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Steam Beyond the Gateways: Steamship Connectivity and Industrial Entry in China

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Steamships were the first Western transport technology to diffuse widely in China, entering through treaty ports but later spreading beyond them. Using a prefecture-decade panel of 284 prefectures from 1840 to 1927, I find that prefectures gaining steamship connections saw substantially more modern industrial entry, concentrated in trade-intensive sectors. The results are robust to pre-steamship economic fundamentals and competing technologies, and are supported by a shift-share instrument based on hypothetical steamship-navigable access to early treaty ports. Foreign trade responded almost immediately, while native banking and industrial entry expanded gradually over subsequent decades, consistent with commercial deepening accompanying industrial entry.

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Abstract

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Keywords: steamship; industrialization; technology diffusion; treaty ports; China

JEL Classification: N75, O14, O33, R12

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1 Introduction

How transport infrastructure reshapes economic geography and industrial location is a central question in the study of long-run economic development. A large literature shows that canals, railways, and steamships lowered trade costs and widened market access, with far-reaching consequences for the location of economic activity (Donaldson and Hornbeck, 2016; Pascali, 2017; Donaldson, 2018; Braun and Franke, 2022; Allen, 2023). The difficulty running through this literature is that new transport infrastructure typically arrived together with wider commercial and institutional change (O’Rourke and Williamson, 2001; Bogart, 2005; Findlay and O’Rourke, 2009), making it difficult to trace how economic change spread through transport networks beyond the gateways where these changes first arrived.

This paper examines this process in China, asking whether steamship connectivity continued to predict industrial entry after the network extended beyond the institutional gateways through which it first entered. Steam navigation reached China through treaty ports, the nodes of foreign trade forcibly established after the First Opium War (1839–1842) and equipped with customs privileges and Western commercial institutions (Fairbank, 1964). Steamships were also the earliest Western modern transport technology to diffuse widely in China, preceding railways by nearly four decades and reaching more prefectures before the 1920s (Figure 1).

[Figure 1 about here]

Crucially, from the 1870s onward, and especially after 1890, steamship routes expanded along preexisting waterways well beyond the treaty-port perimeter. This sequence allows the analysis to compare prefectures that received both steamship access and treaty-port institutions, prefectures that received steamship access without formal treaty-port status, and prefectures that received neither.

The paper asks whether steamship connectivity continued to predict modern industrial entry once the network extended beyond the formal treaty-port perimeter, or whether the relationship was entirely absorbed by the institutional gateways through which the technology first arrived. I assemble a novel prefecture-decade panel covering 284 prefectures from 1840 to 1927 and reconstruct the timing and geography of regular steamship routes—scheduled commercial services serving each prefecture—in modern China. By 1927, 218 routes served 84 prefectures. I then assign each of the 2,736 modern industrial enterprises established between 1858 and 1927 to its prefecture and founding decade, so that routes and firms are observed at the same prefecture-decade level, and measure industrial entry as newly established firms per 100,000 residents, using 1851 population as the denominator.

The baseline fixed-effects results show that one additional steamship route in the previous decade is associated with roughly 0.1 more newly established industrial firms per 100,000 resi-

dents in the following decade, more than twice the prefecture-decade mean. The relationship survives controls for the presence of treaty ports, railways, telegraphs, postal services, and warfare, and persists even after I exclude the treaty-port prefectures. To address a leading concern for any transport treatment, that routes were placed where economic fundamentals were already favorable, the analysis further controls for pre-steamship agricultural and commercial potential interacted with decade fixed effects, and the results are robust to macroregion-by-decade fixed effects based on [Skinner's \(1977\)](#) classification, which absorb unobserved decade-specific shocks common to each macroregion. Exploiting the staggered timing of first steamship access with the estimator of [Callaway and Sant'Anna \(2021\)](#), I find little evidence of differential pre-adoption trends and positive effects that emerge only after adoption.

I complement the identification with a shift-share instrument. The cross-sectional component measures each prefecture's hypothetical steamship access to the seed treaty ports, defined here as the treaty-designated gateways by 1858, the year when the first industrial firm in the sample was established. I construct a hypothetical network of steamship-navigable waterways from HydroRIVERS by imposing hydrological restrictions on slope, discharge, and freezing conditions, and then calculate each prefecture's shortest network distance (rather than straight-line distance) through this network to the 1858 gateways. The time-series component is decade-level national steamship tonnage from Maritime Customs records. Their interaction predicts larger steamship shocks when national tonnage rose in prefectures with better preexisting navigable access to the early gateways. The instrument is motivated by the fact that the 1858 treaty-port set was shaped by war and diplomacy, while the hypothetical waterway network reflects physical geography that predated modern industrialization. Most balance coefficients are statistically insignificant, although the confidence interval for market-town density does not rule out economically meaningful imbalance. The IV is therefore best viewed as complementary evidence, and the second-stage estimates remain robust to controlling for these pre-opening characteristics.

The timing evidence reveals a clear asymmetry across outcomes. Customs-recorded foreign trade responds almost immediately after steamship access, while native banking and industrial entry expand more gradually over subsequent decades. Sectoral heterogeneity supports a goods-circulation channel: the largest estimates appear in textiles, with significant responses also in food processing, machinery and materials, and chemistry. Steamship connectivity also predicts subsequent guild formation, consistent with expanding commercial organization. At decade frequency, native banking and industrial entry cannot be sharply ordered. These patterns are consistent with commercial deepening accompanying later industrial entry, rather than with a fully identified trade-to-finance-to-industry causal chain.

The findings contribute to the literature on transport and economic development. In many settings, transport technology spread alongside new infrastructure corridors and supporting institutions, through trade, colonization, and state action (O’Rourke and Williamson, 2001; Findlay and O’Rourke, 2009; Jedwab and Moradi, 2016; Martinez, Nuvolari, and Vasta, 2025). China’s steamship routes instead diffused over preexisting waterways and eventually operated beyond the coercive gateways through which they first entered. The controls and treaty-port exclusions narrow institutional confounding, but the estimates capture the spatial transmission of treaty-port-era economic change through the steamship network rather than a transport effect fully separable from gateway institutions. Some of this spatial transmission may also reflect institutional and human-capital spillovers that traveled along the same transport corridors. The delayed industrial response also speaks to Crafts’s (2004, 2011) argument that steam’s payoff required complementary investments. Here, those adjustments are visible in the timing of the responses: goods circulation responded first, while commercial finance and industrial entry expanded more gradually over subsequent decades. This parallel speaks to steam as a transport technology; the paper does not measure mechanization or steam power within factories and says nothing about steam’s direct contribution as a production technology.

The paper also speaks to research on modernization in late-developing economies, particularly China. A substantial literature examines how treaty ports reshaped foreign trade, legal institutions, ideas, and capital (Brandt, Ma, and Rawski, 2014; Jia, 2014; Keller, Santiago, and Shiue, 2017; Keller and Shiue, 2021; Jin, 2023; Levine, Lin, Ma, and Xu, 2023). These studies typically treat the gateway as a bundle of technology, institutions, labor, and capital, within which the contribution of technology diffusion itself cannot be directly observed. My results document one channel through which economic change moved outward: steamship connectivity carried cheaper, faster, and more predictable transport into non-port prefectures, reorganizing commodity flows beyond formal treaty-port prefectures. More broadly, treaty-port-era change was also carried by imported technologies whose reach extended beyond the ports themselves. Related work has examined telegraphs and railways (Gao and Lei, 2021; Lin, Ma, Sun, and Xu, 2021; Köll, 2022; Hao, Wang, and Zhang, 2025). Relative to railways and telegraphs, steamships arrived earlier and used preexisting waterways, making their diffusion less entangled with state capacity and fixed investment.¹

The paper proceeds as follows. Section 2 provides historical background; Section 3 describes the data; Section 4 presents the empirical strategy and main results; Section 5 examines the effects

¹Reinhardt (2018) emphasizes that steamship navigation in China was embedded in semi-colonial sovereignty struggles and state-building, rather than being a purely commercial technology. Hao et al. (2025) study steam shipping and market integration in late Qing China. I examine a different margin: whether steamship connectivity shaped modern industrial entry after spreading beyond the treaty-port gateways through which it first entered.

of steamship connectivity on trade and finance, as well as heterogeneity across industrial sectors; and Section 6 concludes.

2 Historical background

2.1 Entry and diffusion of steamships in China

Regular steamship service did not emerge from within the Chinese economy in response to domestic industrial or commercial expansion. It first arrived through a narrow set of coastal gateways opened by military defeat and diplomacy, and only later diffused along the waterways linking those gateways to the interior (Fairbank, 1964; Reinhardt, 2018). Figure 2 summarizes the main phases of steamship route expansion.

