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The effect of transport infrastructure on the location of economic activity: Railroads and post offices in the American West

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ABSTRACT

This paper uses data on the locations of historical US Post Offices to study the effect of railroad construction between 1868 and 1889 on the geographical distribution of towns in the American West. I estimate the probability of survival and expected lifetime of a post office as flexible functions of the distance to the railroad. Existing post offices that were bypassed by the railroad at between 5 and 10 km were 20 to 50 percentage points less likely to remain in operation until 2010 than control post offices over 50 km from the railroad. Given the historically close correspondence between the location of post offices and the location of towns, these results provide evidence that the railroads generated an agglomeration shadow - towns that were "almost" connected to the railroad were more likely to decline than those that remained isolated. I show that the short distances over which the forces of agglomeration act in this setting mean that it is difficult to detect the agglomerative effects of railroad construction using alternative methodologies based on census population data.

1. Introduction

How does transport infrastructure impact the geographical distribution of economic activity? Economic theory suggests that reduced trade costs and greater market access should increase economic activity at locations close to transport hubs. However, some of this growth in local economic activity might be the result of agglomeration economies that relocate activity from areas further away from the transport network. The magnitude and direction of the net effect depends on the distance of the location in question from the transport network - locations very close to the network are likely to grow at the expense of locations that fall within the "agglomeration shadow", while locations sufficiently far away will be unaffected (see Fujita et al., 1999; Fujita and Krugman, 1995; Krugman, 1991). The actual distances at which these different effects dominate depend sensitively on the context, but existing literature suggests that agglomeration effects die out quickly with distance. For example, using modern data on the location of plants in the United States, (Rosenthal and Strange., 2003) find that agglomeration economies are strongest within the first mile, and attenuate rapidly between 2 and 5 miles.[1]

In this paper, I study the agglomerative effects of railroad construction in the 19th Century American West on the distribution of settlement and economic activity over space. In particular, I measure the change in the geographic distribution of towns in seven western states caused by the construction of the railroad between 1868 and 1889. To measure these effects, I use data on the location, opening, and closing dates of post offices. I argue that, in this historical context, the existence of a post office is a good proxy for the existence of a town, and the discontinuation of a post office indicates the dispersal of economic activity and population associated with that town. This data source is new to the economics literature, and allows me to measure the effect of the railroad on the location of settlements at a higher level of spatial and temporal precision than existing census data. The relocation of economic activity due to agglomeration is likely to operate at especially short distances in historical contexts where the cost of overland transportation is high, and such effects are therefore particularly difficult to measure using census data.

The results provide evidence of the heterogeneous effects of transport infrastructure on the location of settlement and economic activity. The spatial distribution of towns in the West was disrupted by the arrival of the railroad, with towns that were "almost" connected to the railroad less likely to survive than both those that were connected *and* those that remained isolated. I measure these effects by estimating two functions: the probability that a post office (possibly established before the railroad was built) survives to some end date as a function of distance from the railroad, and the expected year a post office closes as a function of the year established and distance from the railroad. The post office data allows me to adopt a non-parametric approach such that the relationship between distance and the probability of survival need not be monotonic.

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[1] In their study of the location choice of New York advertising agencies, Arzaghi and Henderson (2008) find that there is rapid decay in the benefits of co-location *within* the first mile.

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Indeed, the baseline estimates suggest a non-monotonic effect. Being directly connected to the railroad (located within 5 km) increases the probability that a post office survives to 2010 by between 7 and 12 percentage points relative to "control" post offices located further than 50 km from the railroad. However, railroad construction between 5 and 10 km of an existing post office *decreases* the probability that post office survives to 2010 by between 25 and 50 percentage points relative to the control post offices. Thus, locations directly connected to the railroad appear to benefit at the expense of locations slightly further away. After this dip between 5 and 10 km the survival probability increases with distance from the railroad. A similar pattern is found for the expected lifetime of a post office.

I interpret these results as demonstrating the effect of railroad construction on the "agglomeration shadow" predicted by Fujita et al. (1999) model of city location. In this model, agglomeration economies lead manufacturers to locate in cities - point masses separated by an agricultural hinterland. One implication of this model is that if the "market potential" of a city increases, for example if it is connected to new markets by a railroad, manufacturers will relocate to that city from the surrounding area and the city's hinterland will expand. In the new equilibrium, other cities that fall within this "agglomeration shadow" are dispersed. The post office data speaks directly to these dynamics of town survival. The negative effect of railroad construction on post office survival extends approximately 10 km from the railroad network, after which it becomes insignificant in many specifications, suggesting that the "agglomeration shadow" created by the railroad was approximately 10 km wide. These findings of large effects at short distances suggest that the growth and decline of frontier towns, and the long run distribution of settlement, was particularly sensitive to local competition between neighboring towns. Towns that were "almost" connected to the railroad network in the 1870s and 1880s were more likely to decline than those that remained isolated. To provide further evidence for this interpretation, I exploit the high temporal resolution of the post office data to show that the positive effect of the railroad on survival at 0–5 km is largest for those post offices established *while* the railroad was being built, and the negative effect at 5–10 km is largest for post offices established *before* the railroad was built. The results indicate that existing towns bypassed by the railroad were likely to decline, with population relocating to newly founded railroad towns.

