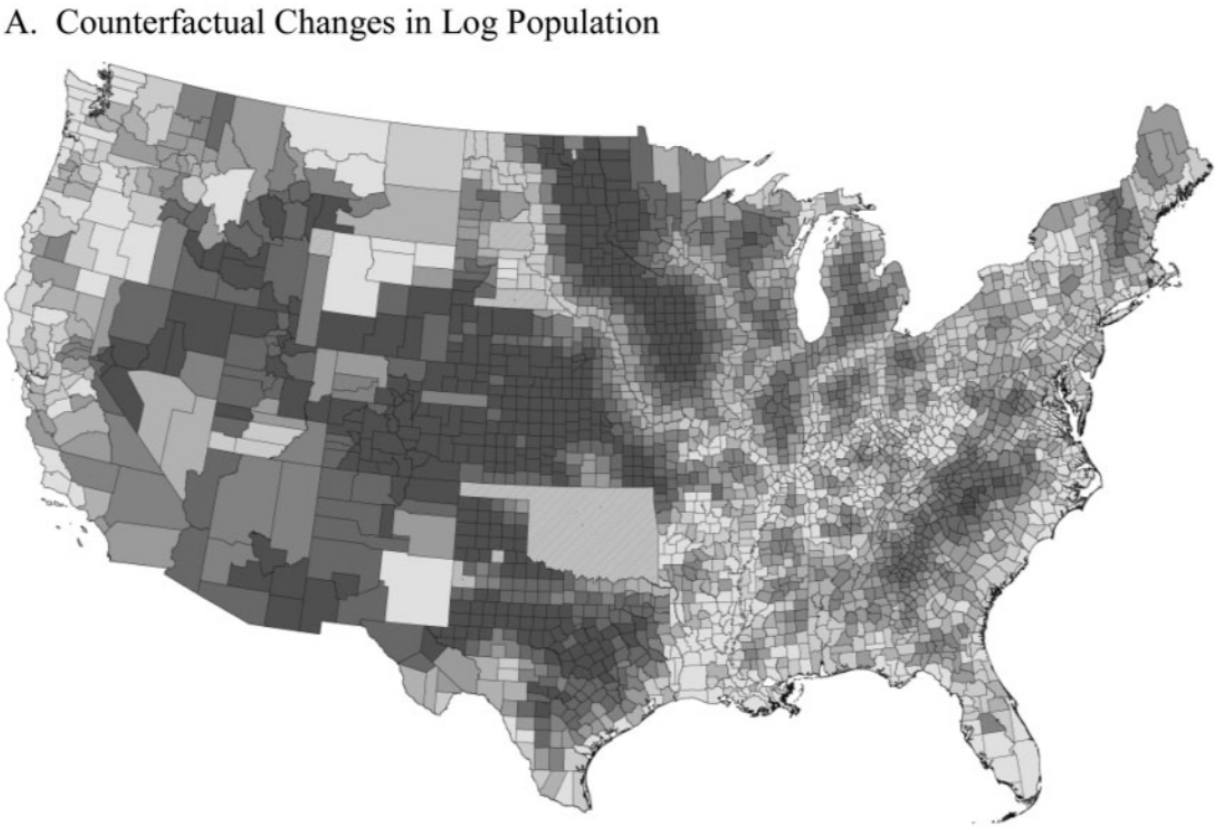
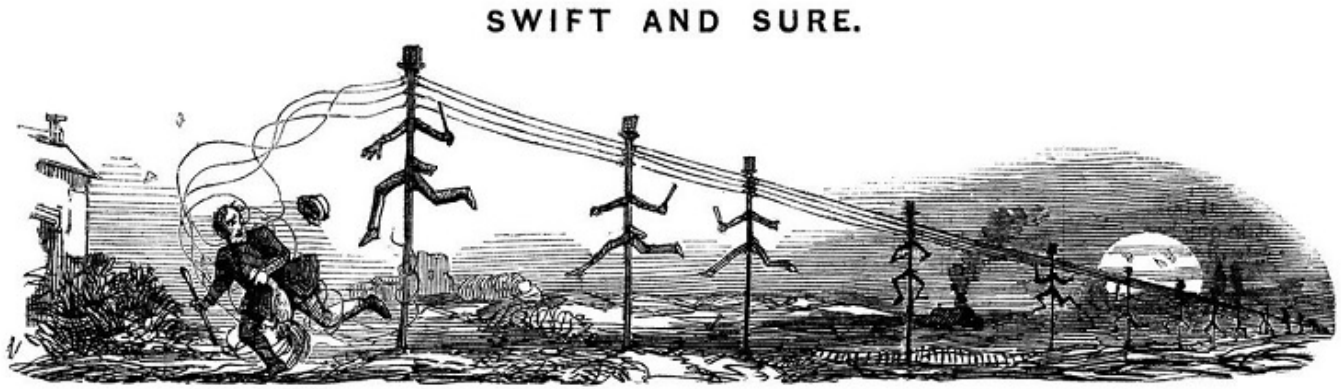