[Figure 2 about here]

In the first phase, from 1842 to 1872, regular steamship services remained closely tied to treaty-port routes. The Treaty of Nanjing (1842), concluded after China's defeat in the First Opium War, opened five ports to British trade (Fairbank, 1964). Within two years, the first regular service operated between Hong Kong and Guangzhou and was extended to Shanghai by 1850 (Nie, 1983). These routes reflected treaty obligations, gunboat power, and foreign merchants' demand for freer market access rather than Chinese industrial policy. The Treaties of Tianjin (1858) and Beijing (1860), concluded in the course of the Second Opium War (1856–1860), further granted foreign vessels inland navigation rights, especially on the Yangtze River (Liu, 1962). Regular services still ran mainly between treaty-port nodes, so early steamship exposure remained tightly bound to treaty-port status.

The second phase began with the founding of the China Merchants' Steam Navigation Company (CMSNC) in 1872, one of the earliest Chinese joint-stock enterprises, and lasted through the early 1890s. The Qing state created the CMSNC under the Self-Strengthening Movement (1861–1895) to regain control over waterway commerce from foreign carriers (Reinhardt, 2018). Steamship routes in this phase began to extend beyond treaty-port nodes to prefectures along major waterways that had not been designated as treaty ports.

The third phase followed the Treaty of Shimonoseki (1895), signed after China's defeat in the First Sino-Japanese War. The treaty expanded foreign commercial and investment rights in China's interior, and fiscal pressure from the war indemnity led the Qing government to relax restrictions on privately operated steamship enterprises (Nie and Zhu, 2002). The consequence was rapid network expansion. Within roughly a decade after 1895, steamship services reached many major waterways

that could physically accommodate steam vessels, including the Yangtze tributaries, the Pearl River system, and other navigable corridors.

These episodes do not make route placement random. Shipping companies still chose commercially viable routes, and navigable waterways were unevenly distributed. They show, however, that steamship expansion was shaped by forces broader than the industrial prospects of individual prefectures: military conflict, treaty obligations, regulatory change, and struggles over shipping sovereignty ([Reinhardt, 2018](#)). This sequence motivates the instrument in Section 4.4, which interacts predetermined navigable access to early treaty-port gateways with national steamship tonnage growth.

2.2 Steamship advantages and conditions for industrial entry

Steamships could expand quickly once regulatory barriers loosened because they offered clear advantages over traditional waterway transport in speed, regularity, and capacity. An article titled “Discussions on Steamships,” published in *Shenpao* on May 30, 1872, compared the two technologies directly: moving goods along the roughly 150-kilometer lower-Yangtze route from Shanghai to Suzhou usually took sailing junks three days or more, while steamships completed the journey in less than one day, and slow junks could miss the moment when merchants were still active and prices remained favorable.²

Traditional junks depended heavily on wind, whereas steamships could run on regular weekly or monthly schedules that let merchants plan shipments and coordinate orders ([Rawski, 1969](#)); typical junks carried 30 to 90 tons against 300 to 1,000 tons per steamship voyage ([Second Historical Archives of China, 2001](#); [Chen, 2013](#)).³

These advantages are visible in aggregate. Figure 3 shows that steamship tonnage and sailing tonnage were broadly comparable in the 1860s, but from the 1870s onward steamship tonnage rose sharply while sailing tonnage remained largely flat. The growing gap also reflects a rapid expansion of waterborne trade volumes, a relationship examined more rigorously in Section 5.

[Figure 3 about here]

These advantages mattered because modern factories required regular input flows, predictable schedules, and wider output markets; steamships made bulk-and-throughput industries more viable where trade had been thin, slow, or episodic. The flour-milling industry in Hankou illustrates

²Appendix Figure ?? presents the original article together with a full English translation.

³According to the *Shina Sōbetsu Zenshishi* ([East Asia Common Culture Society \(1917\)](#)), a junk on the Shanghai-Hankou route could complete about 12 round trips per year, while a steamship could manage roughly 46. A single 500-ton steamship could therefore transport about 23,000 tons annually, equivalent to the capacity of approximately 38 junks.

this link: as a major Yangtze steamship node, Hankou was well placed for modern roller milling, which required continuous wheat procurement and stable outbound shipments; its first modern mill opened in 1904, and six mills were operating by 1910 (Liu, 1980). Steamship access there-fore helped create the regular procurement and distribution environment in which fixed industrial investment became more profitable.

Shanghai’s experience illustrates another financial channel. Connected by steamship services, Shanghai became a major trans-shipment hub; by the early 1900s, more than 56,500 chests of opium passed through the port annually. The resulting demand for trade credit—settlement services, bills of exchange, and working-capital loans—supported approximately 120 native banks,⁴ many providing short-term credit to opium merchants (The People’s Bank of China Shanghai Branch, 1960). As they accumulated capital from trade finance, native banks gradually moved into industrial lending, which accounted for roughly 30 percent of their loan portfolios by the early twentieth century (Cheng, 2003). Commercial expansion in this period was likewise accompanied by organizational growth, as merchants founded guilds to coordinate trade in the cities where they did business (Peng, 1995). Section 5 examines whether this broader pattern of commercial and financial deepening is visible in the data.

3 Data

The empirical analysis uses a prefecture-decade panel covering 284 prefectures from 1840 to 1927. These prefectures span the 18 provinces of China Proper, encompassing both treaty-port regions and interior areas.⁵ The sample begins in the 1840s, when the First Opium War initiated China’s coerced opening to foreign trade and the introduction of regular steamship services, and ends in 1927, the final year covered by the route and industrial-establishment data. Prefectural boundaries changed over this period; I trace these changes in ArcGIS and match all observations to the 1911 base map from version 6 of the China Historical Geographic Information System (2016).

⁴Throughout the paper, “native banks” is used as an umbrella term for indigenous Chinese financial institutions, including qianzhuang (money houses) and piaohao (remittance banks). Many institutions combined the deposit, lending, and money-exchange functions typically associated with qianzhuang with the cross-regional remittance services typically associated with piaohao, so the two categories are not sharply distinguished here (Jiang, 2014).

⁵China Proper refers to the eighteen provinces that constituted the core administrative territory of imperial China, excluding Manchuria, Mongolia, Xinjiang, and Tibet. These provinces encompassed the vast majority of China’s population, agricultural output, and commercial activity.

3.1 Steamship routes

The key explanatory variable is the number of steamship routes serving each prefecture in a given decade. I code a prefecture as connected to a route when the historical source identifies the prefecture, its port city, or a landing point within its boundary as being served by a regularly scheduled commercial steamship service. A route is counted once for each served prefecture, even if the service made multiple stops within that prefecture. Multiple stops along the same service are not counted as separate routes. For example, a Shanghai-Tianjin service and a Shanghai-Guangzhou service count as two routes, whereas intermediate stops on a single Shanghai-Ningbo-Fuzhou-Xiamen-Guangzhou service do not generate additional route counts.⁶ This measure therefore captures the breadth of scheduled connectivity available to each prefecture, rather than the number of intermediate stops.

This measure reflects the structure of the sources: many archives record services by endpoints, and inland-stop information is especially incomplete for central and western China, so a route count is preferable to a stop count that would be precise in some locations but unreliable elsewhere. Route counts nonetheless imperfectly measure the economic intensity of steamship services, because systematic information on service frequency is unavailable: a prefecture served by one high-frequency trunk route may have enjoyed greater effective access than one served by several low-frequency services.⁷ At the same time, route counts capture variation in the breadth of scheduled connections beyond first access, since prefectures could gain or lose routes over time. Section 4.3 nevertheless turns to the extensive margin, replacing route counts with first steamship connection in a staggered design. Complementary specifications below instead measure treatment as binary steamship access, so that route counts capture variation in connection breadth while binary access captures the extensive margin of obtaining regular steamship service.

I collect route information from [Liu \(1962\)](#), [Nie \(1983\)](#), [Nie and Zhu \(2002\)](#), three Ministry of Posts and Transportation surveys from 1908 to 1910, and the Nationalist government's six-volume *jiaotongshi: hangzheng bian* (*History of Transportation: Shipping Administration*), compiled in 1931 ([Transportation History Compilation Committee, 1931](#)).⁸ I georeference the route lines and match them to prefectures in GIS. I also cross-check the route records against the *Shina Sōbetsu Zenshishi* ([East Asia Common Culture Society, 1917](#)), a province-by-province Japanese field sur-

⁶Figure ?? illustrates this coding rule.

⁷Unweighted network-centrality or hub-connectivity measures could in principle be constructed from route topology, but without service-frequency or capacity weights they would continue to treat services of very different economic intensity equally and therefore would not resolve the core measurement limitation. Such weights are unavailable consistently across the full panel.

⁸Figure ?? presents a 1910 steamship-route map from these materials.

vey of commercial and transport conditions in China that records the steamship services calling at each locality. When sources overlap, I harmonize route names and endpoints and prioritize systematic route lists over isolated references.

Across the full sample period, 87 prefectures received regular steamship service. By 1927, the active network included 218 routes serving 84 prefectures, covering nearly all coastal China, the lower and middle Yangtze, and major navigable systems such as the Huai River, Pearl River, and southern Grand Canal (Figure 2).

