Dense Enough To Be Brilliant:
Patents, Urbanization, and Transportation in Nineteenth Century America

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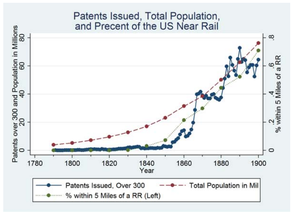
Introduction

I explore the geographical distribution of patenting in the 19th century U.S., revisiting the Sokoloff (1988) hypothesis that increasing market access through transportation infrastructure led to an acceleration of innovation.

Travel over land without mechanical power is costly; before railroads, waterways were the most efficient means of transport. Transportation brings ideas and people, allowing for greater specialization and access to formal credit institutions. Nineteenth century changes made transportation faster, cheaper and safer, effectively reducing the distance between locations, with the most profound effect on places on the periphery of the transportation network.

Data



The data used here have the advantage of being a complete picture of a long time period.

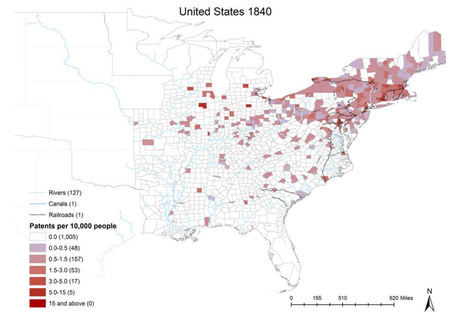
- Tom Nicholas' dataset of patents issued from 1836-1900
- Jim Shaw's spreadsheet of patents issued 1790-1836 linked to the AniMap 3.0.2 Historical Atlas
- Jeremy Atack's Transportation Data
- U.S. Census Data, including minor civil divisions from Michael Haines
- OCRed Text from Westlaw

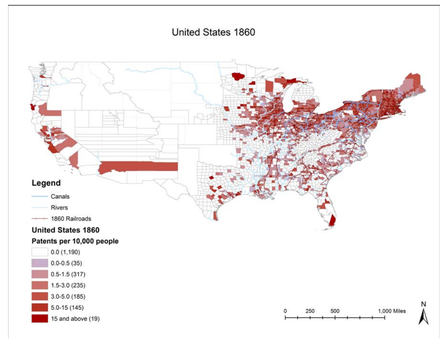
Basic Regressions

The regression below uses cardinal direction lines from important ports in 1826 as an IV, suggesting that 30-70% of the increase in patenting between 1850 and 1860 was caused by the spread of the railroad.

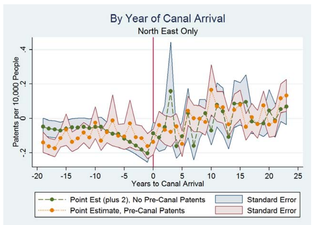
VARIABLES	OLS Pat. per 10K Ppl	First Stage % RR 1.5 Mi	IV Pat. per 10K Ppl	OLS Pat. per 10K Ppl	First Stage % RR 1.5 Mi	IV Pat. per 10K Ppl
Port Instrument		0.0726**			0.0177*	
		(0.0140)			(0.00822)	
% within 5 miles of rail	3.890**		15.55**	0.425*		11.65+
	(0.256)		(3.255)	(0.166)		(6.933)
County Controls	No	No	No	Yes	Yes	Yes
Counties	1250	1250	1250	1055	1055	1055
Wald Stat.			30.74			5.342

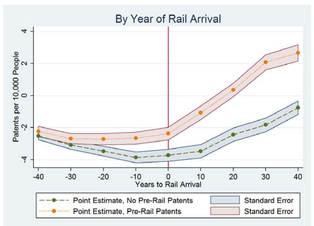
Spread of the Railroad and Patenting





More Detail





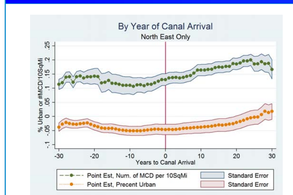
The figures to the left show the βs from $PatentsPer10KPpl_{it} = \alpha + \beta YearstoArrivalDummies_{it} + \gamma_i + \delta_t + \varepsilon$ split into two categories: places that patented before they received transport and places that did not. The increase in patenting is gradual process–the effects are felt for many years after transport arrival.