FIGURE V

Changes in Log Population, by County

Panel A shows the 2,782 counterfactual sample counties, shaded according to their change in log population from 1890 to the counterfactual scenario. Counties are divided into seven equal-sized groups: darker shades denote larger declines in population, and lighter shades denote larger increases in population. The seven groupings correspond to log changes of: less than −1.31 (darkest), −1.31 to

Additional Impacts of the Railroad

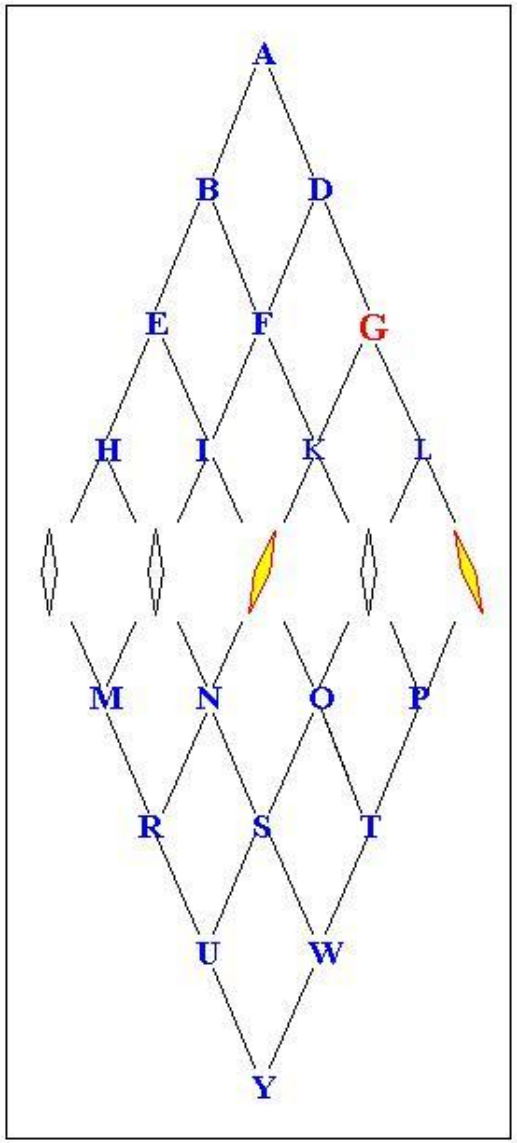


John Tawell and the telegram

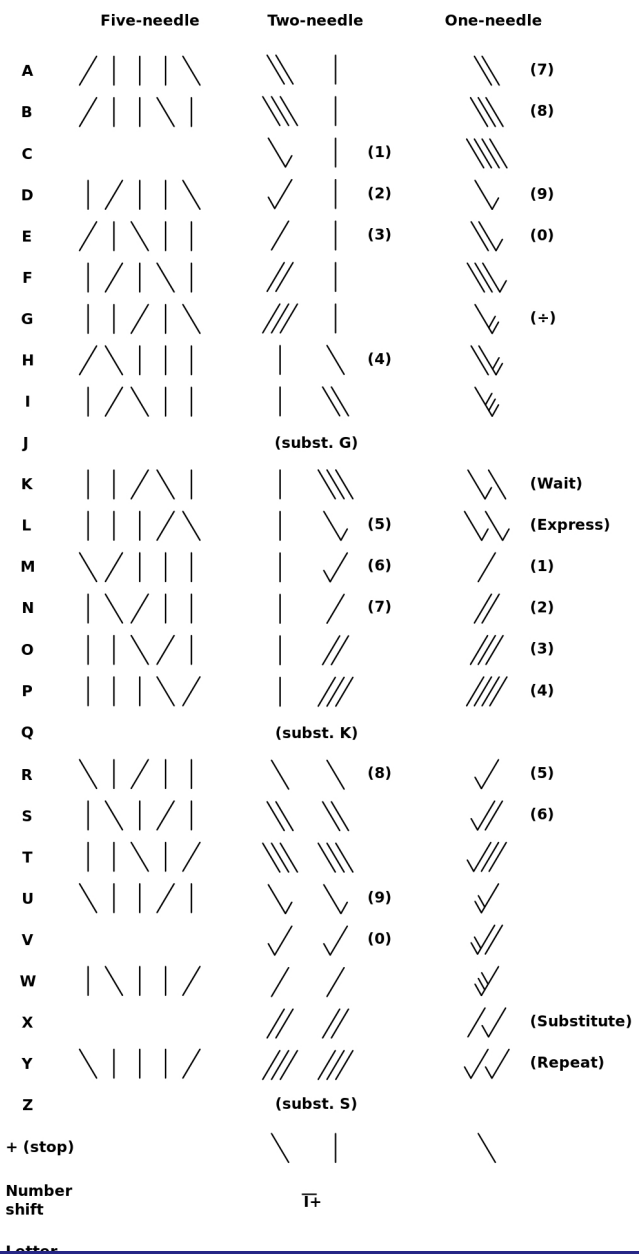
Additional Impacts of the Railroad

A MURDER HAS GUST BEEN COMMITTED AT SALT HILL AND THE SUSPECTED MURDERER WAS SEEN TO TAKE A FIRST CLASS TICKET TO LONDON BY THE TRAIN WHICH LEFT SLOUGH AT 742 PM HE IS IN THE GARB OF A KWAKER WITH A GREAT COAT ON WHICH REACHES NEARLY DOWN TO HIS FEET HE IS IN THE LAST COMPARTMENT OF THE SECOND CLASS COMPARTMENT – *telegram from Slough to Paddington, January 1, 1845*