3.2 Industrial establishments

The main outcome variable is the number of Chinese-founded modern industrial firms established in each prefecture in a given decade, drawn from Du’s (2014) *Minzu zibenzhuyi yu jiuzhongguo zhengfu* (*National Capitalism and the Old Chinese Government*), the most comprehensive compilation of Chinese industrial establishment records for this period. Because the question is whether steamship connectivity shaped Chinese industrial entry beyond the institutional gateways, the baseline outcome focuses on Chinese-founded firms rather than foreign-owned treaty-port establishments.

The dataset covers firms whose primary business involved processing or transforming raw materials into finished or intermediate goods. Du (2014) compiled the records from contemporary business directories, government census records, and local gazetteers. I code each firm’s establishment year and aggregate the counts to prefecture-decade observations using the boundaries described above. The resulting sample contains 2,736 enterprises established between 1858 and 1927. Figure 4 shows their spatial distribution by 1927.

[Figure 4 about here]

Two limitations of this source deserve note. Smaller firms are likely to be underrecorded, so I interpret the outcome as documented modern industrial entry rather than a complete census of firms. Recording practices may also have differed between treaty-port and inland prefectures; the baseline outcome already excludes foreign-owned firms, and I show below that the results survive excluding all prefectures that ever hosted treaty ports.

To examine whether the estimates concentrate in trade-intensive activities, I further classify these enterprises into seven sectors: textiles (including cotton spinning, weaving, and silk reeling); food and grain processing (including milling and oil pressing); machinery and materials (including cement and glass); mining (including coal and ore extraction); chemistry (including dyes and fertilizers); infrastructure (including waterworks and electricity); and miscellaneous manufacturing (including papermaking, printing, and tobacco).

3.3 Baseline controls

Because steamship access is likely correlated with characteristics that independently affect industrial entry, I control for the following potential confounders.

Time-invariant confounders. Prefectures with less rugged terrain and shorter distances to major rivers or the coastline were more accessible to steamship routes and more conducive to commerce and industry. I therefore control for terrain ruggedness, shortest distance to the coastline, and shortest distance to rivers of third rank or above.⁹ Prefectures with higher political status may also have attracted steamship services earlier because of stronger administrative capacity, so I include an indicator for provincial or state capital status. Because the importance of these characteristics likely changed over time, I interact each with decade fixed effects throughout the analysis.

Population density. Population density could shape both demand for steamship services and the attractiveness of industrial locations. I obtain prefecture-level population data from the *Population History of China* (Volume 5) compiled by Cao (2001), which provides records at four benchmark years: 1820, 1851, 1880, and 1910. I linearly interpolate annual values between benchmarks and aggregate to decade-level observations.

Number of treaty ports. Treaty ports conferred institutional advantages on commercial activity, including preferential market access, reduced customs duties, and legal protections under extraterritorial arrangements (Jia, 2014; Jin, 2023). These advantages could independently attract both steamship services and industrial investment. I control for the number of treaty ports in each prefecture-decade using records from Yan (2012). Summary statistics for all key variables are reported in Table 1.

[Table 1 about here]

4 Empirical results

I begin by investigating whether the number of steamship routes serving a prefecture predicts modern industrial firm entry at the prefecture-decade level from 1840 through 1927, using the following OLS specification:

$$Y_{i,t} = \beta \times \text{Steam}_{i,t-1} + \gamma' X_{i,t-1} + \text{pref}_i + \text{decade}_t + \varepsilon_{i,t}. \quad (1)$$

The dependent variable is the number of newly established industrial firms in prefecture i and

⁹This criterion captures China's major river systems, including the Yangtze, Yellow, and Pearl Rivers, along with their primary tributaries.

decade t , normalized by the 1851 population and expressed per 100,000 residents.¹⁰ The estimates therefore capture the density of new industrial establishments, rather than the mechanical tendency for larger prefectures to produce more firms. The key explanatory variable, $Steam_{i,t-1}$, refers to the number of steamship routes operating in prefecture i in decade $t-1$. I lag steamship routes by one decade to mitigate reverse causality and capture a plausible adjustment horizon, as modern industrial entry required raising capital, purchasing machinery, securing inputs, and organizing production over several years (Du, 2014). Prefecture fixed effects ($pref_i$) absorb time-invariant unobservables, while decade fixed effects ($decade_t$) absorb shocks common to all prefectures in a given decade.

The baseline covariate vector ($X_{i,t-1}$) has two components. The first consists of time-invariant geographical confounders, including ruggedness, distance to major rivers, distance to the coastline, and an indicator for provincial or state capitals, each interacted with decade fixed effects. The second includes time-varying controls, namely lagged population density and lagged number of treaty ports, to account for the independent roles of economic scale and institutional gateways. These baseline controls do not include the pre-steamship economic-potential measures, which are introduced separately in Section 4.1. Throughout the analysis, I cluster standard errors at the prefecture level.

The identifying assumption is that, conditional on fixed effects and the controls described above, changes in steamship route counts are not systematically correlated with unobserved determinants of industrial entry. Appendix Table ?? provides a preliminary check: prefectures first connected before and after 1895 are broadly similar in geography and population density, but early-connected prefectures were much more likely to host treaty ports.

Guided by this pattern, I address the main identification concerns in turn. The first is the institutional bundling of treaty ports, which I address by controlling for treaty-port presence and excluding treaty-port prefectures altogether. The second is pre-opening economic potential: routes may have been placed where agricultural and commercial fundamentals were already favorable, so I control for pre-1840 measures interacted with decade fixed effects. The third is confounding from transport and communication technologies and military shocks that expanded alongside steamships, which I address in horse-race specifications. I then probe the identifying assumptions through two additional exercises. I exploit the staggered timing of first steamship connection to test for pre-adoption trends and construct a shift-share instrument using predetermined navigable access interacted with

¹⁰I use 1851 population as the denominator to avoid mechanically linking the dependent variable to time-varying population, which may itself respond to steamship connectivity or industrial entry. The 1851 benchmark predates the Taiping Rebellion (1851–1864) and later demographic disruptions. Results are robust to using beginning-of-decade population instead (not reported).

national steamship-tonnage growth.

4.1 Steamship connectivity and industrial establishments

Table 2 reports the baseline relationship between steamship routes and industrial entry, showing a positive and statistically significant association between lagged steamship routes and subsequent industrial entry across specifications. Columns (1) to (4) use the full sample of 284 prefectures in China Proper. Column (1), which includes only prefecture and decade fixed effects, implies that one additional steamship route in the previous decade is associated with 0.16 more newly founded enterprises per 100,000 residents, a magnitude that is economically large relative to the prefecture-decade mean of 0.044.

[Table 2 about here]

Columns (2) through (4) progressively add potential confounders. Column (2) allows geographic variables to have flexible time-varying effects, column (3) adds lagged population density, and column (4) adds treaty-port presence. With all controls included, the steamship coefficient declines to 0.099, but remains economically and statistically significant, consistent with treaty ports bundling institutional advantages with steamship access; roughly two-thirds of the association remains, indicating that steamship connectivity is not fully absorbed by treaty-port status.

Columns (5) to (7) address the demand-driven-placement concern directly by controlling for pre-steamship economic potential in two blocks. Because most of China remained an agrarian economy in this period, agricultural potential shaped population and market size and hence the commercial viability of steamship service. Column (5) therefore adds agricultural-potential measures, (log) land tax per capita in 1820 and suitability indices for the four principal food crops (wheat, rice, maize, and sweet potato), each interacted with decade fixed effects. Column (6) further adds two indicators of pre-opening commercial potential: market-town density in 1820 and an indicator for traditional textile-production centers, given the long-standing importance of textiles in Chinese trade (Liu, 2020); both are again interacted with decade fixed effects. Column (7) additionally includes Skinner's (1977) macroregion-by-decade fixed effects, which absorb unobserved shocks common to all prefectures of a physiographic macroregion in a given decade, such as region-wide commercial fluctuations or political disturbances. The steamship coefficient is 0.075 in column (7) and remains positive and statistically significant throughout. Column (8), retaining the full set of controls, restricts the sample to 141 prefectures in the top quartile of proximity to major rivers or the coastline.¹¹ This provides a stricter comparison among places with more com-

¹¹This restriction initially yields 142 prefectures; however, under Skinner's (1977) macroregion classification, the Tibetan Plateau macroregion contains only one prefecture in the sample, Maogong Ting, which forms a singleton and

comparable waterway access, narrowing the scope for a simple geography-based explanation. Within this water-adjacent sample, steamship connectivity continues to predict industrial entry, with a coefficient slightly larger than in the full sample.