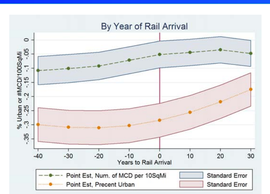
The tables to the right explore the expansion of market access and urbanization due to canals and railroads. As one might expect from a response to increased market access, it is not immediate. Town formation is important in the canal era, but precedes the railroads (see below); increased urban population follows both and is highly correlated with patenting.

VARIABLES	Pat. per 10K Ppl	Pat. per 10K Ppl	Pat. per 10K Ppl	Pat. per 10K Ppl
log Market Access (Over 3.8)	0.0291+ (0.0154)	0.00997 (0.00690)		-0.0338* (0.0172)
Lag log MA			0.0798** (0.0163)	
% within 5 mi of transport				3.378** (0.400)
County Dummies	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Full Controls		Yes		

VARIABLES	Canal Pat. per 10K Ppl	RR era Pat. per 10K Ppl	Canal Pat. per 10K Ppl	RR era Pat. per 10K Ppl
% Urban, 2500+	0.338* (0.144)	15.40** (1.640)		
Lag % Urban			0.150 (0.175)	13.66** (1.371)
MCD per 10SqMi	1.83e-05** (2.05e-06)	0.273 (0.677)		
Lag MCD per 10SqMi			5.33e-06* (2.52e-06)	0.561 (0.562)
County Dummies	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes

Timing of Increases

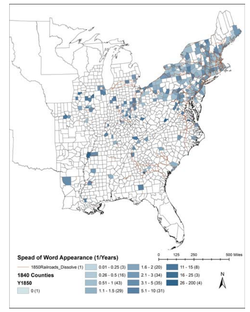


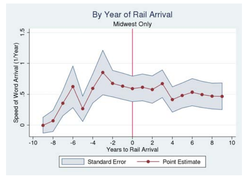


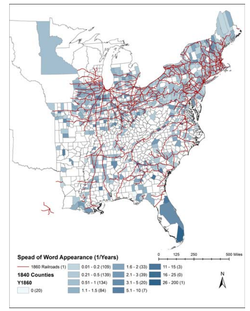
These figures explore the timing of town formation and urbanization to transportation vis-a-vis infrastructure.

VARIABLES	(1) 1810-30 Patents per 10K People	(2) 1840-50 Patents per 10K People	(3) 1850-60 Patents per 10K People	(4) 1860-70 Patents per 10K People	(5) 1870-80 Patents per 10K People
North East- -% Tran 5.0 mi	1.265* (0.541)	0.810** (0.273)	0.879+ (0.496)	0.728 (1.113)	-0.378 (1.609)
# Counties	192	192	192	192	192
Midwest- -% Tran 5.0 mi	-0.0529 (0.392)	0.241 (0.201)	1.445** (0.283)	3.599** (0.437)	3.705** (0.406)
# Counties	379	379	379	379	379
South- -% Tran 5.0 mi	0.0528 (0.101)	0.200+ (0.109)	0.235 (0.409)	0.985* (0.420)	1.026** (0.355)
# Counties	351	351	351	351	351

The Spread Of Information







Patents are treated as collections of words (or n-grams). In each year new n-grams to all counties are found, along with when that n-gram first appeared in the patent recored. The speed is the number of 10,000 person-years needed for one new word to arrive in that year. Such n-grams include "camera" (1851), "reaping machine" (1853), and "carbonate soda" (1855). Some important categories of patents are highlighted below.

VARIABLES	Chemical Patents per 10K Ppl	Mechanical Pat per 10K Ppl	Agriculture, Husbandry, Food Pat per 10K Ppl	Apparel, Textile Pat per 10K Ppl	Furniture, House Fixtures Pat per 10K Ppl
% Tran 5.0 mi	0.0981** (0.0282)	0.559** (0.0913)	0.197** (0.0295)	0.0554+ (0.0332)	0.141** (0.0227)
Non-zero Ops	2022	3907	2249	1659	1673

Future Directions

While improved transport increases patenting; it isn't an immediate jump. There is a puzzle left (not shown): Why primarily railroads and canals, but not ports? Further steps in the project include exploring potential shocks to market access, information and bureaucracy.

References

[1] Jeremy Atack, Fred Bateman, Michael R Haines, and Robert A Margo. Did Railroads Induce or Follow Economic Growth?: Urbanization and Population Growth in the American Midwest, 1850-1860. *Social Science History*, 34(2):171–197, April 2010.

[2] Kenneth L Sokoloff. Inventive Activity in Early Industrial America: Evidence From Patent Records, 1790-1846. *The Journal of Economic History*, 48(04):813–850, March 1988.