# Railroad expansion and entrepreneurship: evidence from Meiji Japan

John Tang*
The Australian National University

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Abstract

Railroads in Meiji Japan are credited with facilitating factor mobility as well as access to human and financial capital, but the impact on firm activity is unclear. Using a newly developed firm-level dataset and a difference-in-differences model that exploits the temporal and spatial variation of railroad expansion, this paper assesses the effect of railroad access on startup activity across Japanese prefectures. Results indicate that railroad expansion corresponded with increased firm activity, particularly in manufacturing, although this effect is mitigated in less populous regions. These findings are consistent with industrial agglomeration in areas with larger markets and earlier development among both new and existing establishments.

Keywords: agglomeration, entrepreneurship, firm genealogy, late development, social savings

JEL classification: L26, N75, O53

* Research School of Economics, The Australian National University, LF Crisp Building 26, Acton ACT 0200 Australia. E-mail: john.tang@anu.edu.au; office: +61 2 6125 3364; fax: +61 2 6125 5124. The author thanks seminar participants at the Universitat de Barcelona, University of Oxford, the London School of Economics, Massey University, and the University of Otago as well as participants at the Asian Historical Economics Conference for useful comments. This research is supported by grants provided by the ANU College of Business and Economics and the Australian Research Council.

I. Introduction

One of the foreign inventions Commodore Matthew Perry brought with him on his visit to Japan in 1854 was a miniature steam locomotive that ran on a mile-circumference track.[1] Curious onlookers were impressed not only by the novelty of the design, but especially with its rapidity: one impromptu rider sitting atop the train "clung with a desperate hold to the edge of the roof… and described the experience `as though it were flying.'"[2] Eighteen years and a revolution later, the Meiji emperor opened the country's first railroad between Tokyo and Yokohama, which cut the day's long journey by foot to less than an hour by train.[3]

Among the many technological and institutional changes sweeping Japan in the late nineteenth century, the railroad has been credited with a leading role in promoting industrialization and economic growth[4]. This premise is consistent with the benefits of improved transportation infrastructure, which include lower transit costs, market integration and expansion, and intersectoral linkages.[5] Casual observation of Japan's economic performance seems to corroborate this view: between 1872, when the Tokyo-Yokohama line was completed, and 1907, when the government nationalized the industry, national income had tripled in real terms.[6] During this same period, the domestic rail network had expanded from 29 to 7,152 kilometers; the number of locomotives from 10 to 1,924; and annual passengers carried from 495,000 to 101 million.[7]

Correlation, however, is not causation, and studies ascribing a causal link between railroads and economic development have typically relied on counterfactual comparisons of social savings or indirect measures of economic activity like population growth.[8] Less clear are how the arrival of the railway directly affects entrepreneurs and industries or how these would have behaved differently in the absence of locomotive technology, especially for countries that

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[1] This was not the first train seen in Japan; the prior year a Russian envoy demonstrated locomotive technology aboard his ship, but the model was smaller in scale and viewed by many fewer (Free, 2008, p. 22).

[2] Ericson (1996), p. 4. This is echoed in contemporary newspaper accounts, which stated that "'[t]he railway train will be as fast as the wind or a cloud. Without such a miraculous device it would be impossible for a human being to do a thing like this unless he possessed the wings of a bird"; in Nagao (1929), p. 5, quoting from the 6 September 1872 issue of *Nichi Nichi Shimbun*.

[3] Free (2008), pp. 11 and 85.

[4] Lockwood (1954) writes that unlike western countries, railroads allowed Japan to "[gain] the economies of a national system almost at the outset" and "facilitated a geographic extension of the internal and external market by lowering the cost of moving goods and people" (p. 106). See also Crawcour (1997), pp. 58-61, and Ericson (1996), pp. 31-32 and 52.

[5] Rostow (1960), chapter 4.

[6] Data from Maddison (2003). Official Japanese data provide nominal income series starting in 1875, which indicate a six-fold increase by 1907; see Japan Statistical Association (2007), series 13-3, Yamada estimates.

[7] Ibid., series 8-4, 8-6, and 8-14. Historical data for freight traffic begin in 1886, which grew from 426,000 tons to 18,605,000 in 1907 (series 8-15).

[8] Classic studies include Fogel (1964) and Fishlow (1965), while Atack et al (2009) and Herranz-Loncan (2011) are more recent examples.

may have well-developed shipping transport links like Japan. This uncertainty is in part due to a lack of historic firm-level data as well as difficulty in finding appropriate analogues with which to compare economic outcomes.

Another factor to consider is that railroad access may have differential consequences on the connected locations themselves. While railroads may increase economic activity for the macroeconomy, economic geography suggests that agglomeration forces can draw business activity away from newly accessible areas (aka, periphery) toward already established manufacturing centers, and thus mitigate potential economic gains in the former.[9] This theoretical prediction would seem to apply to Meiji Japan, where there were already large disparities in population and commerce between major cities like Tokyo and Osaka and the more remote prefectures. Taking account of differences between regions may clarify the distributional effects of the railroad and other spatially oriented technologies at a country's early stage in development.[10]

The aims of this paper are twofold: to examine the railroad-growth relationship through the lens of startup firm activity; and to highlight the variable effect of railway access across industries and regions. The research design uses a newly developed firm-level dataset drawn from corporate genealogies and a difference-in-differences methodology that exploits the variation in the timing of railroad network expansion across Japan. The genealogies comprise one of the oldest sources of Japanese establishment data across the industrial spectrum, thus providing a more representative view of microeconomic activity than that based on government records and case studies of major firms.[11] The empirical analysis compares firm activity in regions before and after they gained railroad access while controlling for regions that did not experience a change to their transport technology. Furthermore, by including prefectural population as a measure of market size, one can separate the general effects of railroad expansion on firm activity from those due to agglomeration and provide a simple test of theoretical predictions from economic geography.

Results indicate that railway access had a small, but positive impact on entrepreneurship across prefectures in general; while point estimates differ depending on the specification, access corresponded with an increase of firm activity by at least three percent. Nevertheless, firm activity differed between industries following the arrival of the railroad, with manufacturing

[9] Krugman (1991a). Using Spanish industrialization as an example, Krugman (1991b) writes that depending on how much transport costs decrease, "over some range closer integration actually leads production to move perversely from the point of view of comparative cost" and he concludes that "railroads and steamships led to deindustrialization of the periphery" (pp. 97-98). This point has been refined more recently with the distinction of original (climate) and acquired (resource investment) features specific to locations; see Crafts and Wolf (2012).

[10] Present-day examples may include the expansion of high-speed rail and rollout of broadband internet access; see Crafts (2004).

[11] See Tang (2011) for an empirical analysis of technological leadership using firm genealogical data.

enterprises (in particular, textiles) increasing more rapidly as well as shifting toward more populated locations. This finding is consistent with the rationalization of capital-intensive production away from smaller markets given greater labor availability and lower transport costs. The documented role of low-value manufacturing to early Japanese industrialization suggests that this discrete change in firm activity represents a modest contribution of railroads to economic growth despite an uneven distribution of activity. Discussion of these findings and a number of important caveats to interpreting them follows in the final section of the paper.

## II. Background and motivation

Railroad construction in Japan began with the 29 kilometer stretch between Tokyo and its nearest deepsea port Yokohama. Two years later, in 1874, a similar length of track was laid between Osaka and the port city Kobe, approximately 500 kilometers to the west. While the government, which provided funding for these projects, anticipated that the two major cities of Tokyo and Osaka would be connected by rail in the near future, it was not until 1889 that the Tokaido route between them was finally completed.[12]

The delay owed chiefly to financing. Given the costs of the its modernization program, deteriorating balance of payments, pacifying restless samurai, and controlling inflation, the central government found it difficult to continue investing in railroad infrastructure.[13] It was not until the 1880s that network expansion began apace, during which the government allowed the private sector to enter the industry and lay its own tracks in local areas and other parts of the country not served by the public network, as shown in Table 1. Both public and private railroads expanded methodically, radiating away from Tokyo and Osaka toward the extremities of the main island of Honshu and connecting major cities in other prefectures, as shown in Figure 1. Short tracks were also laid on the islands of Hokkaido, Shikoku, and Kyushu, which tended to be privately-owned and resource extraction oriented.[14]

[Table 1 and Figure 1]

The motivations to build a national railway system were legion: for the government, better transport infrastructure meant centralization of political authority, national defense, and

[12] The Tokaido route was one of five major routes pre-dating the Meiji Period that were extensively used for long distance travel between the administrative (Tokyo) and commercial (Osaka) centers and outlying regions.
[13] Crawcour (1997), p. 59, and Aoki et al (2000), p. 11. See also Free (2008), chapter 6, and Ericson (1996), chapter 2, for greater discussion of the political and economic context of Meiji railway financing.
[14] Hokkaido and Kyushu were major coal producing regions, which attracted private investment in railway construction linked to the mining industry; Free (2008), pp. 28 and 398-399. Shikoku was relatively resource poor and had minimal railway development except around the two ports of Takamatsu and Tokushima (ibid, p. 28).

spreading economic growth to rural areas.[15] For the private sector, following fiscal retrenchment in the 1880s and interest rate guarantees, railways were also viewed as a profitable venture.[16] As railroad investments required larger sums than could be provided by any single private investor, these ventures also made active use of the newly established equity exchanges. To coordinate public objectives with private financing, the government issued a number of laws in the 1880s and 1890s that standardized railway construction as well as identified which government-planned lines could be bid on by private investors. Localities could also petition for amendments or extensions after 1892, when the Railway Construction Law was passed. Public-private collaboration continued until the nationalization of major trunk lines between 1906 and 1907, which left only urban tramlines and ancillary extensions in the hands of private investors.