4.2 Accounting for alternative technologies and shocks

With the full set of geographic and socioeconomic covariates in place and the sample restricted to comparable water-adjacent prefectures, a remaining concern is that steamship expansion coincided with a broader wave of imported technologies: from the 1870s onward, railways, telegraphs, and postal services expanded ([Gao and Lei, 2021](#); [Guo and Dong, 2021](#); [Köll, 2022](#)), so the estimates may capture general modernization rather than steamship connectivity itself. Table 3 therefore reports horse-race specifications that add alternative technologies while maintaining the restricted sample of 141 water-adjacent prefectures and the full set of controls from Table 2.

[Table 3 about here]

Column (1) adds the one-decade-lagged number of railway stations in each prefecture, compiled from [Sun \(2003\)](#). Railways were the main land-based transport technology introduced in late Qing China. The Kaiping Tramway, the first operational line, opened in 1881 to connect the Kaiping coal mines to nearby transport nodes, and the network expanded rapidly after the 1890s ([Köll, 2022](#)). Lagged steamship routes and railway stations are both positively and significantly associated with industrial entry. The steamship coefficient remains sizeable at 0.080, or 1.18 times the prefecture-decade mean in this restricted sample. The railway coefficients should not be read as causal comparisons across technologies: railway placement responded to commercial opportunity, and railways and steamships were often complements, as when inland prefectures received imported machinery through combined steamship-and-rail routings ([Köll, 2022](#)). Nevertheless, the steamship coefficient changes little once railway expansion is controlled for, reducing the concern that it merely reflects a general wave of imported modernization.

Columns (2) and (3) consider communication technologies, which could facilitate information flows and cross-regional coordination ([Gao and Lei, 2021](#); [Hao and Wang, 2025](#)). Column (2) adds the lagged number of telegraph stations, introduced from the 1880s onward, and column (3) adds the lagged number of postal offices from the imperial postal system established in 1896. Both variables are compiled by [Lin et al. \(2021\)](#). The steamship coefficient remains robust in both specifications, while neither communication measure is significant. These null coefficients hold communication-network expansion fixed and should not by themselves be read as evidence against an information channel.

is therefore dropped when macroregion-by-decade fixed effects are included, leaving 141 prefectures.

Column (4) considers warfare, which could disrupt production and deter investment. I construct prefecture-decade war frequency for 1840 to 1927 from *A Chronology of Warfare in Chinese History* ([China's Military History Editorial Committee \(2003\)](#)) and *Chronicles of Major Battles in China's Modern Military History* ([Shizhengchu, 1967](#)). These data cover the Taiping Rebellion (1851–1864), the 1911 Revolution, post-1916 warlord conflicts, and foreign wars including the Opium and First Sino-Japanese Wars. Warfare does not significantly predict industrial entry, while the steamship coefficient remains robust.

Column (5) simultaneously includes all transport and communication technologies, war frequency, and the baseline controls. The steamship coefficient remains essentially unchanged across these horse-race specifications. In the fully saturated horse-race specification, one additional route in the previous decade is associated with an increase of roughly 0.085 newly established firms per 100,000 residents, equivalent to about 0.23 standard deviations of industrial entry. Railway stations remain positively and significantly associated with industrial entry, while telegraph and postal stations do not; these coefficients are descriptive rather than causal comparisons across technologies. Taken together, the horse-race results are consistent with market-access models in which lower trade costs shape production location ([Donaldson and Hornbeck, 2016](#); [Donaldson, 2018](#)).

The horse-race specifications also shed light on treaty ports. The treaty-port coefficients across columns (1) to (5) are at most marginally significant, but this need not imply that gateway institutions were unimportant: treaty ports may have operated primarily through the technologies and trade flows they enabled rather than through a direct, separable effect on firm counts. Column (6) excludes the 34 prefectures that ever hosted treaty ports. Steamships and railways remain positive and significant, although the steamship coefficient declines, consistent with stronger associations where gateway institutions were present; steamship connectivity nevertheless retains predictive power outside formal treaty-port prefectures.

Column (7) replaces route count with a binary indicator of steamship access on the same non-treaty-port sample; the estimate remains positive and significant, confirming that the result is robust to replacing route counts with binary steamship access. Moreover, Table ?? reports robustness checks using [Conley \(1999\)](#) standard errors that allow for spatial correlation up to 500 kilometers, while Table ?? uses log-transformed industrial firm density to reduce the influence of outliers. The estimates remain consistent in both exercises.

4.3 Dynamic effects of steamship entry

The baseline and horse-race specifications show a robust relationship between steamship connectivity and industrial entry, but they do not fully address the possibility that prefectures already

approaching industrialization attracted steamship services earlier. I therefore exploit the staggered timing of first steamship access across prefectures in an event-study framework. Let G_i denote the first decade in which prefecture i receives regular steamship service; treatment is defined by this first connection and remains absorbing thereafter, irrespective of subsequent changes in the number of active routes. Following [Callaway and Sant’Anna \(2021\)](#), I first estimate cohort- and period-specific treatment effects:

$$ATT(g, t) = E[Y_{i,t}(g) - Y_{i,t}(0) \mid G_i = g], \quad (2)$$

where g indexes the adoption cohort, t indexes calendar decades, $Y_{i,t}(g)$ denotes the potential outcome for prefecture i in decade t if it first received steamship access in cohort g , and $Y_{i,t}(0)$ denotes the potential outcome without steamship access. The estimator uses never-treated prefectures as the comparison group for each treated cohort in each calendar decade and is therefore robust to treatment-effect heterogeneity across cohorts. I then aggregate these cohort-time effects by event time. Figure 5 also reports corresponding event studies for foreign trade, transit trade, and native banking, which are discussed in Section 5. To facilitate comparison across outcomes, all four panels use the common 1850–1927 window, the same adoption-cohort definition, and the same never-treated comparison group.¹²

[Figure 5 about here]

Panel A reports the dynamic response of industrial entry. The pre-adoption estimates provide little evidence of differential trends between treated and never-treated prefectures. The estimates turn positive after adoption, but the largest increase occurs about two decades after first access. This pattern points to a gradual buildup rather than a discrete twenty-year delay. It aligns with the historical timing: steamship routes expanded most rapidly after 1890, while industrial enterprises in the sample were disproportionately founded after 1900.

The pattern also echoes [Crafts’s \(2004\)](#) argument that steam’s contribution to British growth arrived slowly because general-purpose technologies required complementary investments and organizational adjustment. In this setting, the lag suggests that steamship access did not translate mechanically into factory entry, but operated through intermediate commercial adjustments. Aggregating the cohort-time effects into a single overall average treatment effect yields 0.14 additional firms per 100,000 residents, using 1851 population as the denominator, a formal extensive-margin estimate that complements the route-count estimates in Tables 2 and 3. Nevertheless, because sparse pre-treatment industrial entry limits the power of the pre-trend test, the event-study evidence

¹²Because Guangzhou prefecture received regular steamship service before 1850, it is treated as already exposed throughout the common window and enters neither as a newly treated cohort nor as a comparison unit.

is most persuasive when read alongside the horse-race results in Section 4.2 and the mechanism timing in Section 5.

4.4 A shift-share instrument for steamship connectivity

The event-study estimates show little evidence of differential pre-adoption trends but do not rule out anticipation or time-varying confounding: steamship routes may still have expanded more intensively along corridors with unobserved economic advantages that preceded industrial entry and are not captured by the controls above. I therefore complement the analysis with a shift-share instrument that interacts predetermined cross-sectional exposure with a common time-series shock. The cross-sectional component measures each prefecture’s hypothetical steamship access to the 14 seed treaty ports, defined as the treaty-designated gateways by 1858, the year in which the first industrial firm in the sample was established. For the ports designated in 1858, formal opening occurred only after 1860, further separating the exposure measure from contemporaneous local commercial outcomes (Yan, 2012).¹³

[Figure 6 about here]

I first construct a hypothetical network of waterways plausibly navigable by steamships using HydroRIVERS (Lehner and Grill, 2013). I retain waterways with sufficiently large average discharge, DEM-derived gradients of no more than 1 m/km, and fewer than four months of seasonal freezing, following engineering guidance that inland navigation depends jointly on discharge, channel dimensions, current speed, and ice conditions (U.S. Army Corps of Engineers, 1980).¹⁴ These thresholds restrict the network to waterways plausibly navigable by steam vessels, although they do not by themselves isolate conditions that steamships required and junks did not. I then calculate each prefecture’s negative shortest distance through this network to the early treaty-port set. Figure 6 maps this cross-sectional access component; its spatial pattern reflects both proximity to the early gateways and navigable-waterway structure, rather than coastal distance alone. The time-series component is decade-level national steamship tonnage from Maritime Customs records (Second Historical Archives of China, 2001). Interacting the two yields larger predicted steamship shocks when national tonnage rose in prefectures with better preexisting waterway access to the early gateways.