Additional Impacts of the Railroad



Additional Impacts of the Railroad

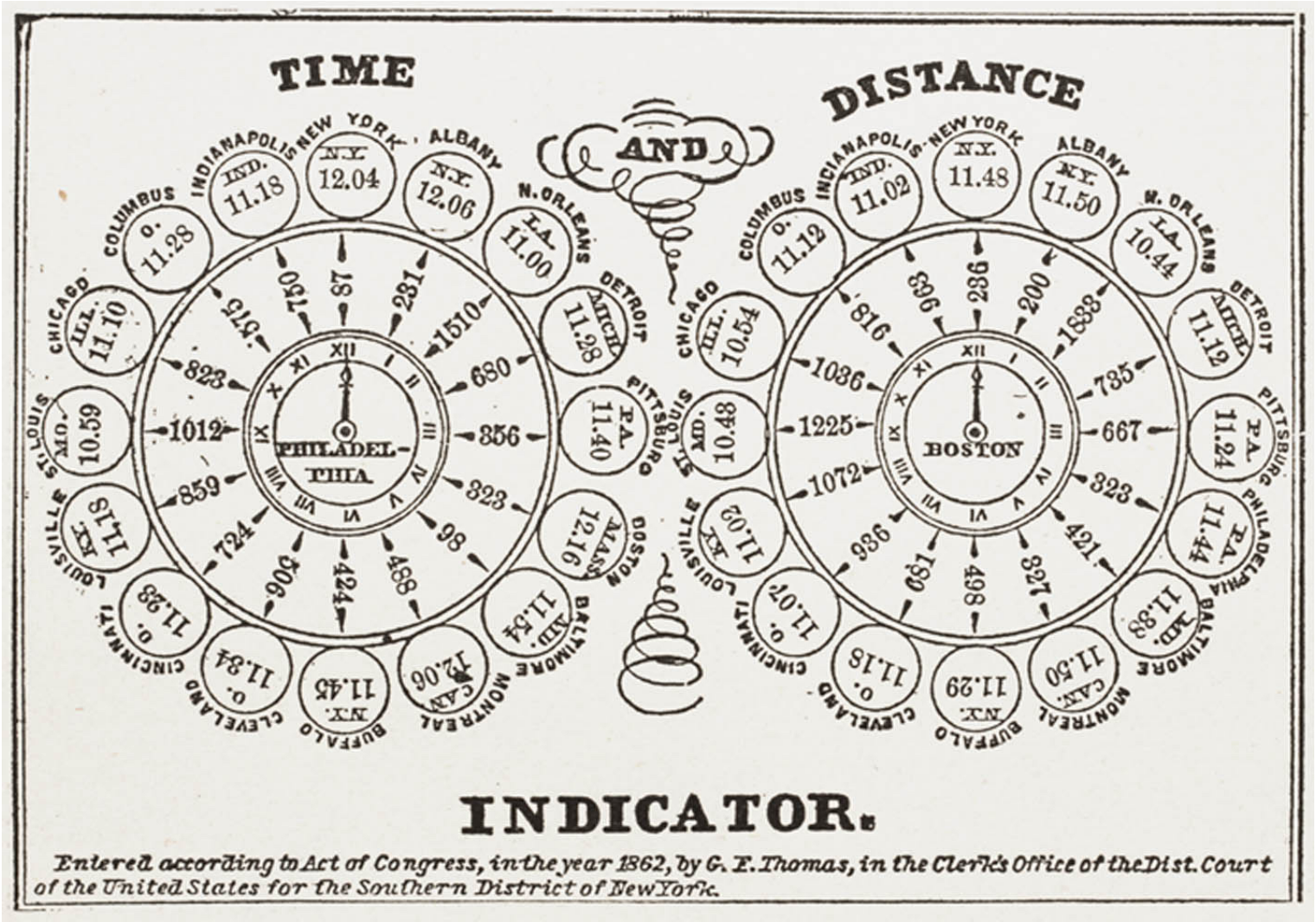


Additional Impacts of the Railroad

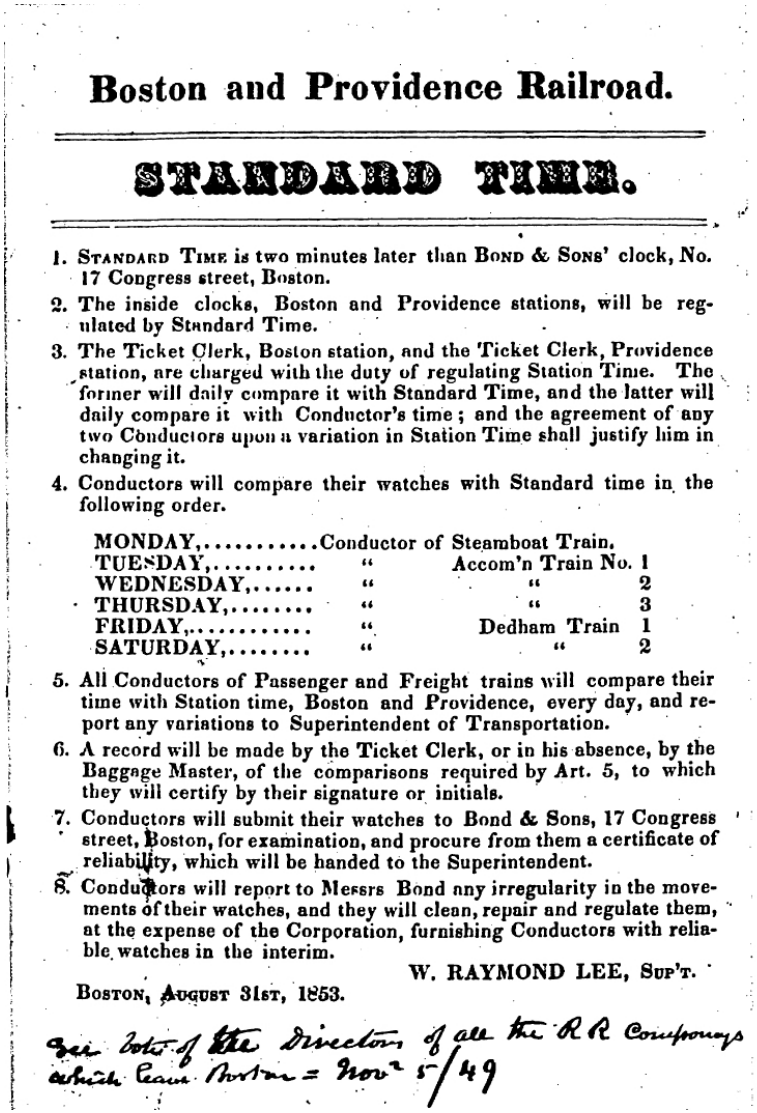
Speed of Information Travel

Event	Year	Distance (miles)	Days	Speed (mph)
Battle of the Nile	1798	2073	62	1.4
Earthquake, Kutch, India	1819	4118	153	1.1
Charge of the Light Brigade	1854	1646	17	4
Treaty of Tien-Sin	1858	5140	82	2.6
Assassination of Lincoln	1865	3674	13	12
Assassination of Alexander II	1881	1309	0.46	119
Nobi Earthquake	1891	5916	1	246

Additional Impacts of the Railroad



Additional Impacts of the Railroad



Boston and Providence Railroad.

STANDARD TIME.

1. Standard Time is two minutes later than Bond & Sons' clock, No. 17 Congress street, Boston.
2. The inside clocks, Boston and Providence stations, will be regulated by Standard Time.
3. The Ticket Clerk, Boston station, and the Ticket Clerk, Providence station, are charged with the duty of regulating Station Time. The former will daily compare it with Standard Time, and the latter will daily compare it with Conductor's time; and the agreement of any two Conductors upon a variation in Station Time shall justify him in changing it.
4. Conductors will compare their watches with Standard time in the following order.