That certain localities and sectors benefitted from railway access is readily documented, such as the silk producing area in central Nagano prefecture. Following the completion of the Shin'etsu railroad between northern Nagano and Tokyo-Yokohama in 1893, highly perishable raw silk could be carried to the closest train station 40 kilometers away instead of five times that distance to the capital. When the line was extended to the Suwa district itself, "production...increased dramatically and the coccoon collection area expanded" to cover most of sericultural area in central Japan.[17] Consumption of coal also grew with the national economy (and was used by the railroad industry itself), which largely relied on railroad or mixed rail-sea transport for distribution.[18] Countering these examples, however, is the iron and steel sector, which despite obvious industrial linkages to rail construction and transport arguably did not benefit from them over most of the Meiji Period. Only following government intervention did railroads contribute to the industry's growth, notably with the 1907 railway nationalization that guaranteed demand for domestically produced iron and steel.[19]

These industrial and prefectural differences relationship suggest a closer examination of the relationship between Japan's expanding rail system and economic activity. As shown in Figure 2, if one looks at period-wide trend rates of rail network length, national income, exports,

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[15] Aoki et al (2000), p. 15; Crawcour (1997), pp. 58-61.
[16] Ibid. These considerations notwithstanding, given the existence of coastal and riverine shipping, mountainous terrain, and a system of roads connecting the central cities to outer regions, it is possible that the spread of railroads did not represent a fundamental improvement in transportation access. Since the Tokugawa Period (1603-1868), rice and fish-meal fertilizer were shipped from the northern regions and Hokkaido to central Honshu; Aoki et al (2000), p. 5. Furthermore, hundreds of feudal nobility *daimyo* paid biennial visits to Tokyo as part of their *sankin kotai* obligations to the ruling shogunate, which promoted inter-regional transit and commerce.
[17] Aoki et al (2000), pp. 21-22, and Ericson (1996), p. 42-48.
[18] Ibid.
[19] Ibid., pp. 32 and 38.

and the number enterprises, it is difficult to discern similar patterns between rail expansion and the other indicators, especially given the former's discontinuous growth.[20]

[Figure 2]

Historical studies of Japanese railroads have typically eschewed statistical analysis, however, and few explicitly estimate the railway's impact on the economy.[21] This may owe to a lack of data from this period, appropriate methods to test hypotheses, or interest in visiting a topic considered already settled. Fortunately, there is an extensive literature available on this subject for other countries, and empirical studies suggest that the railroad usually had a positive effect on economic welfare (although whether the impact is sufficient to drive growth is still debated), as measured through cost savings, consumer surplus, urbanization, or agglomeration.[22] Many of these studies, especially those using the social savings approach, rely on counterfactuals to support the claim of welfare gains, which can pose an epistemological problem in identifying causality.[23]

Alternative methods have been used to demonstrate a link between railroads and growth. Donaldson (2010) uses a general equilibrium trade model and highly detailed region price data to estimate the direct impact of an expanding railway system on the colonial Indian economy. His approach allows him to calculate reductions in trade costs and regional price differences as well as gains in income, which he finds amounting to a 16 percent increase due to rail access, much higher than Fogel's estimate of 4.7 percent for the United States in 1890. Atack et al (2009), on the other hand, focus on population growth and urbanization as possible consequences of railroad development, and find evidence that railroads "caused" urbanization in the American Midwest. They do so using a novel GIS-augmented dataset and a difference-in-differences empirical model to compare pre- and post-access census years in affected counties against those that remained unaffected in the mid 1800s. In terms of research design, this paper is more similar to that of Atack et al, with the data and methodology described below.

[20] That said, the consequences of railroad construction may not behave in a monotonic or linear fashion. The trend for manufacturing output is highly similar to that for GDP, and is omitted from the figure for clarity.

[21] That said, these works provide a wealth of detail and historical context and are cited throughout this paper. There also may be studies written in Japanese that are not readily accessible or known to the author; if so, apologies.

[22] A survey of older literature on social savings can be found in O'Brien (1977), while a more recent discussion is Leunig (2010).

[23] Besides a number of assumptions about the elasticity of substitution, actual and opportunity costs, and pricing behavior, the use of an fabricated reality as a control group renders long term estimates more difficult to calculate reliably. Externalities and general equilibrium effects are separate and even less tractable issues.

III. Research design

This paper uses a new firm-level dataset collected from corporate genealogies and a difference-in-differences model to identify causality.[24] The genealogies are based on company histories of 1,089 firms listed on the Tokyo Stock Exchange in 1984 and contain establishment entries dating back to the nineteenth century or earlier. Besides dates of establishment and exit (or reorganization), each entry may also provide the type of ownership, an industry identifier, and the location of establishment (prefecture). To be able to compare across prefectures and between major industries during the Meiji Period, non Meiji-era startups and those without both these pieces of information are excluded; this decreases the number of establishments to 1,644. These remaining data cover all 47 prefectures and are disaggregated into four major industry categories: primary production and construction; manufacturing; finance; and other services. The three latter groups can be further classified into thirteen narrower categories, which are shown in Table 2 along with other summary statistics. The sector that had the largest relative change in startup activity following rail access was non-financial services, followed by manufacturing, while the greatest absolute increase occured in finance. However, because railroad expansion took place over a few decades, a simple difference between the two periods may be misleading.

[Table 2]

Before proceeding with statistical analysis of the data, it may be useful to assess their validity for use. From the table, it is readily apparent in this dataset that banking by far had the highest number of startups over the whole of the Meiji Period, followed by transport and communication, and then by textiles. The possible undercount of firms in the primary and non-finance tertiary sectors, which usually predominate in non-industrial economies, may owe to the composition of the corporate genealogies that they are drawn from (ie, large listed firms), and that both manufacturing and financial firms were better documented historically than those in other sectors, especially in other services.[25] Many individual genealogies for a given industry do, however, include antecedent firms in different sectors, which arguably reduces the bias from the industrial distribution of firms that were listed in 1984.

Even with possible representational bias between sectors in the firm sample, for this paper's analysis, more relevant is whether the within industry distribution is consistent over time and location. Unfortunately, there is little documentation of firms at the prefectural level prior to the 1900s for Japan as a whole, much less for individual sectors. Official

[24] Yagura and Ikushima (1986).
[25] Over half (627) of the genealogical collection are manufacturing firms, while financial companies number 131. As of March 2012, there are 1,684 firms listed in the first tier (ie, large capitalization) of the Tokyo Stock Exchange, of which 823 are classified as manufacturing; see Tokyo Stock Exchange (2012).

comprehensive statistics exist for banking at the prefectural level, but only starting in 1893, when considerable railroad expansion had already taken place.[26] To compensate for the first 25 years of the Meiji Period not covered by official statistics, this paper also uses banking establishment data from the Japanese Bankers Association (JBA) to construct a separate prefectural-level series that dates back to 1868.[27] These two series, the official statistics and the banking association data, can be used as a baseline reference against which the genealogical data are compared.

[Table 3]

Table 3 provides correlation results of the three banking series across all prefectures using annual bank establishment data. The correlation between the official statistics (GS series) and the banking association (JBA series) is 0.993 at 1 percent statistical significance for the years 1893 to 1912, which indicates virtual equivalence across time and location. For the same period, the GS series has a positive correlation coefficient of 0.828 with the genealogical data (Shuyo series), also at 1 percent significance. Using the entire Meiji Period (1868-1912), the correlation coefficient for the two JBA and Shuyo annual series is 0.875. Breaking down these two series by individual prefecture, the estimates show positive correlations exceeding 0.70 for all 47 prefectures at the 1 percent level, with 41 prefectures have correlations exceeding 0.90.[28] As further illustration, Figures 3 and 4 show the share of banks by prefecture from each of the three series in the years 1893 and 1912. The similarity of bank establishment counts among the three series over time and across prefectures indicates reasonable confidence that the genealogical firm data in the banking sector is representative of Japanese banking as a whole. The analysis of the paper in turn assumes similar representativeness for the other sectors.