¹³The seed treaty ports are Guangzhou, Xiamen, Fuzhou, Ningbo, and Shanghai, required under the Treaty of Nanjing in 1842; and Niuzhuang, Dengzhou, Hankou, Jiujiang, Nanjing, Zhenjiang, Shantou, Qiongzhou, and Taiwan, designated under the Treaty of Tianjin in 1858 but not formally opened until 1860 or later (Yan, 2012). This timing reinforces the hypothetical character of the instrument: the 1858 set reflects treaty designation following military and diplomatic events, rather than subsequent port operation. For the controls, I code treaty-port presence by actual opening date, when treaty-port institutions became operative.

¹⁴Appendix ?? describes the construction of the instrument.

[Figure 7 about here]

Following [Borusyak, Hull, and Jaravel \(2022\)](#), identification rests primarily on the cross-sectional exposure component. Because the time-series shift is a single national shock, the instrument provides no staggered variation in the timing of treatment; following [Goldsmith-Pinkham, Sorkin, and Swift \(2020\)](#), the historical construction and exogeneity of the geographic exposure therefore carry the identifying burden. Conditional on geographic controls, including ruggedness, river distance, and coastal distance, prefectures with better hypothetical steamship access to the 1858 gateways should not differ systematically in pre-opening economic potential. Figure 7 provides balance checks for this exposure measure. Most coefficients are statistically insignificant, but the point estimate for market-town density is economically sizeable despite its wide confidence interval; the exercise therefore cannot rule out meaningful imbalance in pre-opening commercial potential along this dimension. I consequently place greater weight on the controlled IV specifications reported below, which add market-town density and other pre-opening characteristics interacted with decade fixed effects, than on the statistical insignificance of individual balance coefficients.

[Table 4 about here]

I then report the two-stage least squares (2SLS) results in Table 4. Because national steamship-tonnage data are unavailable for the 1840s, the IV analysis covers eight decades. Column (1) reports the first stage for the most saturated specification, showing that prefectures with better hypothetical access to the seed treaty ports experienced larger increases in steamship connectivity as national steamship tonnage rose. Columns (2) and (3) use $1,136 = 142 \times 8$ prefecture-decade observations, while column (4), which adds Skinner macroregion-by-decade fixed effects, uses $1,128 = 141 \times 8$ observations because Maogong Ting is dropped as a singleton. The second-stage estimate is 0.146 in column (2), remains virtually unchanged at 0.142 after adding pre-opening commercial potential in column (3), and rises to 0.182 after further adding macroregion-by-decade fixed effects in column (4), where it remains significant at the 10 percent level. The Kleibergen–Paap F-statistics range from 24.695 to 39.913, suggesting limited weak-instrument concerns.

The most saturated IV estimate is larger than the baseline fixed-effects estimate. This difference may reflect measurement error in route counts, heterogeneous effects for prefectures whose route expansion responded to national tonnage growth through navigable access, or finite-sample imprecision; it should not by itself be interpreted as evidence that the OLS estimates are downward biased.¹⁵

These IV estimates strengthen the evidence, but they do not by themselves settle all endogeneity concerns. The exclusion restriction would fail if hypothetical access to early treaty ports affected

¹⁵Table ?? reports 2SLS estimates that sequentially add interactions between each pre-opening characteristic and period indicators, with the final specification including all such interactions simultaneously.

industrial entry through unobserved channels that also varied with national steamship tonnage. The balance checks and controls make this interpretation less likely, but the IV is best viewed as complementary evidence alongside the fixed-effects, horse-race, and event-study results.

5 Sectoral heterogeneity, trade flows, and native banking

I next examine the sectoral and temporal patterns linking steamship connectivity to industrial entry. The effects are concentrated in trade-intensive sectors, while customs-recorded foreign trade responds first and native banking and industrial entry build more gradually, consistent with commercial deepening accompanying later industrial investment.

5.1 Sectoral heterogeneity and recorded trade flows

I begin by examining heterogeneity across industrial sectors, with the results reported in Table 5. If steamships mattered through bulky-goods circulation, the estimates should concentrate in sectors requiring regular inflows of raw materials, shipment of outputs, and access to trade networks.

[Table 5 about here]

The largest and most precise response appears in textiles. This pattern fits the historical organization of the industry. Large mills required regular inflows of bulky raw materials such as cotton, silk, and dyes, imported machinery, and dependable outbound shipment of yarn and cloth.¹⁶ The responses for food processing, machinery and materials, and chemistry are also positive and significant, though smaller. Railways, in turn, show positive and significant associations with food processing and mining, which is historically plausible: early Chinese railways were concentrated in the wheat-producing North China Plain and inland mining regions (Köll, 2022), making rail better suited to flour mills dependent on overland grain procurement and mines tied to inland deposits. Steamships and railways thus operated on overlapping but distinct margins: waterborne transport mattered more for manufacturing dependent on bulky tradable goods, while rail mattered more where production was tied to agricultural hinterlands or mineral geography.¹⁷

These sectoral patterns raise a direct mechanism question: did steamships actually increase the movement of goods? Trade should respond faster than industrial entry because merchants can

¹⁶The Dasheng Cotton Mill, founded in Nantong in 1895, illustrates this dependence: its lower-Yangtze location allowed steamships to bring in cotton and distribute output through Shanghai and other markets, supporting continuous factory production (Du, 2014).

¹⁷Robustness checks on these results include: the expanded China Proper sample of 283 prefectures (Table ??); Conley (1999) standard errors with 500-kilometer spatial correlation (Table ??); 2SLS estimates using the shift-share instrument described in Section 4.4 (Table ??); and a finer sector classification (Table ??).

reroute existing commodity flows when transport costs fall and schedules improve, while factories require fixed investment and expectations of sustained market access. If steamships worked through goods circulation, recorded trade should rise quickly.

To measure goods circulation, I compile trade data from the annual Chinese Maritime Customs reports from 1859, the earliest year with trade records, to 1927. Established in 1854 under British administration, the Maritime Customs kept standardized records of trade passing through treaty ports (Brandt et al., 2014). I extract decadal trade values in silver taels and match them to the prefecture-decade level. The data include imports, exports, and transit trade. Transit trade is divided into outward transit, goods from inland origins passing through treaty ports for export, and inward transit, goods entering through treaty ports for inland destinations. I interpret the transit results as evidence on recorded port-interior circulation.

[Table 6 about here]

I take the natural logarithm of each trade value plus one and use these variables as outcomes in Table 6. The estimates are positive and significant for foreign trade. An additional route is associated with increases of 0.745 log points in total foreign trade, 0.742 in imports, and 0.698 in exports.¹⁸ The transit associations are weaker: inward transit remains significant at the five percent level, total transit is marginal, and outward transit is insignificant, a composition consistent with the import-led pattern (Keller et al., 2017).¹⁹ This composition is what one would expect if steam navigation improved access to imported raw materials, machinery, and intermediate inputs while enlarging downstream market access. The more precisely estimated import response is also historically plausible: foreign imports were high-value manufactured goods, such as machine-made cotton yarn and cloth, whose penetration into interior markets was constrained chiefly by inland distribution costs, which steamships lowered directly, whereas China's principal exports were collected through long-established native marketing networks and responded less to the new technology (Feuerwerker, 1970).

However, the import composition also means that the design cannot cleanly separate two channels: market deepening that enabled factory entry, and the direct arrival of production equipment along the same steamship corridors. The Customs series does not distinguish capital-goods imports from other imports at the prefecture level, and systematic prefecture-level data on steam-engine power or installations are unavailable. The results in this section should therefore be read as documenting the overall transport channel and its timing, rather than as isolating market deepening to the exclusion of a capital-goods channel.

¹⁸Because many prefecture-decade observations have zero recorded Customs trade, these log-point estimates should be interpreted as changes in recorded flows rather than proportional changes around a representative positive baseline.

¹⁹Table ?? reports the 2SLS estimates using the shift-share instrument described in Section 4.4.

Because Maritime Customs stations were located at treaty ports, the trade results should be read as evidence that steamship connectivity increased recorded flows through the Customs network, not as a complete accounting of commercial activity. Import and export records were, moreover, the most complete and consistently maintained series of the Customs system, whereas transit recording depended directly on whether goods moved under the transit-pass system rather than through unrecorded routings; the import and export results therefore carry the main weight, and the transit results are read as supplementary evidence on recorded port-interior circulation (Brandt et al., 2014; Keller et al., 2017).

Beyond the Customs series, two further pieces of evidence make a pure rerouting interpretation less complete. Hao et al. (2025), using grain-price convergence rather than Customs records, document evidence consistent with improved commodity-market integration in late Qing China. The guild-formation results below likewise indicate broader commercial development in sources compiled outside the Customs system. Neither piece of evidence measures unrecorded trade directly.

The event-study estimates in Panel B of Figure 5 further support this interpretation, with flat pre-adoption coefficients and foreign trade responding almost immediately and persistently after steamship adoption. The transit estimates in Panel C are less pronounced and mostly short of conventional significance, though they display a gradually rising pattern after steamship access, consistent with the recorded-flows character of this series. The foreign-trade response thus clearly preceded the later industrial response.