MONDAY,.....	Conductor of	Steamboat Train.	
TUESDAY,.....	"	Accom'n Train No.	1
WEDNESDAY,.....	"	"	2
THURSDAY,.....	"	"	3
FRIDAY,.....	"	Dedham Train	1
SATURDAY,.....	"	"	2

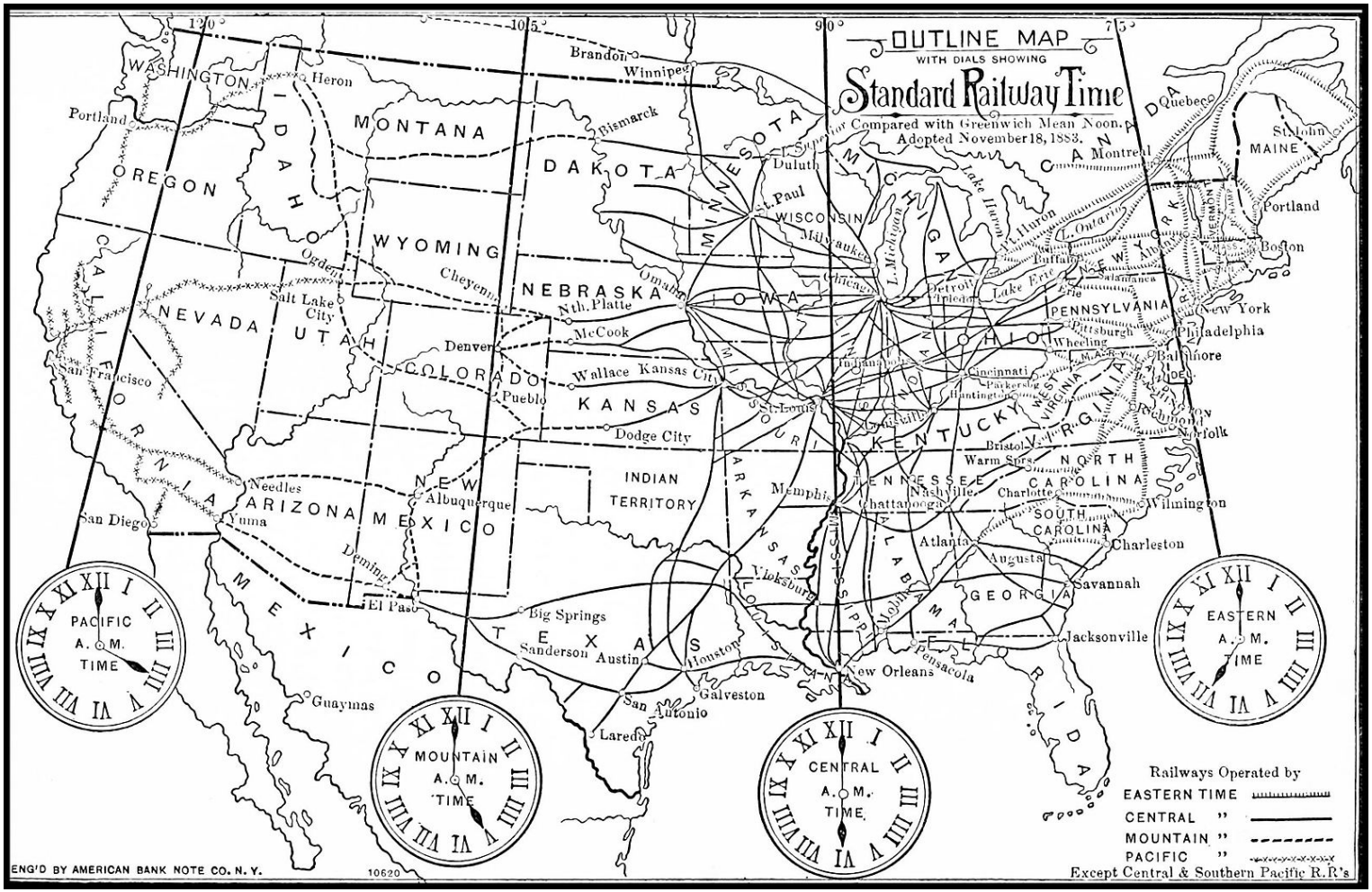
5. All Conductors of Passenger and Freight trains will compare their time with Station time, Boston and Providence, every day, and report any variations to Superintendent of Transportation.
6. A record will be made by the Ticket Clerk, or in his absence, by the Baggage Master, of the comparisons required by Art. 5, to which they will certify by their signature or initials.
7. Conductors will submit their watches to Bond & Sons, 17 Congress street, Boston, for examination, and procure from them a certificate of reliability, which will be handed to the Superintendent.
8. Conductors will report to Messrs Bond any irregularity in the movements of their watches, and they will clean, repair and regulate them, at the expense of the Corporation, furnishing Conductors with reliable watches in the interim.