[Figure 3 and 4]

The genealogical data are aggregated by year, prefecture, and major industry to create a balanced panel dataset that covers the entire Meiji Period, between 1868 and 1912. They are also combined with railway data from the *Ekimei Jiten* [Rail Stations in Japan] handbook, published by Chuo Shoin. The handbook provides a comprehensive list of all rail stations established in the country, their founding dates, locations by city and prefecture, and other identifying information. The earliest year of station establishment in each prefecture is used to

[26] Japan Ministry of Finance (various).
[27] Japanese Bankers Association (2012).
[28] Estimates with Bonferroni and Sidak adjustments do not change the significance levels. The six prefectures with correlation coefficients less than 0.90 are Kumamoto, Miyazaki, Okinawa, Shiga, Tokushima, and Tottori.

determine access, and is verified with secondary sources.[29] Other data come from the *Historical Statistics of Japan*, published by the Japan Statistical Association, which provide prefecture level data on population and geography. Note that since prefectural population data were collected of a five-yearly basis starting in 1884 until 1920, data for intervening years are estimated using the arithmetic trend between each five year period.

For the empirical analysis, the paper employs a difference-in-differences methodology, comparing the number of startup firms in each prefecture before and after it gains access to railroads.[30] In line with predictions from economic geography and transaction cost literature, the rationale is that railroad access is a discrete change that increases factor mobility through lower transportation costs and wider market access, so firm activity would corresponding increase to take advantage of these improvements. At the same time, it is anticipated that activity would vary based on extant conditions like pre-access market size, leading to agglomeration in larger markets and dispersion in smaller ones. As a point of reference, prefectures that gain access are compared to others that did not experience a contemporaneous change to their railroad infrastructure. The reduced form OLS model follows, with separate regressions for each industry group:

$$y_{it} = \beta_0 + \beta_1 \cdot x_{1it} + \beta_2 \cdot x_{2i} + \beta_3 \cdot x_{3t} + \beta_4 \cdot x_{4it} + \varepsilon_{it}, \text{ where}$$

$y_{it}$ = number of firms for prefecture $i$ in year $t$

$x_{1it}$ = rail access dummy variable for prefecture $i$ in year $t$

$x_{2i}$ = prefecture fixed effect

$x_{3t}$ = year fixed effect

$x_{4it}$ = other control variables for prefecture $i$ in year $t$

$\varepsilon_{it}$ = error term

To measure the effect on firm activity, the dependent variable $y_{it}$ is the total annual number of enterprises in each of the prefectures, indexed by $i$. This number is a net firm count includes both new Meiji-era startup establishments in the prefecture and those that continue their operations; those that changed location or discontinued activity are excluded. The main control variable of interest is the term $x_{1it}$, which takes the value of zero for all years prior to rail access in prefecture $i$ and the value of one in post-access years. Additional control variables include prefectural population and fixed effects for prefecture and year. Prefectural population can be interpreted as a proxy for local market demand and agglomeration potential. One drawback to including this variable is that it reduces the number of years available for analysis as prefectural population data are unavailable prior to 1883, since eleven prefectures gained

[29] These include Aoki et al (2000), Ericson (1996) and Free (2008).
[30] Card and Krueger (1994) is a well known study using this methodology, and Atack et al (2009) apply it to their study on nineteenth century American railroads.

access prior to 1884.[31] Furthermore, three prefectures gained access after the Meiji Period, and are also excluded from analysis as the genealogical data are collected up to 1912. This reduces the number of prefectures available for analysis to 33.

For a causal interpretation of estimates based on the difference-in-differences methodology, two conditions should be observed. The first is in the choice of control group (ie, prefectures that did not gain railroad access) and whether it is sufficiently similar to the treatment group in aspects aside from the treatment itself. Since most prefectures gained rail access during the Meiji Period, this suggests that there were no characteristics that predisposed them against rail development.[32] Moreover, outliers in access timing, such as prefectures that gained access earliest (eg, Tokyo, Osaka) and latest (eg, Okinawa), are also excluded from the analysis for the abovementioned reasons. This allows for division of the prefectures into control and treatment groups based on year of access and other time-invariant features. Table 4 provides the list of prefectures, their dates of railroad access, and other characeteristics.

[Table 4]

One approach is to divide the prefectures into two numerically similar groups, excluding those that gained access prior to 1884 and those after 1912. Using the year 1893 to separate the two groups, this gives a treatment group of 18 prefectures that gained access between 1884 and 1893, and a control group of 15 prefectures that gained access between 1894 and 1912.[33] Analysis of these two groups is based on changes in firm activity between 1883 and 1893. These groups are shown on the map of Japan in Figure 5 along with those excluded from analysis.

[Figure 5]

The second condition for a causal interpretation is that the decision to extend the railway network itself is not itself determined by the measured outcome of firm establishment. In other words, entrepreneurs intending to establish firms or maintain operations should not influence the decision to expand rail access to a particular location. This appears to be valid since the

[31] These prefectures include Tokyo, Kanagawa, Hyogo, Osaka, Kyoto, Hokkaido, Shiga, Fukui, Saitama, Gunma, and Gifu. Note that prefectures gaining access in 1883 also not included as they would appear to have been treated for the entire period starting that year.
[32] This may not have been true for three prefectures that gained railroad access after the Meiji Period: Ehime (1914), Kochi (1924), and Okinawa (2003). These prefectures are also off the main island of Honshu, where most commercial activity took place and government policy was focused.
[33] The eighteen prefectures in the treatment group include Aichi, Aomori, Ibaraki, Fukuoka, Fukushima, Hiroshima, Iwate, Kagawa, Kumamoto, Mie, Miyagi, Nagano, Nara, Niigata, , Okayama, Saga, Shizuoka, and Tochigi. The fifteen prefectures in the control group include Akita, Chiba, Ishikawa, Kagoshima, Miyazaki, Nagasaki, Oita, Shimane, Tokushima, Tottori, Toyama, Wakayama, Yamagata, Yamaguchi, and Yamanashi.

government's initial objective to railroad expansion at the start of the Meiji Period was for national security and resource access, not commercial development.[34] Extensions of the railway system north and west in Honshu were meant to (and did) facilitate troop movements and securing the Pacific coastline.[35] Moreover, local and commercial lobbying for the placement of railroad track was also not observed prior to the creation of the national parliament in 1890 and the aforementioned passage of the 1892 Railway Construction law, which presented the government's vision of a national railway system and proposed lines identified for private investment.[36]

To address concerns about control group selection and endogeneity, additional specifications exclude prefectures that have correlation coefficients less than 0.90 in the banking series comparison; those that are landlocked or have large coastlines (over 1,000 kilometers); and those potentially affected by legal changes that could allow for investor interference in policymaking. Also, instead of numerically similar sized groups, the similar average surface area (approximately 7,000 square kilometers) was used to determine group membership. Based on this criterion, which arguably is an exogenous factor that influence the timing of railroad construction but not firm activity or local market size per se, selects the threshold year 1898, resulting in new treatment and control groups of 25 and 8 prefectures, respectively.

## IV. Results

The main regression results from the difference-in-differences analysis are presented in Tables 5 and 6, the former comparing estimates of firm activity aggregated across all sectors and the latter by major industry group. In Table 5, columns A through C include all prefectures that gained access to railroads between the years 1883 and 1912, and indicate that rail access is associated with an average prefectural increase of between four (column A) and nine firms (columns B and C) per year.[37] These estimates, however, do not identify rail access as a causal factor and may obtain from a general increase in economic activity and population since all prefectures gained access over the period. When the period of analysis is shortened to create a

[34] The disinterest in (or ignorance of) commercial viability is highlighted by the lack of cost-revenue analysis made by the government in its early railway ventures and the large cost overruns in the first railroad between Tokyo and Yokohama (Free, 2008, p. 55).
[35] This was true even in the late Tokugawa Period, with proposals to build a railroad from Osaka to the then imperial capital Kyoto so as to "speed troops from the Choshu and Satsuma domains in the south [via steamer to Osaka] in the event of an emergency to `defend' the Emperor from colonizing foreigners" (Free, 2008, p. 29).
[36] "[I]n railroad policy, government bureaucrats essentially had the field to themselves and were able to make decisions independently of private business, which had yet to organize politically or to secure formal representation in the national government" (Ericson, 1996, p. 16). See also Free (2008), p. 21.
[37] This is calculated using statistically significant coefficients and the average prefectural population of 910,851 between 1883 and 1912. For the years 1883 through 1893, the mean population is 836,875.

control group (columns D through F), the net increase in the number of firms following rail access is much more modest, from 3.97 (column D) to 0.14 (column F). Given the average number of firms by prefecture without rail access for this period is 3.77, the lower bound for a net increase in activity due to rail access is approximately 3.7 percent.