Beyond recorded flows, steamship connectivity also left a footprint in the organization of commerce. I measure this using a new prefecture-decade panel of newly founded merchant and artisan guilds for 1840–1910, compiled from Peng (1995), a two-volume collection of source materials on Chinese guilds drawn from local gazetteers, guild regulations, and stele inscriptions. I code each documented organization’s founding year and location, including native-place lodges (huiguan) and trade associations (gongsuo), aggregate new foundings to prefecture-decade observations using the boundaries described above, and normalize them by the 1851 population, expressed per 100,000 residents. Because the compilation ends with the Qing period, this outcome is available through 1910. Column (7) of Table 6 shows a positive and statistically significant association between lagged steamship connectivity and subsequent guild density (coefficient = 0.045).

Guild formation does not directly measure trade volumes, but it provides evidence of broader commercial and organizational development associated with steamship access, making an interpretation of the trade results based only on the rerouting of existing flows into recorded channels less complete.

5.2 Native banks and commercial finance

A further intermediate response involves native financial intermediation. I measure this using native-bank density at the prefecture-decade level, constructed from Jiang’s (2014) *Encyclopedic Dictionary of Chinese Banking Institutions and Bankers* and the county-level gazetteers in [Lin et al. \(2021\)](#).

Merchants moving larger volumes of goods required short-term credit, bills of exchange, and deposit services, precisely the functions supplied by native banks; these institutions could also support industrial entry by financing firms or merchants in supply chains ([Rajan and Zingales, 1998](#)).

Column (8) of Table 6 shows a positive association between steamship routes and subsequent native-bank density. Panel D of Figure 5 shows that native-bank density rises after first steamship connection, with flat pre-adoption coefficients. This dynamic pattern, rather than the level association, carries the main evidential weight. At decade frequency, the banking and industrial responses cannot be sharply ordered: both build gradually, with much of the increase appearing two to three decades after access, whereas recorded foreign trade responds almost immediately. Native banking is therefore interpreted as one dimension of the commercial deepening associated with steamship access and as a plausible complement to later industrial entry, rather than as a separately identified causal step from finance to industry.

The finance evidence should nonetheless be read cautiously. These regressions measure bank density rather than lending volumes or loan allocation. The purpose of this section is therefore not to prove a complete steamships-to-banks-to-factories chain, but to show that the commercial and financial environment became more supportive alongside the later expansion of industrial entry.

5.3 Functional-form robustness

A remaining concern with the estimates above is functional form. The outcome variables are non-negative densities or values with many zeros: most prefecture-decades record no new industrial firms, no Customs trade, and no native banks. Linear per-capita specifications can be sensitive to the resulting skewness, and logarithmic transformations of the form $\log(y+1)$, used above for the foreign trade outcomes, yield coefficients that depend on the units of measurement and lack a proportional-effects interpretation ([Chen and Roth, 2024](#)). A related concern applies to the treatment side: in a multiplicative model, a route count would impose a constant proportional effect of each additional route, a strong restriction given the concentration of routes in a few hub prefectures.

I therefore measure treatment as a binary indicator of steamship access, lagged one decade, the

extensive-margin definition that matches the staggered-adoption design of Section 4.3. Table ?? re-estimates the principal outcomes with Poisson pseudo-maximum-likelihood (PPML), which models the conditional mean multiplicatively, accommodates zeros directly, and, for the trade outcomes, is applied to values in levels rather than logarithms. All specifications retain prefecture and decade fixed effects and the full set of interacted controls, including macroregion-by-decade fixed effects. PPML drops prefectures whose outcome is zero in every period, which accounts for the smaller estimation samples.²⁰

[Table ?? about here]

The estimates are positive and statistically significant for all five outcomes. Gaining steamship access is associated with roughly 70 percent more newly established industrial firms (column (1); $\exp(0.533) - 1 \approx 0.70$) and a considerably larger proportional increase in native-bank density (column (5)). The trade coefficients in columns (2)–(4) are substantially larger, implying several-fold increases in Customs-recorded values; these magnitudes reflect the low recorded-trade base of newly connected prefectures, where access moved many observations from zero or near-zero to positive values. Across outcomes, the PPML estimates provide complementary evidence that the positive relationships also appear under a multiplicative specification that accommodates zeros directly and defines steamship treatment at the extensive margin.

6 Conclusion

This paper documents a robust relationship between steamship connectivity and subsequent industrial entry in China from the 1840s through 1927. The relationship extends beyond formal treaty-port prefectures, survives controls for pre-steamship economic fundamentals, macroregion-by-decade fixed effects, and other transport and communication technologies, and is supported by complementary shift-share IV evidence. The estimates are largest in trade-intensive sectors, especially textiles. Customs-recorded foreign trade responds almost immediately after access, while native banking and industrial entry expand more gradually, a pattern consistent with commercial deepening accompanying fixed industrial investment.

The broader implication is that transport technology and gateway institutions should be studied together but not conflated. In Britain and continental Europe, improved transport, wider markets, and industrial concentration often advanced together, making the separate role of connectivity difficult to assess (Szostak, 1991; Bogart, 2005; Allen, 2023). In China, steam navigation entered through treaty ports and subsequently extended beyond formal treaty-port prefectures along navi-

²⁰PPML also drops separated observations, yielding outcome-specific estimation samples.

gable waterways, while remaining embedded in the broader treaty-port trade and institutional system. The estimates therefore capture the spatial transmission of treaty-port-era economic change through the steamship network, rather than a transport effect strictly separable from the institutions with which it arrived. The finding that industrial entry lagged behind trade and commercial finance also extends Crafts's (2004) argument that steam's payoff required complementary adjustments beyond the European settings in which it is usually studied.

Data availability

The data and replication code underlying this article will be deposited in the OpenICPSR repository upon acceptance; a DOI-based citation and link will be provided at that time.

References

- Allen, Robert C., 2023, The transportation revolution and the English coal industry, 1695–1842: A geographical approach, *The Journal of Economic History* 83, 1175–1220.
- Bogart, Dan, 2005, Turnpike trusts and the transportation revolution in 18th century England, *Explorations in Economic History* 42, 479–508.
- Borusyak, Kirill, Peter Hull, and Xavier Jaravel, 2022, Quasi-experimental shift-share research designs, *Review of Economic Studies* 89, 181–213.
- Brandt, Loren, Debin Ma, and Thomas G. Rawski, 2014, From divergence to convergence: Re-evaluating the history behind China's economic boom, *Journal of Economic Literature* 52, 45–123.
- Braun, Sebastian Till, and Richard Franke, 2022, Railways, growth, and industrialization in a developing German economy, 1829–1910, *The Journal of Economic History* 82, 1183–1221.
- Callaway, Brantly, and Pedro H. C. Sant'Anna, 2021, Difference-in-differences with multiple time periods, *Journal of Econometrics* 225, 200–230.
- Cao, Shuji, 2001, *Zhongguo renkoushi: qing shiqi [Population History of China: Qing Period]* (Fudan University Press, Shanghai).
- Chen, Jiafeng, and Jonathan Roth, 2024, Logs with zeros? Some problems and solutions, *The Quarterly Journal of Economics* 139, 891–936.
- Chen, Yuqing, 2013, *Guomin zhengfu qingcha zhengli zhaoshangju weiyuanhui baogaoshu [Report of the Nationalist Government Committee on Investigation and Rectification of the China Merchants Bureau]* (Social Sciences Academic Press, Beijing).

- Cheng, Linsun, 2003, *Banking in Modern China: Entrepreneurs, Professional Managers, and the Development of Chinese Banks, 1897–1937* (Cambridge University Press, Cambridge).
- China Historical Geographic Information System, 2016, CHGIS, version: 6, Fairbank Center for Chinese Studies of Harvard University and the Center for Historical Geographical Studies at Fudan University.
- China's Military History Editorial Committee, 2003, *Zhongguo lidai zhanzheng nianbiao [A Chronology of Warfare in Dynastic China]* (Zhongguo Renmin Jiefangjun Chubanshe).
- Conley, Timothy G., 1999, GMM estimation with cross sectional dependence, *Journal of Econometrics* 92, 1–45.
- Crafts, Nicholas, 2004, Steam as a general purpose technology: A growth accounting perspective, *The Economic Journal* 114, 338–351.
- Crafts, Nicholas, 2011, Explaining the first Industrial Revolution: two views, *European Review of Economic History* 15, 153–168.
- Donaldson, Dave, 2018, Railroads of the Raj: Estimating the impact of transportation infrastructure, *American Economic Review* 108, 899–934.
- Donaldson, Dave, and Richard Hornbeck, 2016, Railroads and American economic growth: A 'market access' approach, *The Quarterly Journal of Economics* 131, 799–858.
- Du, Xuncheng, 2014, *Minzu ziben zhuyi yu jiuzhongguo zhengfu, 1840–1937 [National Capitalism and the Old Chinese Government, 1840–1937]* (Shanghai Renmin Chubanshe, Shanghai).
- East Asia Common Culture Society, 1917, *Shina Sōbetsu Zenshishi [A Comprehensive Gazetteer of the Provinces in China]* (Guojia Tushuguan Chubanshe, Beijing), Reprint 2015.
- Fairbank, John King, 1964, *Trade and Diplomacy on the China Coast: The Opening of Treaty Ports, 1842–1854* (Harvard University Press).
- Feuerwerker, Albert, 1970, Handicraft and manufactured cotton textiles in China, 1871–1910, *The Journal of Economic History* 30, 338–378.
- Findlay, Ronald, and Kevin H. O'Rourke, 2009, *Power and Plenty: Trade, War, and the World Economy in the Second Millennium* (Princeton University Press, Princeton, NJ).
- Gao, Pei, and Yu-Hsiang Lei, 2021, Communication infrastructure and stabilizing food prices: evidence from the telegraph network in China, *American Economic Journal: Applied Economics* 13, 65–101.
- Goldsmith-Pinkham, Paul, Isaac Sorkin, and Henry Swift, 2020, Bartik instruments: What, when, why, and how, *American Economic Review* 110, 2586–2624.