W. RAYMOND LEE, Sup't.

Boston, August 31st, 1853.

See Vote of the Directors of all the R R Companys which leave Boston = Nov 5/49

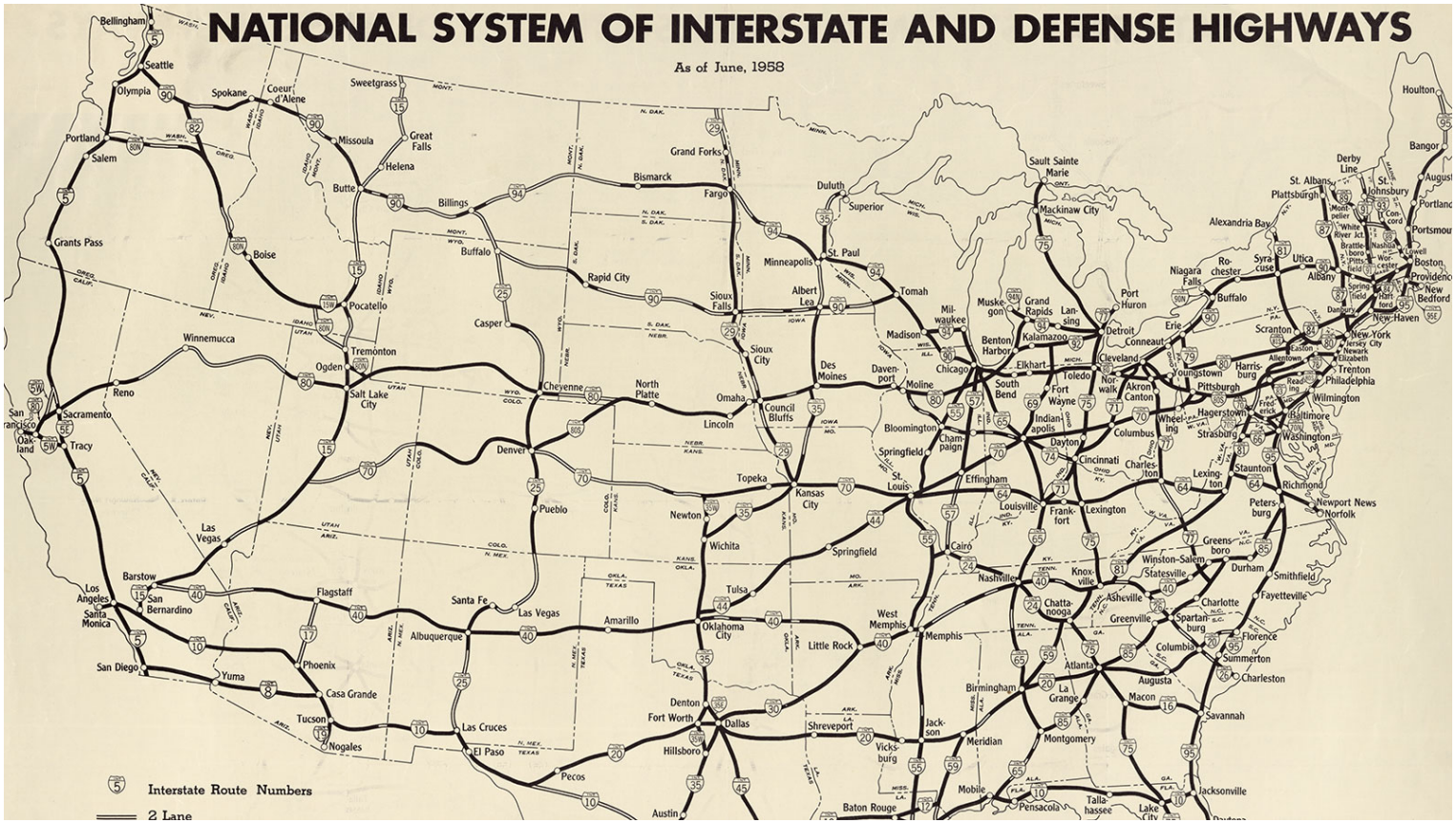
Additional Impacts of the Railroad



Additional Impacts of the Railroad

- Backward linkages:
  - The growth of railroads created increasing demand for other industries
  - Expanding railroads increased demand for coal, iron, and engineering technology
  - The magnitude of these increases in demand was not overwhelming
- Forward linkages:
  - The growth of railroads impacted those people who consumed the rail services
  - Gains to the economy could result if the people using the railroad became more productive as a result of the railroad
  - Railroad expansion may have led to greater investment in skills and engineering that would benefit other industries
  - Telegraph lines came with the railroads and provided broad benefits to the economy