[Tables 5 and 6]

This overall positive effect notwithstanding, when population is interacted with rail access (column F), the individual effect of rail access (row 1) is negative and statistically significant while the estimated coefficient on the interaction is positive (row 3). This indicates a decrease in firm activity in prefectures with less than 800,000 inhabitants, which is true for seven of the eighteen prefectures in the treatment group for all years between 1883 and 1893.[38] For these least populated areas, which averaged two firms per year over the period, the annual net loss of 0.65 firms represents nearly a 32 percent fall in firm activity.

The results in Table 6 disaggregate firm activity by industry, and show that the change in firm activity is almost wholly manifest in the manufacturing sector (column B), particularly in textiles (column E). All else equal, manufacturing each year (row) in treatment prefectures increased by 0.22 firms after accounting for population, which represents a 31 percent increase in activity following rail access. In textiles, the population-adjusted increase is 0.13 firms per annum, which is a rise in activity of over 72 percent.

To check the robustness of these estimates, a number of different specifications are used and shown in Tables 7 through 10. The first check limits analysis to prefectures that had correlation coefficients exceeding 0.90 when comparing the genealogical bank series against the banking association series. Consistent with the earlier estimates, the population-adjusted increase in firm activity across all sectors (column A) is 0.23, which is an increase of nearly 5 percent.[39] Again, the effect is concentrated in manufacturing (textiles), which experienced a rise in firm activity of nearly 37 percent (52 percent), while financial sector firms decreased by nearly a quarter compared to their pre-access levels (although this estimate is only slightly significant).

[Table 7]

To improve the correspondence between prefectures in both control and treatment groups, those that were landlocked or had coastlines exceeding 1,000 kilometers are excluded

[38] These seven prefectures are Aomori, Kagawa, Iwate, Miyagi, Nara, Saga, and Tochigi, each averaging 610,783 in population over this period.
[39] The average population of prefectures for robustness specifications between 1883 and 1896 is: 865,874 (Table 7); 835,457 (Table 8); 832,576 (Table 9); and 854,505 (Table 10).

from the estimates reported in Table 8.[40] As before, the general effect of rail access is negative and the interaction with population is positive, but the cumulative impact is no longer positive. That is, population-adjusted firm activity across all sectors (column A) appears to have decreased by 0.6 percent following rail access. This may owe to the decrease in firm activity in non-financial services (column E) following rail access. The population-adjusted decrease is 0.1 firms per annum, which represents a three-quarter contraction compared to pre-access years. In contrast, estimates for manufacturing (textiles) still show a net positive impact from rail access, increasing by nearly 20 percent (60 percent).

[Table 8]

The issue of possible endogeneity of rail access with firm activity may be partly addressed by limiting treated prefectures to those that gained access prior to two major legal changes, the 1890 Diet and 1892 Railway Acts.[41] These laws established a (restricted) representative legislature and provisions to bid for specific extensions of the national railway network, respectively, and thus could have been used by entrepreneurs planning operations in affected areas. Estimates in Table 9 exclude the seven prefectures that gained access on or after 1890 from the treatment group, and show that rail access still lead to a net increase in firm activity after adjusting for population: 0.26 firms (6 percent) across all sectors, 0.13 firms (18 percent) in manufacturing, and 0.12 firms (48 percent) in textiles. Services, however, saw a decrease in firm activity of 0.04 (29 percent).

[Table 9]

Lastly, instead of using designating treatment and control prefectures by similar group numbers, one can use similar land surface area to improve identification, especially if geographic factors like surface area are relevant to railroad construction and timing. Thus, new treatment and control groups were chosen based on comparable average size as determined by the threshold year, in this case 1898, with the years of analysis commensurately expanded to that year.[42] The results indicate that as before firm activity increased across all sectors after adjusting for population, with a change of 0.79 firms (14 percent) per annum. In manufacturing, the increase is 0.24 (25 percent), while in textiles it is 0.27 (57 percent); at the same time, firm

[40] The excluded prefectures are Hiroshima, Kagoshima, Kumamoto, Mie, Nagano, Nagasaki, Nara, Tochigi, Yamaguchi, and Yamanashi.
[41] The excluded prefectures are Aomori, Hiroshima, Iwate, Kumamoto, Mie, Nara, and Okayama.
[42] Control group prefectures average 7,068 square kilometers, while treatment group prefectures average 6,948 square kilometers. The prefectures of Akita, Ishikawa, Nagasaki, Oita, Toyama, and Yamaguchi now are classified in the treatment group instead of the control group.

activity in non-financial services show a decrease of 0.09, or 46 percent.

[Table 10]

## V. Conclusion and discussion

The findings from the difference-in-differences analysis suggest that rail access has a positive impact on firm activity for the economy in general, although there are notable differences between prefectures and industries. Manufacturing, unlike other sectors, has increased startups following access, even after adjusting for prefectural population. Nevertheless, the opposing signs on rail access and its interaction with population suggests that industrial agglomeration, as measured in the number of firms, took place as a response to the railroad and came at the expense of less populated areas.

There are a number of caveats to taking these results at face value, however. The first relates to the dataset, which despite having a larger number of historically undocumented firms than existing sources, still is small for more precise estimates. The 1,644 startup firms in the dataset only include firms that started up during the Meiji Period, and thus ignores the contribution of those existing prior to 1868. Furthermore, more than 900 additional firms were excluded from the analysis as they either had no industry or location identifiers. Considering that the prefectures with the most economic activity, Tokyo and Osaka, were also excluded given their early acquisition of railroads, also diminishes the generalizability of the results to the economy in absolute measure. As a whole, while the qualitative results are illustrative, the relatively small sample and numerous exclusions warrant caution in relying on the coefficient estimates to measure changes in firm activity precisely.

The issue of data selection aside, the findings of increased firm activity, particularly in manufacturing, and of agglomeration are perhaps not obvious given features of the Meiji Japanese economy and existing infrastructure.[43] While entrepreneurs may have started and continued operations as a result of improved transport links and wider markets, it can be argued that extensive measures of firm activity are not representative of higher capital intensity and within-firm scale expansion. Using firm counts that account for firm entry and exit may not wholly address this concern.

Furthermore, dispersive forces seem as likely to operate since entrepreneurs may not be able to fully capitalize on improved transportation infrastructure for industrial production. Contributing factors include private monopolies of regional track and the precedence of

[43] That said, research on early twentieth century Japanese factory location suggests that agglomeration took place due to inter-industry linkages and demand for consumption goods; see Imaizumi (2008). These data, however, postdate most of the railway expansion era, so do not directly implicate railroad access itself as a determining factor, although changes in rail freight may have been influential.

passenger over freight traffic, which led to excess demand for freight services.[44] A consequence of this meant that railways were not obliged to provide discounts for bulk shipping, and thus reduced the incentive to produce more than what was locally demanded, which is one of the qualifications of the Krugman model.[45] The availability of coastal freight, which was extensively used prior and throughout Japan's industrialization, may weaken the relevance of newer forms of freight transport.[46] This ranking of traffic preferences could be seen in the revenues earned by private railways, where earnings from passengers exceeded those of freight for every year since 1890 until their nationalization in 1906-07.[47] Thus, a general equilibrium model that accounts for some of these features may provide clearer predictions for this setting.

In terms of economic significance, the difference-in-differences methodology using startup establishment has the advantages of clear explication and direct measurement of industrial activity. This approach also allows analysis that does not require price and output data, which are difficult to find at the subnational level. Taking the next step of measuring welfare impact, however, is less tractable without more detailed data. While some scholarship directly link between entrepreneurship and economic growth, the findings in this paper are only suggestive.[48] In contrast, since studies using the social savings approach incorporate price information, estimates of welfare gains for the economy as a whole can be obtained. If disaggregated price data can be found prior to and following rail access, it may be possible to apply the same difference-on-difference approach but also measure welfare improvement.

With these caveats in mind, the empirical results from the current analysis are still suggestive in qualifying received wisdom about the impact of railways on Meiji Japanese industrialization. While the aims of the government and industrialists may not have been necessarily aligned in motivating the expansion of the railroad network, the utility of such infrastructure for both strategic and economic objectives became increasingly obvious, leading to the nationalization of the network toward the end of the Meiji Period.