- Guo, Yibei, and Baomin Dong, 2021, Railway and trade in modern China: evidence from the 1930s, *China Economic Review* 69, 101661.
- Hao, Yu, and Yuxiang Wang, 2025, Telegraph and capital market integration: Evidence from late imperial China, *The Economic History Review* 79, 781–810.
- Hao, Yu, Zhiqiang Wang, and Zhe Zhang, 2025, Steamship shipping and market integration: Evidence from late Qing China, *Jingji kexue [Economic Science]* 215–237.
- Jedwab, Remi, and Alexander Moradi, 2016, The permanent effects of transportation revolutions in poor countries: Evidence from Africa, *The Review of Economics and Statistics* 98, 268–284.
- Jia, Ruixue, 2014, The legacies of forced freedom: China’s treaty ports, *The Review of Economics and Statistics* 96, 596–608.
- Jiang, Jianqing, 2014, *Jindai zhongguo yinhangye jigou renming dacidian [Encyclopedic Dictionary of Chinese Banking Institutions and Bankers]* (Shanghai Guji Chubanshe, Shanghai).
- Jin, Gan, 2023, Circle of fortune: The long-term impact of Western customs institution in China, *Journal of Development Economics* 163, 103075.
- Keller, Wolfgang, Javier Andres Santiago, and Carol H. Shiue, 2017, China’s domestic trade during the treaty-port era, *Explorations in Economic History* 63, 26–43.
- Keller, Wolfgang, and Carol H. Shiue, 2021, The economic consequences of the opium war, NBER Working Paper 29404.
- Köll, Elisabeth, 2022, Transport and communication infrastructure, in Debin Ma, and Richard von Glahn, eds., *The Cambridge Economic History of China, Volume II: 1850–1950*, 457–495 (Cambridge University Press, Cambridge).
- Lehner, Bernhard, and Günther Grill, 2013, Global river hydrography and network routing: baseline data and new approaches to study the world’s large river systems, *Hydrological Processes* 27, 2171–2186.
- Levine, Ross, Chen Lin, Chicheng Ma, and Yuchen Xu, 2023, The legal origins of financial development: Evidence from the Shanghai concessions, *The Journal of Finance* 78, 3423–3464.
- Lin, Chen, Chicheng Ma, Yuchen Sun, and Yuchen Xu, 2021, The telegraph and modern banking development, 1881–1936, *Journal of Financial Economics* 141, 730–749.
- Liu, Cong, 2020, The effects of World War I on the Chinese textile industry: Was the world’s trouble China’s opportunity?, *The Journal of Economic History* 80, 246–285.
- Liu, Kwang-Ching, 1962, *Anglo-American steamship rivalry in China, 1862–1874* (Harvard University Press).

- Liu, Ts'ui-jung, 1980, *Trade on the Han River and Its Impact on Economic Development, c. 1800–1911* (Institute of Economics, Academia Sinica, Taipei).
- Martinez, Marco, Alessandro Nuvolari, and Michelangelo Vasta, 2025, Rails of progress? exploring the nexus between railroad access and innovation in Italy (19th–20th centuries), *Explorations in Economic History* 101718.
- Nie, Baozhang, 1983, *Zhongguo jindai hangyunshi ziliao [Historical Materials of Ship Transport in Modern China]*, vol. 1 (Shanghai People's Press, Shanghai).
- Nie, Baozhang, and Yingui Zhu, 2002, *Zhongguo jindai hangyunshi ziliao [Historical Materials of Ship Transport in Modern China]*, vol. 2 (China's Social Science Press, Beijing).
- O'Rourke, Kevin Hjortshøj, and Jeffrey G. Williamson, 2001, *Globalization and history: the evolution of a nineteenth-century Atlantic economy* (MIT Press, Cambridge, MA).
- Pascali, Luigi, 2017, The wind of change: Maritime technology, trade, and economic development, *American Economic Review* 107, 2821–2854.
- Peng, Zeyi, 1995, *Zhongguo gongshang hanghui shiliao ji [Source Materials on Chinese Commercial and Artisan Guilds]*, 2 vols (Zhonghua Shuju, Beijing).
- Rajan, Raghuram G., and Luigi Zingales, 1998, Financial dependence and growth, *American Economic Review* 88, 559–586.
- Rawski, Thomas G., 1969, Chinese dominance of treaty port commerce and its implications, 1860–1875, *Explorations in Economic History* 7, 451–473.
- Reinhardt, Anne, 2018, *Navigating Semi-Colonialism: Shipping, Sovereignty, and Nation-Building in China, 1860–1937* (Harvard University Asia Center, Cambridge, MA).
- Second Historical Archives of China, 2001, *Zhongguo jiu hai guan shiliao [China's Old Customs Historical Materials]*, 1859–1948 (Jinghua Publishing House, Beijing).
- Shizhengchu, 1967, *Zhongguo xiandai junshishi zhuyao zhanyi biao [Chronicles of Major Battles in China's Modern Military History]* (Shizhengchu, Taipei).
- Skinner, G. William, 1977, Regional urbanization in nineteenth-century China, in G. William Skinner, ed., *The City in Late Imperial China*, 211–249 (Stanford University Press, Stanford).
- Sun, Benxiang, 2003, *Zhongguo tielu zhanming cidian [Dictionary of Chinese Railway Stations]* (Zhongguo Tiedao Chubanshe, Beijing).
- Szostak, Rick, 1991, *The Role of Transportation in the Industrial Revolution: A Comparison of England and France* (McGill-Queen's University Press, Montreal).
- The People's Bank of China Shanghai Branch, 1960, *Shanghai qianzhuang shiliao [Historical Materials on Money Houses in Shanghai]* (Shanghai Renmin Chubanshe, Shanghai).

Transportation History Compilation Committee, 1931, *Jiaotong shi: hangzheng bian [History of Transportation: Shipping Administration]* (Guojia Tushuguan Chubanshe, Beijing), Reprint 2009.

U.S. Army Corps of Engineers, 1980, Layout and design of shallow-draft waterways, Technical Report Engineer Manual EM 1110-2-1611, Department of the Army, Washington, DC.

Yan, Zhongping, 2012, *Zhongguo jindai jingjishi tongji ziliao xuanji [Selected Statistics of the Early Modern China]* (Zhongguo Shehui Kexue Chubanshe, Beijing).

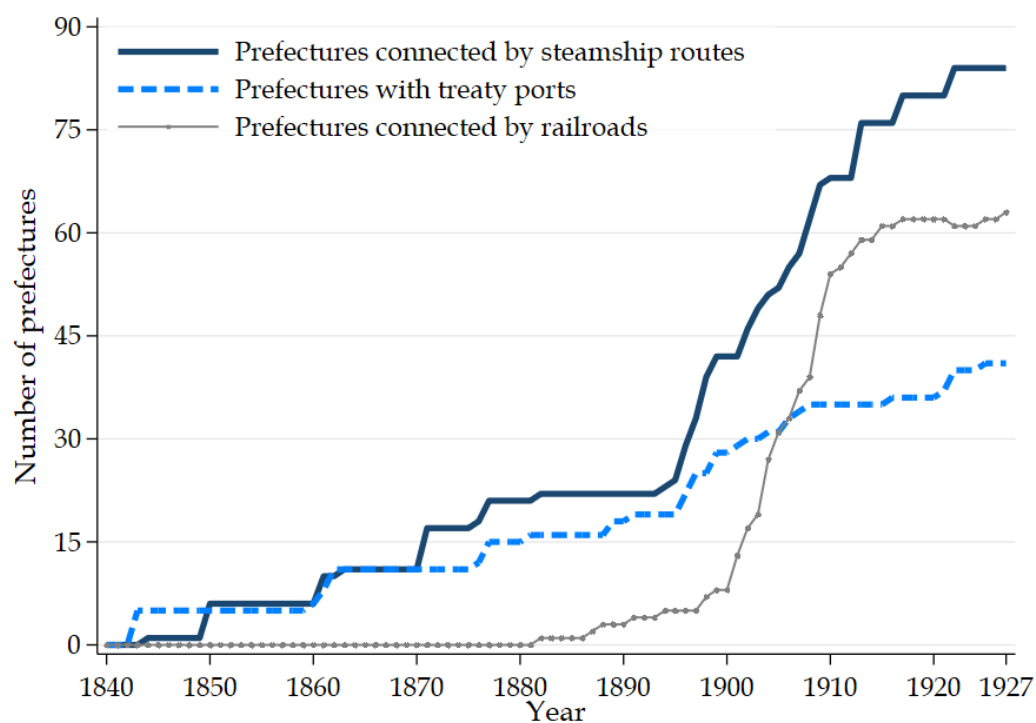


Figure 1. **The spread of steamships, treaty ports, and railways, 1840–1927**

Note: See Section 3 for data sources. This figure reports the number of prefectures served by regular steamship routes, hosting treaty ports, and served by railways in each year from 1840 to 1927.