From Railways to Highways



From Railways to Highways

[Highways should be] so located as to connect by routes as direct as practicable, the principal metropolitan areas, cities, and industrial centers, to serve the national defense, and to connect at suitable border points with routes of continental importance in the Dominion of Canada and the Republic of Mexico. . .– Federal Aid Highway Act of 1944

From Railways to Highways

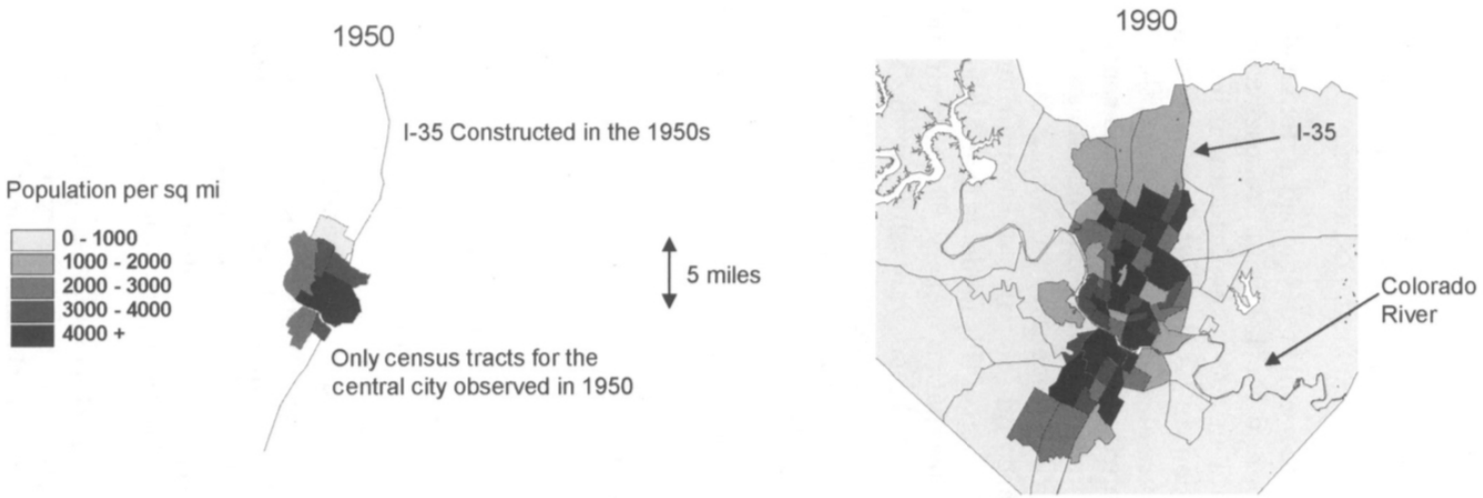
Missouri Department of Transportation

From Railways to Highways

From Railways to Highways

- The federal highway system was a massive change to our transportation infrastructure
- It was designed to link industrial centers, population centers, and to aid in national defense
- It was not explicitly designed to facilitate commuting
- However, one of its most profound impacts was on suburbanization
- Let's take a quick look at Baum-Snow (2007) "Did Highways Cause Suburbanization?"

From Railways to Highways



Note: Each shaded region is a separate census tract.

FIGURE II
Development Patterns in Austin, TX.

From Railways to Highways

Panel B: Evolution between 1970 and 1990

Sample		ΔLog population density
Large MSAs in 1950 (36,250 tracts, 139 MSAs)	Distance to CBD	.021
		(.000)**
	ΔDistance to highway	−.015
		(.002)**
Large MSAs in 1950 with central cities at least 20 miles from a coast or border (17,336 tracts, 100 MSAs)	Distance to CBD	.021
		(.001)**
	ΔDistance to highway	−.008
		(.003)**