In addition to these empirical findings, this paper contributes to the literature by demonstrating that the lack of spatial precision in census data can be overcome using data on the locations of US Post Offices. Existing studies of the effects of transportation on economic activity in 19th century America have typically used census population data at the county level.[2] Counties in the 19th Century west were large - the average county in Kansas in 1870 was 883 km^2, approximately the area of a 30 × 30 km square. This lack of spatial precision makes the measurement of any effects that take place at less than 30 km difficult. Indeed, I show that the main finding of an agglomeration shadow at 10 km cannot be replicated precisely using county level data and that this result is identified mostly by within-county variation in post office survival. More precise census data is limited for this era, and sub-county units are difficult to link over time. As far as I know, the only geo-coded sub-county data for this era was assembled by Michaels et al. (2012), who map the population of minor civil divisions in 1880 to the nearest MCD centroid in 2000. I use this data to corroborate my interpretation of the findings on post office survival. Among rural MCDs, population growth between 1880 and 2000 is lowest in those centered between 5 and 10 km from the railroad. These results do not hold for MCDs near major cities, for which long term trends in population such as the growth of suburbs likely obscure the short run effects of railroad construction. This highlights the relative utility of the post office data as a measure of the survival of independent towns during the 19th and early 20th centuries.

The economic effects of railroad construction in 19th Century America have been studied extensively in the economic history literature, starting with Fogel (1964) and Fishlow (1965) who quantified the impact of the railroads on American economic growth. More recently, the creation of GIS databases on the precise location of railroads and canals in the 19th century (Atack, 2013, 2015) has encouraged economists to revisit these questions. For example, Donaldson and Hornbeck (2015) use a "market access" approach based on general equilibrium trade theory to quantify the contribution of the rail network to agricultural land values. The results in this paper are most closely related to the findings of Atack et al. (2010), who compare levels of urbanization in railroad and non-railroad counties in the American Midwest during the 1850s. They find that connection to a railroad has a significant positive effect on a county's urbanization, measured by the share of residents living in incorporated cities of more than 2500 inhabitants, but does not have a significant impact on county-level population density. These results suggest that the construction of the railroads relocated settlement and economic activity towards urban centers at small distances *within* railroad counties, consistent with the findings of this paper.

More broadly, this paper is related to previous empirical studies of the effects of transport investments on the distribution of economic growth. In line with this paper's findings on railroads, Chandra and Thompson (2000) find that interstate highways in the US increase economic activity in counties that they pass through partly by relocating activity away from adjacent counties. Jedwab and Moradi (2016) examine the effect of the construction of railroads in colonial Ghana on cocoa output and population in rural locations. Using data on output and population aggregated to grid cells of 0.1 × 0.1 degrees (approximately 121 Sq. km), the authors find that output and population increased in grid cells through which the railroad passed. Furthermore, they find a positive effect on output for adjacent grid cells that diminished with distance from the railroad, and, unlike Chandra and Thompson, find no evidence of relocation of activity or population from adjacent cells to railroad cells. Contrary to these results, Faber (2014) study of China's National Trunk Highway System finds that peripheral (non-metropolitan) counties through which the highways pass experience a reduction in GDP growth. He also finds that the effect is diminished for counties further away from the highways. This is suggestive of agglomeration at the level of metropolitan locations - economic activity appears relocated away from connected rural counties towards connected urban counties. Faber finds no evidence of the relocation of activity from unconnected to connected rural counties.

These studies all use a difference in differences approach in which the levels of some measure of economic activity before and after the transport improvement are compared between connected (treated) an non-connected (control) counties or grid cells.[3] One downside of this approach is that the geographical units, usually counties, are of an arbitrary size. There is no reason to expect, for example, highway construction to have a uniform treatment effect across areas the size of Chinese counties - there is likely within county variation in the treatment effect which is not picked up by measures of total county output. Data aggregated to differently sized geographic units can therefore lead to different conclusions about the effect of transportation on the distribution of economic activity. I avoid this problem by measuring how the spatial distribution of *points* of urbanization and concentration of economic activity changes with railroad construction, allowing me to estimate how the effect of railway construction on economic activity varies over arbitrarily small distances.

Finally, note that Acemoglu et al. (2016) provide an alternative interpretation of the geographic distribution of post offices. They

[2] See for example Donaldson and Hornbeck (2015) and Atack et al. (2010).

[3] For a survey of this literature, see Redding and Turner. (2014).