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[44] Nagao (1929), pp. 18-19.

[45] Free (2008) writes: "[s]uch was the excess demand for railway shipment of goods that when one particular shipper asked for a discount from the [privately-owned] Nippon Tetsudo, the general manager would not allow for any discount at all if the shipper shipped 10,000 tons of freight or 100,000 tons. Freight hauling concerns took second priority to passenger traffic for almost the entire Meiji era" (p. 187). Krugman (1991a) states that a combination of lower transport costs, scale economies, and greater demand for manufacturing would lead to agglomeration. However, even with falling transport costs, it may be that local characteristics still prevail in determining industrial location; see Crafts and Mulatu (2006).

[46] Nagao (1929) writes that the inversion of the passenger-freight revenue ratio compared to other countries "is partly due to the circumstance that Japan, being surrounded by seas, can avail herself more readily of the facilities of maritime transportation" (p. 9). At the same time, rail freight could have positive feedback on sea freight, and thus act as complements instead of substitutes.

[47] Japan Statistical Association (2007), series 8-20.

[48] See for example Gries and Naudé (2008) and Dejardin (2000).

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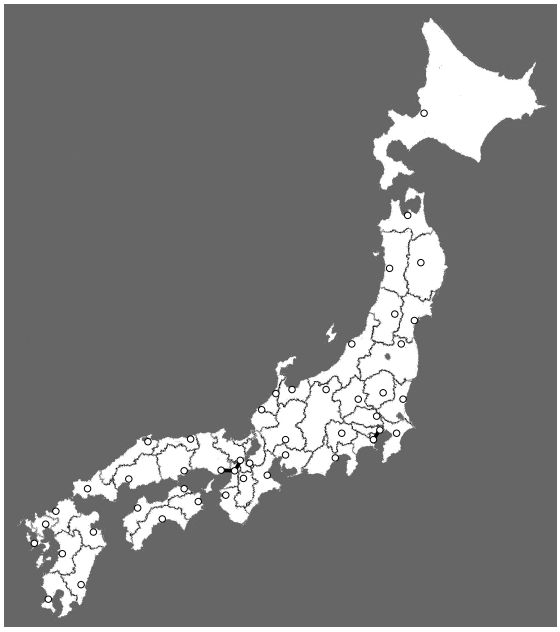
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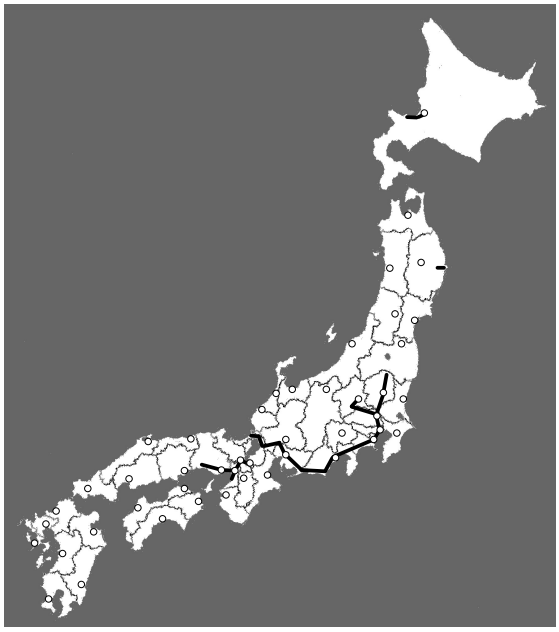
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**Figure 1: Japanese rail network expansion**

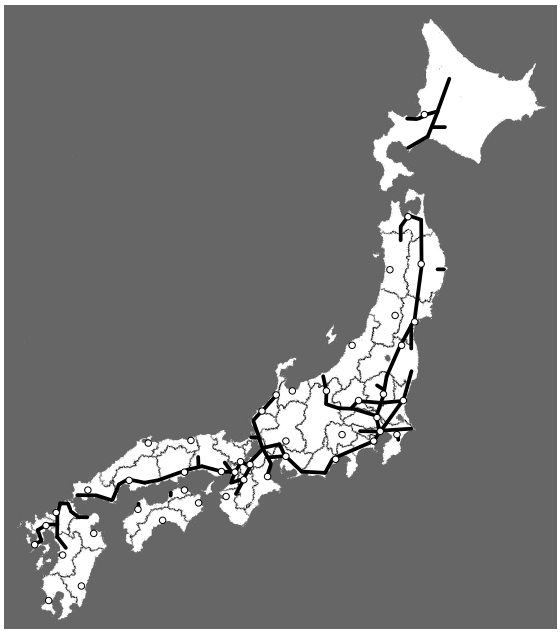
1877



1887



1897

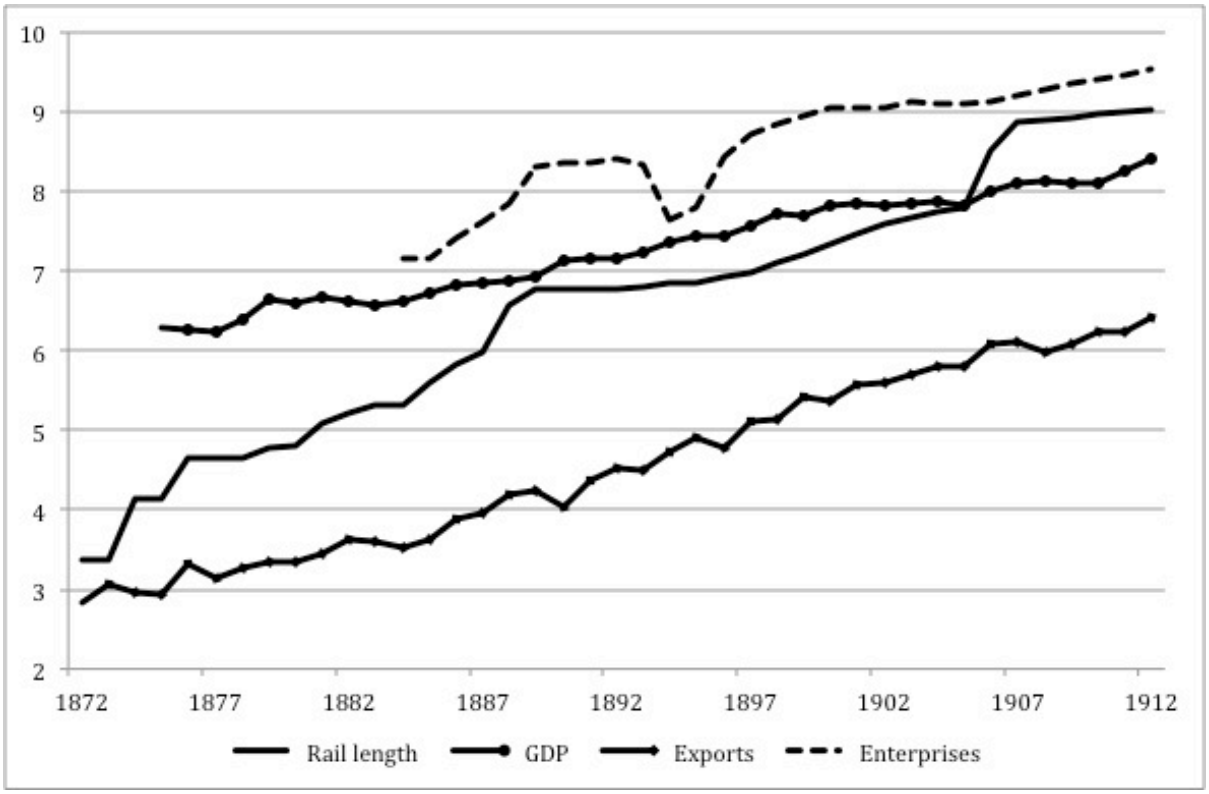


1907



Source: see text.