From Railways to Highways

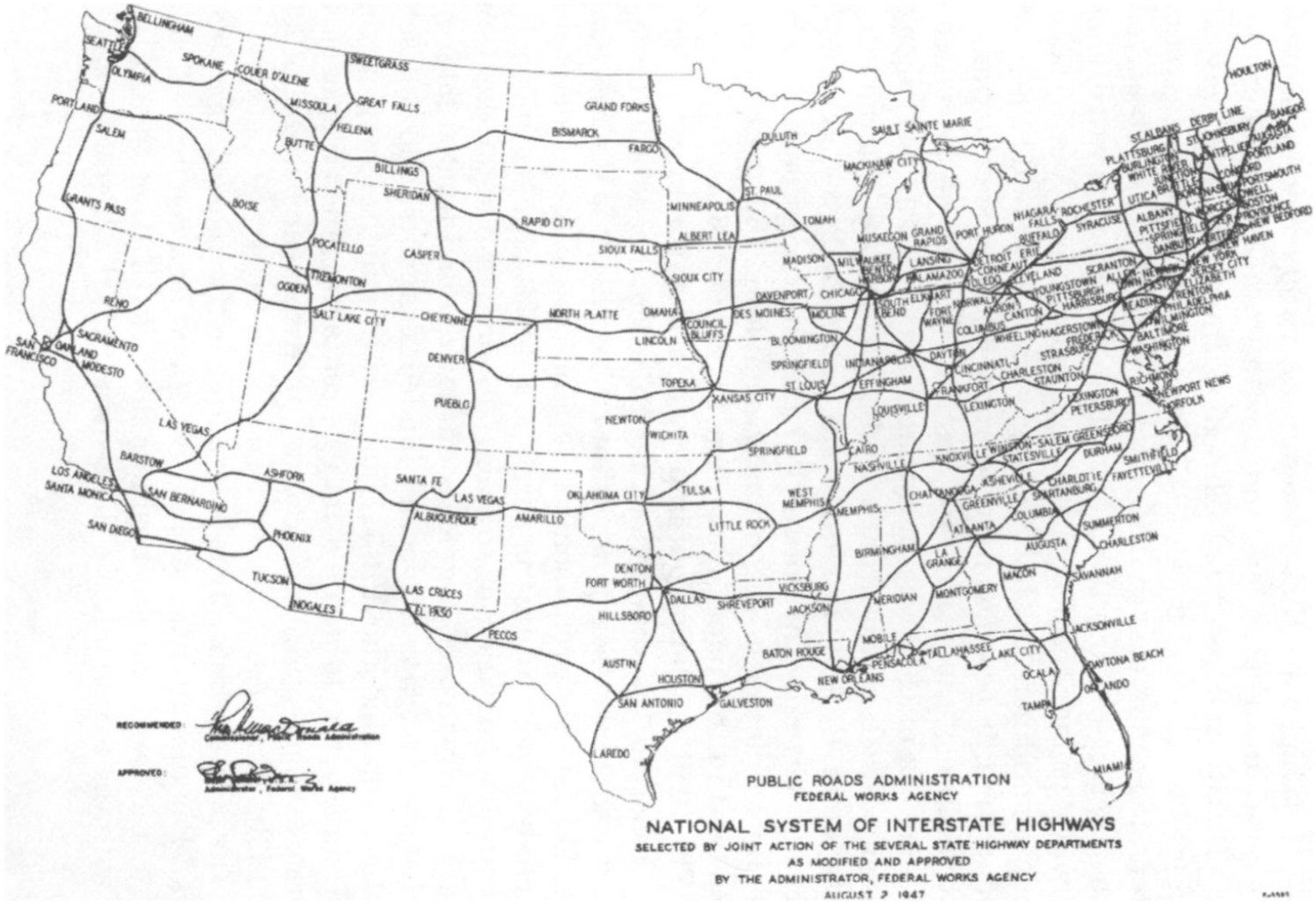


FIGURE I
The Projected System of Interstate Highways in 1947

From Railways to Highways

TABLE VI

PANEL IV REGRESSIONS OF THE DETERMINANTS OF CONSTANT GEOGRAPHY CENTRAL CITY POPULATION, 1950–1990

	Large MSAs in 1950					
	Log central city population					
	1	2	3	4	5	6
Number of rays	−0.111	−0.142	−0.140			
	(0.016)**	(0.026)**	(0.028)**			
(1990 Rays) × (Fraction of Ray miles completed at t)				−0.097	−0.089	−0.086
				(0.016)**	(0.012)**	(0.013)**
Log simulated income		−0.083	−0.061		−0.288	−0.229
		(0.117)	(0.109)		(0.075)**	(0.077)**
Log MSA population		0.266	0.263		0.294	0.286
		(0.104)*	(0.105)*		(0.100)**	(0.098)**
Simulated Gini coefficient			−0.623			−1.415
			(1.106)			(0.847)
MSA Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared	0.20	0.22	0.22	0.14	0.56	0.57

Notes: The instrument used is (rays in the plan) × (MSA mileage of highways running through the central city at time t)/(MSA mileage of highways running through the central city in 1990). Standard errors are clustered by the state of the central city. Standard errors are in parentheses. ** indicates significant at the 1 percent level, * indicates significant at the 5 percent level. First stage results are in Table II. Each regression includes 132 MSAs with five observations each, one for each year 1950–1990. There are fewer MSAs in this sample than that in Table IV because of lack of census tract data for seven MSAs in 1960.