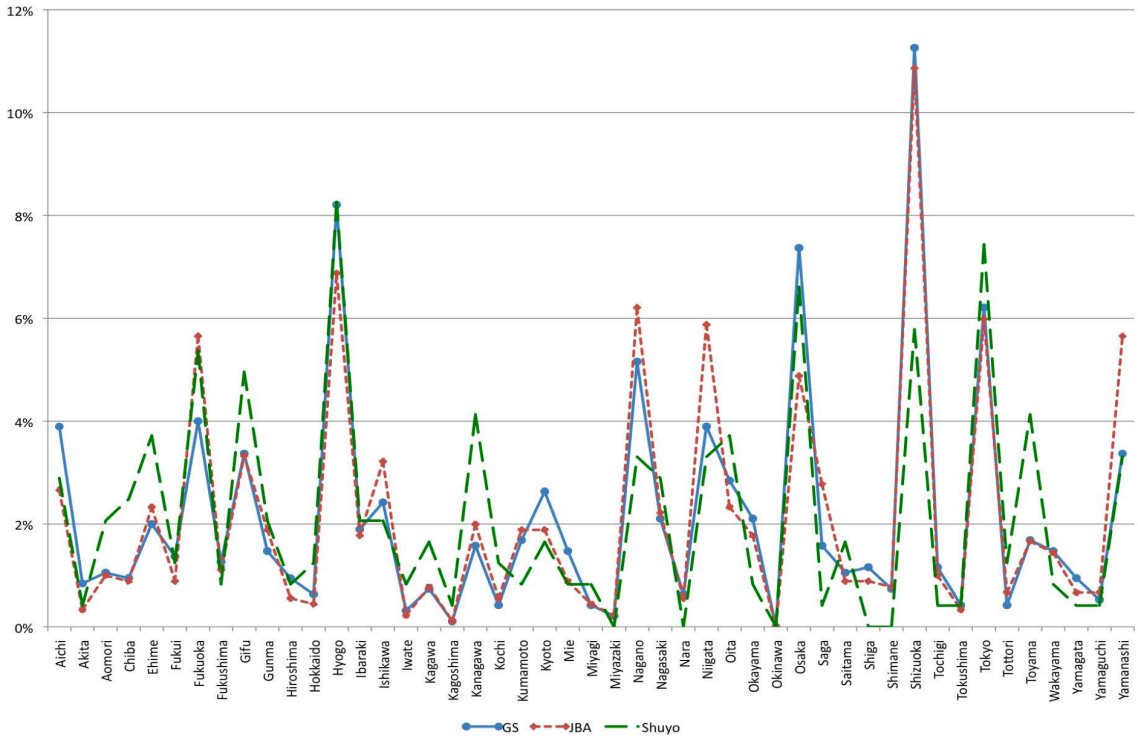
**Figure 2: Meiji-era trends of economic indicators**




Source: Japan Statistical Association (2007), series 8-4, 10-1, 13-3, and 15-5.

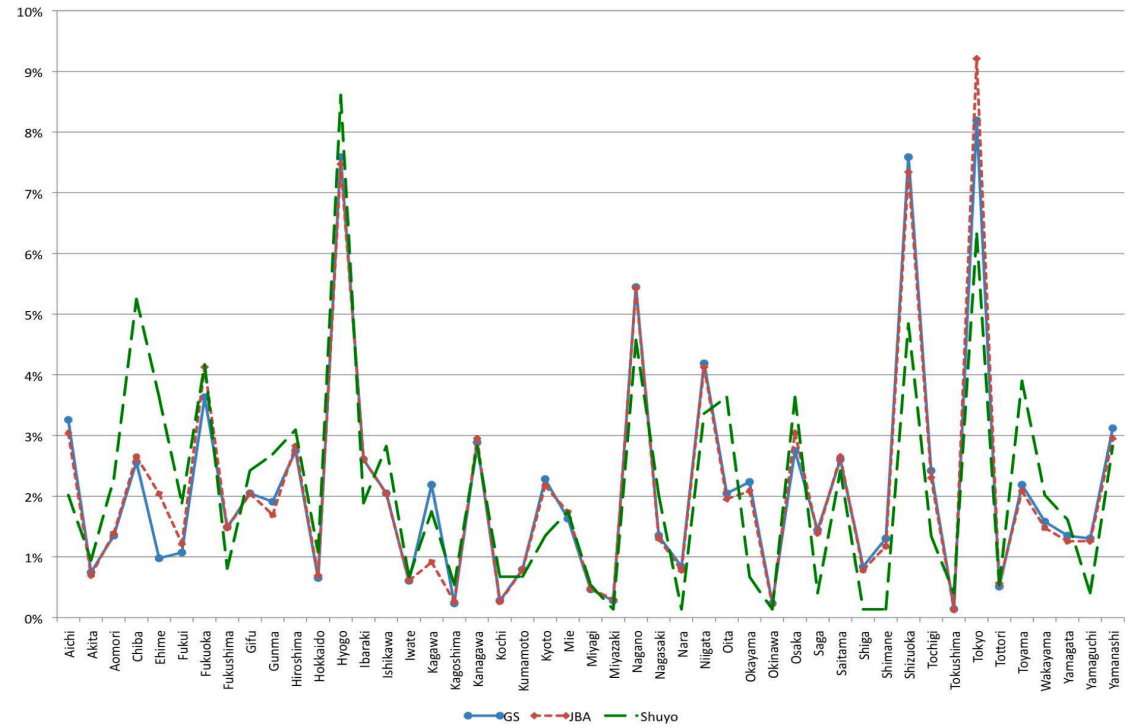
Note: values reported in logs with the following units: rail length (kilometers), GDP and exports (millions of yen, current value), and enterprises (total).

**Figure 3: Bank series comparison, 1893 prefecture share**



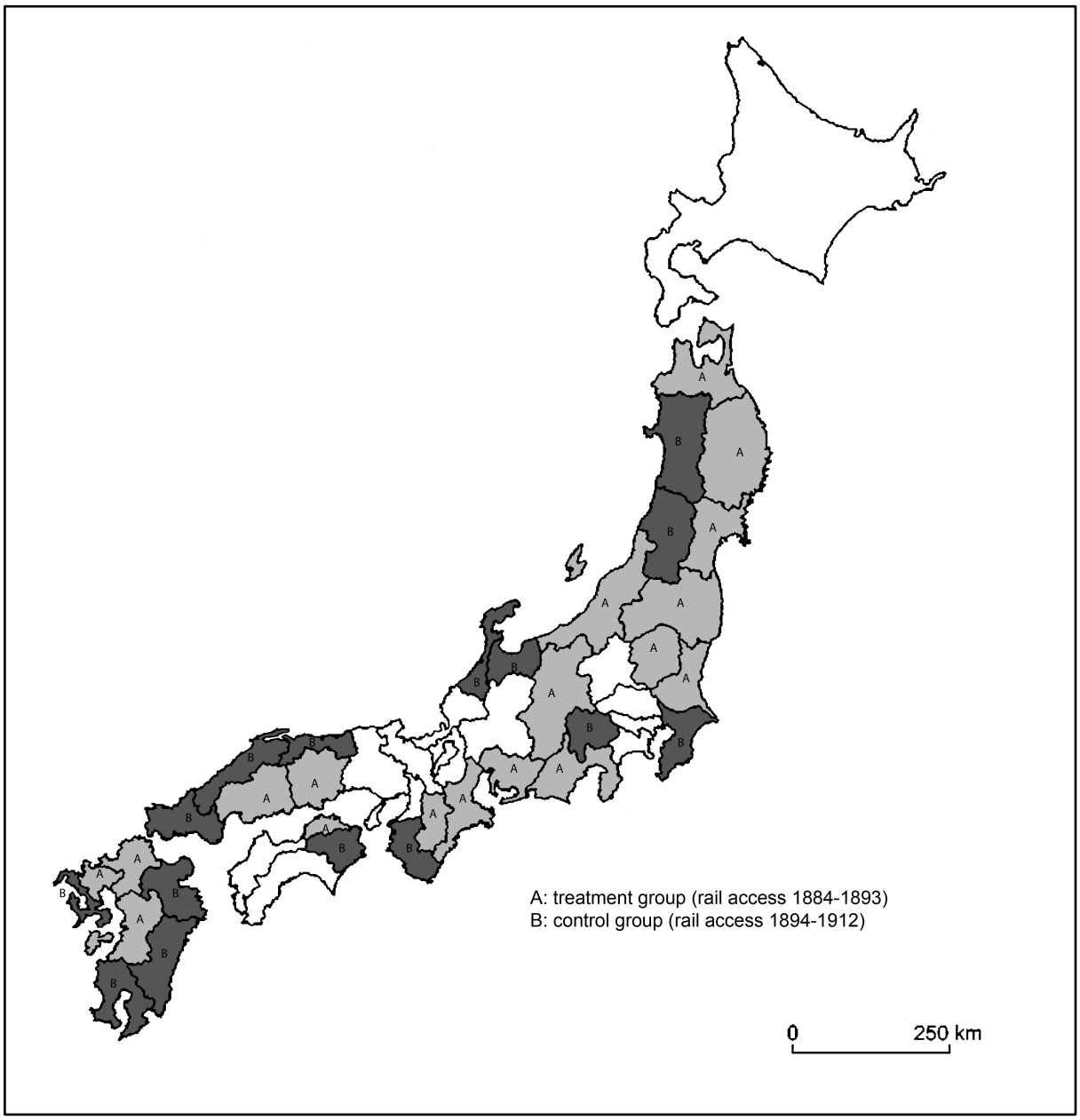

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**Figure 4: Bank series comparison, 1912 prefecture share**




Source: see text

**Figure 5: Difference-in-differences groups**




Source: see text.

**Table 1: Length of Japanese rail network, kilometers**

| Year | Public | Private[a] | Total |
|---|---|---|---|
| 1872 | 29 | 0 | 29 |
| 1877 | 105 | 0 | 105 |
| 1882 | 185 | 0 | 185 |
| 1887 | 393 | 472 | 865 |
| 1892 | 886 | 2,125 | 3,011 |
| 1897 | 1,065 | 3,681 | 4,746 |
| 1902 | 1,974 | 5,398 | 7,372 |
| 1907 | 7,152 | 1,568 | 8,720 |
| 1912 | 8,396 | 2,988 | 11,384 |

Source: Japan Statistical Association (2007), series 8-4 and 8-14.
[a] includes long-distance and local rail/tram networks

**Table 2: Descriptive statistics**

| | Total | Pre-rail access | Post-rail access |
|---|---|---|---|
| Number of startups | **1,644** | **339** | **1,305** |
| Primary production | **65** | **14** | **51** |
| Manufacturing | **462** | **60** | **402** |
| Ceramic, glass | 32 | 5 | 27 |
| Chemicals | 80 | 1 | 79 |
| Food processing | 53 | 11 | 42 |
| Machinery | 70 | 8 | 62 |
| Metal processing | 41 | 3 | 38 |
| Textiles | 142 | 25 | 117 |
| Wood processing | 42 | 7 | 35 |
| Other manufacturing | 2 | 0 | 2 |
| Finance | **870** | **250** | **620** |
| Banking | 757 | 213 | 544 |
| Other finance | 113 | 37 | 76 |
| Services | **247** | **15** | **232** |
| Retail | 64 | 7 | 57 |
| Transport and utilities | 171 | 6 | 165 |
| Other services | 12 | 2 | 10 |

Source: see text.

**Table 3: Banking series correlations**

| | GS series, 1893-1912 | JBA series, 1893-1912 | JBA series, 1868-1912 |
|---|---|---|---|
| JBA series, 1893-1912 | 0.993 (940) | 1.000 | |
| Shuyo series, 1893-1912 | 0.828 (940) | 0.831 (940) | |
| Shuyo series, 1868-1912 | | | 0.875 (2,115) |

Source: see text.
Note: all correlation coefficients are statistically significant at the 1 percent level. Number of observations in parentheses.

**Table 4: Prefecture statistics**

| | Rail access year | Population (1912) | Coastline (km) | Surface area (km$^2$) |
|---|---|---|---|---|
| **Japan** | | **52,193,100** | **33,889** | **381,808** |
| Aichi | 1886 | 1,927,300 | 548 | 5,055 |
| Akita | 1899 | 909,000 | 304 | 11,724 |
| Aomori | 1891 | 737,540 | 744 | 9,631 |
| Chiba | 1894 | 1,356,360 | 535 | 5,079 |
| Ehime | 1914 | 1,079,340 | 1,533 | 5,699 |
| Fukui | 1882 | 632,100 | 397 | 4,018 |
| Fukuoka | 1889 | 1,773,640 | 589 | 4,940 |
| Fukushima | 1887 | 1,245,140 | 191 | 13,782 |
| Gifu | 1883 | 1,051,020 | 0 | 10,462 |
| Gunma | 1883 | 968,940 | 0 | 6,315 |
| Hiroshima | 1891 | 1,606,380 | 1,113 | 8,437 |
| Hokkaido | 1880 | 1,584,560 | 4,377 | 88,454 |
| Hyogo | 1874 | 2,017,000 | 783 | 8,427 |
| Ibaraki | 1885 | 1,275,280 | 186 | 6,100 |
| Ishikawa | 1897 | 773,920 | 581 | 4,198 |
| Iwate | 1890 | 814,160 | 661 | 15,235 |
| Kagawa | 1889 | 736,180 | 694 | 1,845 |
| Kagoshima | 1900 | 1,344,180 | 2,722 | 9,081 |
| Kanagawa | 1872 | 1,134,500 | 400 | 2,352 |
| Kochi | 1924 | 681,720 | 691 | 7,088 |
| Kumamoto | 1891 | 1,264,260 | 1,068 | 7,438 |
| Kyoto | 1876 | 1,198,120 | 310 | 4,559 |
| Mie | 1890 | 1,068,560 | 1,105 | 5,702 |
| Miyagi | 1887 | 900,980 | 846 | 7,287 |
| Miyazaki | 1911 | 574,200 | 445 | 7,738 |
| Nagano | 1888 | 1,429,320 | 0 | 13,557 |
| Nagasaki | 1897 | 1,075,860 | 4,137 | 4,116 |
| Nara | 1890 | 573,880 | 0 | 3,730 |
| Niigata | 1886 | 1,855,180 | 585 | 12,579 |
| Oita | 1897 | 890,920 | 725 | 6,225 |
| Okayama | 1890 | 1,222,300 | 539 | 7,019 |
| Okinawa | 2003 | 524,160 | 1,652 | 2,387 |
| Osaka | 1874 | 2,130,200 | 223 | 1,814 |
| Saga | 1889 | 673,020 | 357 | 2,444 |
| Saitama | 1883 | 1,289,660 | 0 | 3,804 |
| Shiga | 1880 | 668,440 | 0 | 4,051 |
| Shimane | 1908 | 745,000 | 814 | 6,618 |
| Shizuoka | 1888 | 1,434,060 | 514 | 7,770 |
| Tochigi | 1885 | 981900 | 0 | 6,448 |
| Tokushima | 1899 | 719,520 | 363 | 4,135 |
| Tokyo | 1872 | 2,783,960 | 760 | 2,142 |
| Tottori | 1902 | 449,420 | 144 | 3,489 |
| Toyama | 1897 | 777,020 | 117 | 4,257 |
| Wakayama | 1898 | 746,240 | 628 | 4,733 |
| Yamagata | 1901 | 578,560 | 0 | 4,455 |
| Yamaguchi | 1899 | 938,980 | 110 | 9,306 |
| Yamanashi | 1897 | 1,051,120 | 1,398 | 6,082 |

Source: see text.

**Table 5: Difference-in-differences results, all industries**

| DV: Number of firms, prefecture-year panel | [A] | [B] | [C] | [D] | [E] | [F] |
|---|---|---|---|---|---|---|
| Rail access | 1.170 | 1.901* | -5.757 | 0.442 | 0.258 | -2.773** |
| | (0.966) | (0.948) | (3.843) | (0.484) | (0.366) | (1.080) |
| Population (100,000) | | 3.160** | 1.405 | | 1.259 | 0.236 |
| | | (1.245) | (1.533) | | (1.212) | (1.042) |
| Rail x Population | | | 0.920* | | | 0.348** |
| | | | (0.476) | | | (0.142) |
| Constant | 3.909*** | -21.240** | -3.415 | 3.970*** | -6.076 | 2.091 |
| | (0.797) | (10.071) | (15.289) | (0.170) | (9.721) | (8.321) |
| Control/treatment | n/a | n/a | n/a | 15/18 | 15/18 | 15/18 |
| Year coverage | 1883-1912 | 1883-1912 | 1883-1912 | 1883-1893 | 1883-1893 | 1883-1893 |
| Observations | 990 | 990 | 990 | 363 | 363 | 363 |
| $R^2$ | 0.579 | 0.633 | 0.653 | 0.181 | 0.199 | 0.276 |

Source: see text.
Significance levels: *10%, **5%, ***1%
Note: all specifications include prefecture and year fixed effects. Robust standard errors are clustered by prefecture.

**Table 6: Difference-in-differences results, major industry groups**

| DV: Number of firms, prefecture-year panel | [A] Primary | [B] Manufacturing | [C] Finance | [D] Services | [E] Mfg-Textiles | [F] Fin-Banking | [G] Ser-Transport |
|---|---|---|---|---|---|---|---|
| Rail access | -0.126 | -1.434*** | -0.936 | -0.277* | -1.023*** | -0.311 | -0.084 |
| | (0.338) | (0.383) | (0.560) | (0.162) | (0.330) | (0.554) | (0.078) |
| Population (100,000) | -0.082 | 0.170 | -0.004 | 0.150 | -0.178 | 0.199 | -0.150 |
| | (0.253) | (0.479) | (0.634) | (0.219) | (0.353) | (0.526) | (0.146) |
| Rail x Population | 0.032 | 0.198*** | 0.093 | 0.026 | 0.137*** | 0.029 | 0.006 |
| | (0.046) | (0.048) | (0.070) | (0.016) | (0.042) | (0.068) | (0.007) |
| Constant | 0.893 | -0.784 | 3.089 | -1.107 | 1.664 | 0.901 | 1.193 |
| | (2.030) | (3.810) | (5.074) | (1.742) | (2.785) | (4.233) | (1.148) |
| Control/treatment | 15/18 | 15/18 | 15/18 | 15/18 | 15/18 | 15/18 | 15/18 |
| Year coverage | 1883-1893 | 1883-1893 | 1883-1893 | 1883-1893 | 1883-1893 | 1883-1893 | 1883-1893 |
| Observations | 363 | 363 | 363 | 363 | 363 | 363 | 363 |
| $R^2$ | 0.132 | 0.305 | 0.115 | 0.085 | 0.256 | 0.157 | 0.083 |

Source: see text.
Significance levels: *10%, **5%, ***1%
Note: all specifications include prefecture and year fixed effects. Robust standard errors are clustered by prefecture.

**Table 7: Difference-in-differences robustness check, JBA correlation**

| DV: Number of firms, prefecture-year panel | [A] All sectors | [B] Primary | [C] Manufacturing | [D] Finance | [E] Services | [F] Mfg-Textiles |
|---|---|---|---|---|---|---|
| Rail access | -3.015** | -0.168 | -1.502*** | -1.045* | -0.299 | -1.077*** |
| | (1.120) | (0.348) | (0.395) | (0.589) | (0.181) | (0.347) |
| Population (100,000) | -0.129 | -0.141 | 0.078 | -0.185 | 0.120 | -0.264 |
| | (1.150) | (0.275) | (0.545) | (0.696) | (0.251) | (0.419) |
| Rail x Population | 0.375** | 0.038 | 0.208*** | 0.102 | 0.028 | 0.144*** |
| | (0.148) | (0.048) | (0.049) | (0.075) | (0.018) | (0.044) |
| Constant | 5.408 | 1.443 | 0.015 | 4.836 | -0.886 | 2.451 |
| | (9.487) | (2.285) | (4.476) | (5.759) | (2.064) | (3.421) |
| Control/treatment | 12/17 | 12/17 | 12/17 | 12/17 | 12/17 | 12/17 |
| Year coverage | 1883-1893 | 1883-1893 | 1883-1893 | 1883-1893 | 1883-1893 | 1883-1893 |
| Observations | 319 | 319 | 319 | 319 | 319 | 319 |
| $R^2$ | 0.291 | 0.145 | 0.314 | 0.125 | 0.091 | 0.262 |

Source: see text.
Significance levels: *10%, **5%, ***1%
Note: all specifications include prefecture and year fixed effects. Robust standard errors are clustered by prefecture. Prefectures from the control and treatment groups are limited to those with correlation coefficients exceeding 0.90 based on the Japanese Bankers Association series; see text.

**Table 8: Difference-in-differences robustness check, coastline restriction**

| DV: Number of firms, prefecture-year panel | [A] All sectors | [B] Primary | [C] Manufacturing | [D] Finance | [E] Services | [F] Mfg-Textiles |
|---|---|---|---|---|---|---|
| Rail access | -4.313** | -0.484 | -1.806*** | -1.428 | -0.594*** | -1.294*** |
| | (1.567) | (0.506) | (0.486) | (0.881) | (0.188) | (0.427) |
| Population (100,000) | -0.147 | -0.090 | 0.075 | 0.008 | -0.140 | -0.357 |
| | (1.083) | (0.282) | (0.511) | (0.716) | (0.244) | (0.367) |
| Rail x Population | 0.513** | 0.078 | 0.231*** | 0.143 | 0.061*** | 0.172** |
| | (0.222) | (0.071) | (0.070) | (0.116) | (0.018) | (0.062) |
| Constant | 5.402 | 1.113 | -0.188 | 3.313 | 1.165 | 2.989 |
| | (8.631) | (2.266) | (4.052) | (5.724) | (1.924) | (2.884) |
| Control/treatment | 11/12 | 11/12 | 11/12 | 11/12 | 11/12 | 11/12 |
| Year coverage | 1883-1893 | 1883-1893 | 1883-1893 | 1883-1893 | 1883-1893 | 1883-1893 |
| Observations | 253 | 253 | 253 | 253 | 253 | 253 |
| $R^2$ | 0.375 | 0.215 | 0.363 | 0.153 | 0.225 | 0.354 |

Source: see text.
Significance levels: *10%, **5%, ***1%
Note: all specifications include prefecture and year fixed effects. Robust standard errors are clustered by prefecture. Prefectures from the control and treatment groups are limited to those with coastlines between 1 and 1,000 kilometers in length; see text.

**Table 9: Difference-in-differences robustness check, legal change exclusion**

| DV: Number of firms, prefecture-year panel | [A] All sectors | [B] Primary | [C] Manufacturing | [D] Finance | [E] Services | [F] Mfg-Textiles |
|---|---|---|---|---|---|---|
| Rail access | -3.292* | -0.300 | -1.756*** | -0.792 | -0.444** | -1.394*** |
| | (1.709) | (0.532) | (0.575) | (0.847) | (0.190) | (0.495) |
| Population (100,000) | 0.125 | 0.067 | 0.299 | -0.318 | 0.077 | -0.238 |
| mean 8.326 | (1.171) | (0.216) | (0.562) | (0.647) | (0.248) | (0.413) |
| Rail x Population | 0.427* | 0.044 | 0.226*** | 0.109 | 0.048** | 0.182** |
| | (0.237) | (0.073) | (0.079) | (0.115) | (0.020) | (0.069) |
| Constant | 3.358 | -0.259 | -1.787 | 5.902 | -0.498 | 2.077 |
| | (9.230) | (1.725) | (4.434) | (5.131) | (1.959) | (3.224) |
| Control/treatment | 15/11 | 15/11 | 15/11 | 15/11 | 15/11 | 15/11 |
| Year coverage | 1883-1893 | 1883-1893 | 1883-1893 | 1883-1893 | 1883-1893 | 1883-1893 |
| Observations | 286 | 286 | 286 | 286 | 286 | 286 |
| $R^2$ | 0.276 | 0.125 | 0.274 | 0.145 | 0.105 | 0.281 |

Source: see text.
Significance levels: *10%, **5%, ***1%
Note: all specifications include prefecture and year fixed effects. Robust standard errors are clustered by prefecture. Prefectures in the treatment group are limited to those gaining access between 1884 and 1889, prior to both the 1890 Diet and 1892 Railway Acts; see text.

**Table 10: Difference-in-differences robustness check, 1898 threshold year**

| DV: Number of firms, prefecture-year panel | [A] All sectors | [B] Primary | [C] Manufacturing | [D] Finance | [E] Services | [F] Mfg-Textiles |
|---|---|---|---|---|---|---|
| Rail access | -3.774*** | 0.018 | -1.946** | -1.383 | -0.463* | -1.509** |
| | (1.151) | (0.300) | (0.763) | (1.008) | (0.262) | (0.616) |
| Population (100,000) | 0.028 | 0.069 | 0.365 | -0.683 | 0.276 | -0.405 |
| m=8.545 | (1.504) | (0.150) | (0.760) | (1.222) | (0.230) | (0.554) |
| Rail x Population | 0.534*** | 0.012 | 0.256*** | 0.222* | 0.044* | 0.208*** |
| | (0.119) | (0.038) | (0.090) | (0.116) | (0.026) | (0.069) |
| Constant | 3.749 | -0.310 | -2.333 | 8.506 | -2.114 | 3.473 |
| | (11.945) | (1.198) | (6.071) | (9.681) | (1.840) | (4.416) |
| Control/treatment | 8/25 | 8/25 | 8/25 | 8/25 | 8/25 | 8/25 |
| Year coverage | 1883-1898 | 1883-1898 | 1883-1898 | 1883-1898 | 1883-1898 | 1883-1898 |
| Observations | 528 | 528 | 528 | 528 | 528 | 528 |
| $R^2$ | 0.557 | 0.161 | 0.297 | 0.475 | 0.169 | 0.237 |

Source: see text.
Significance levels: *10%, **5%, ***1%
Note: all specifications include prefecture and year fixed effects. Robust standard errors are clustered by prefecture. Control and treatment prefectures are grouped based on average group surface area of approximately 7,000 square kilometers, based on a threshold year of 1898; see text.