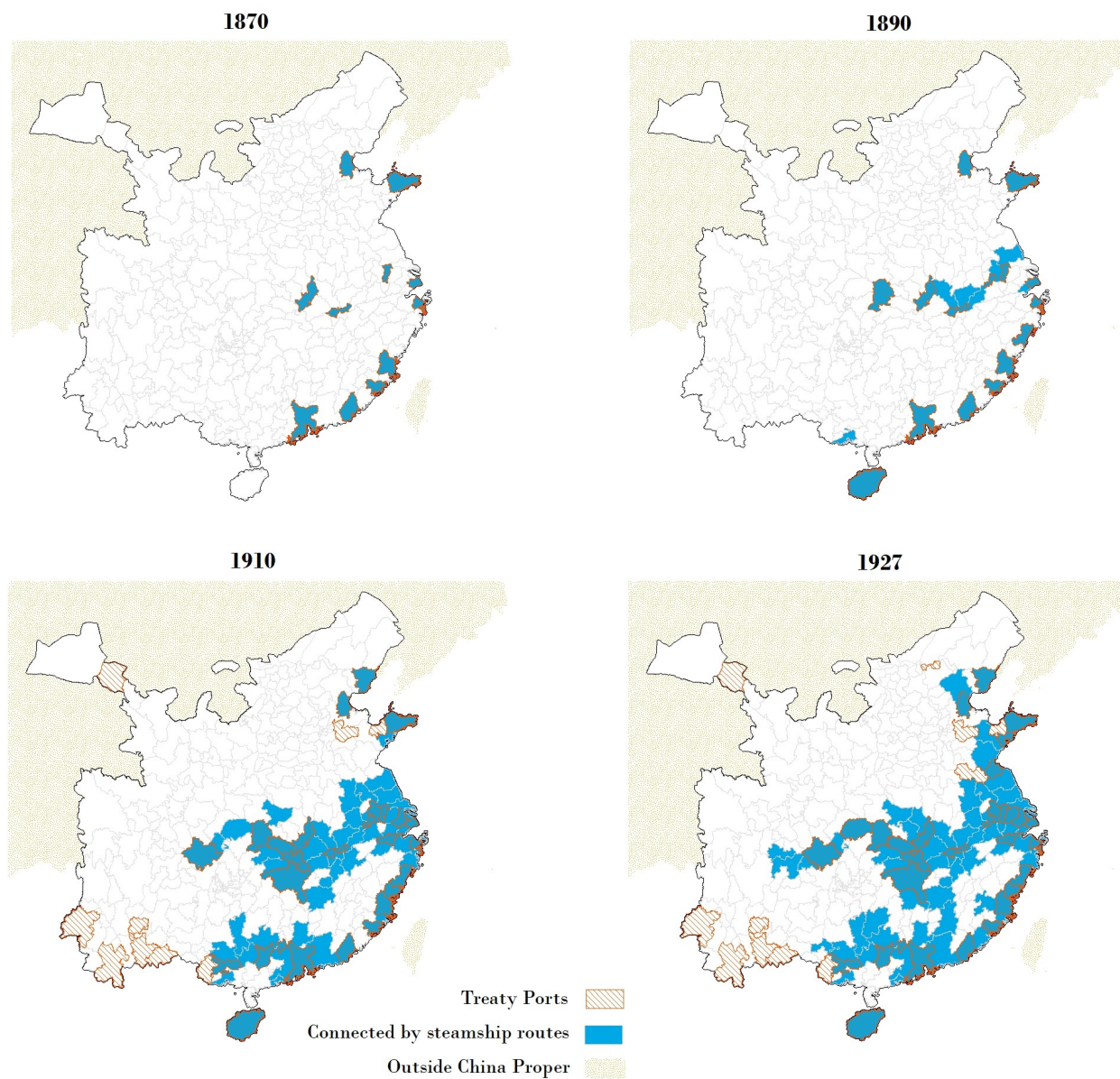
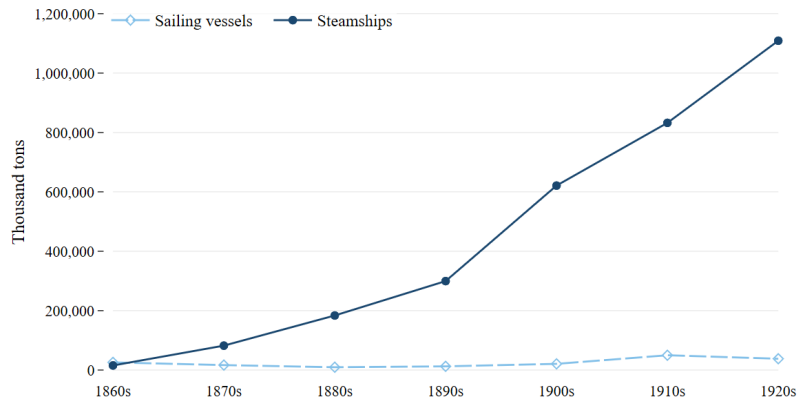
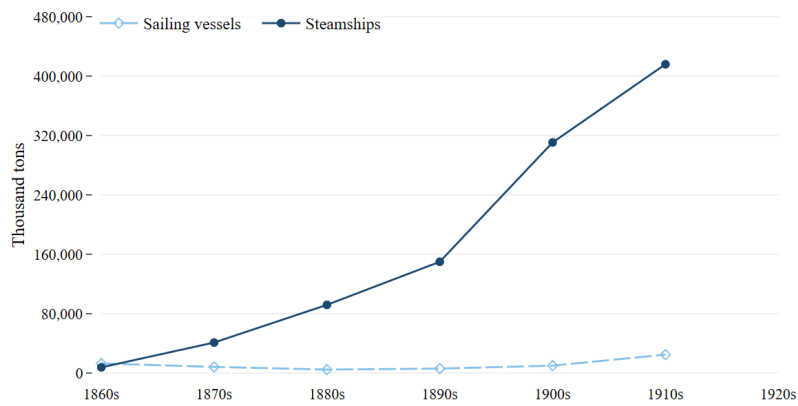


Figure 2. **Steamship routes and treaty ports**

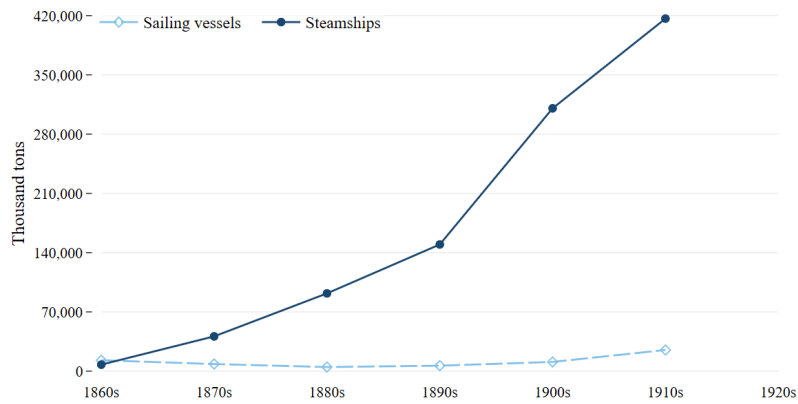
Note: This figure shows the number of steamship routes serving each prefecture (in blue) and the prefectures hosting treaty ports (orange hatched areas) over time.



Panel A. Total tonnage



Panel B. Entered inwards tonnage



Panel C. Cleared outwards tonnage

Figure 3. Tonnage carried by sailing vessels and steamships in Maritime Customs records

Note: This figure reports decade-level vessel tonnage from Maritime Customs records, 1860–1927. Panels B and C distinguish vessels entering and departing Customs ports. For 1920–1927, only total tonnage is recorded.

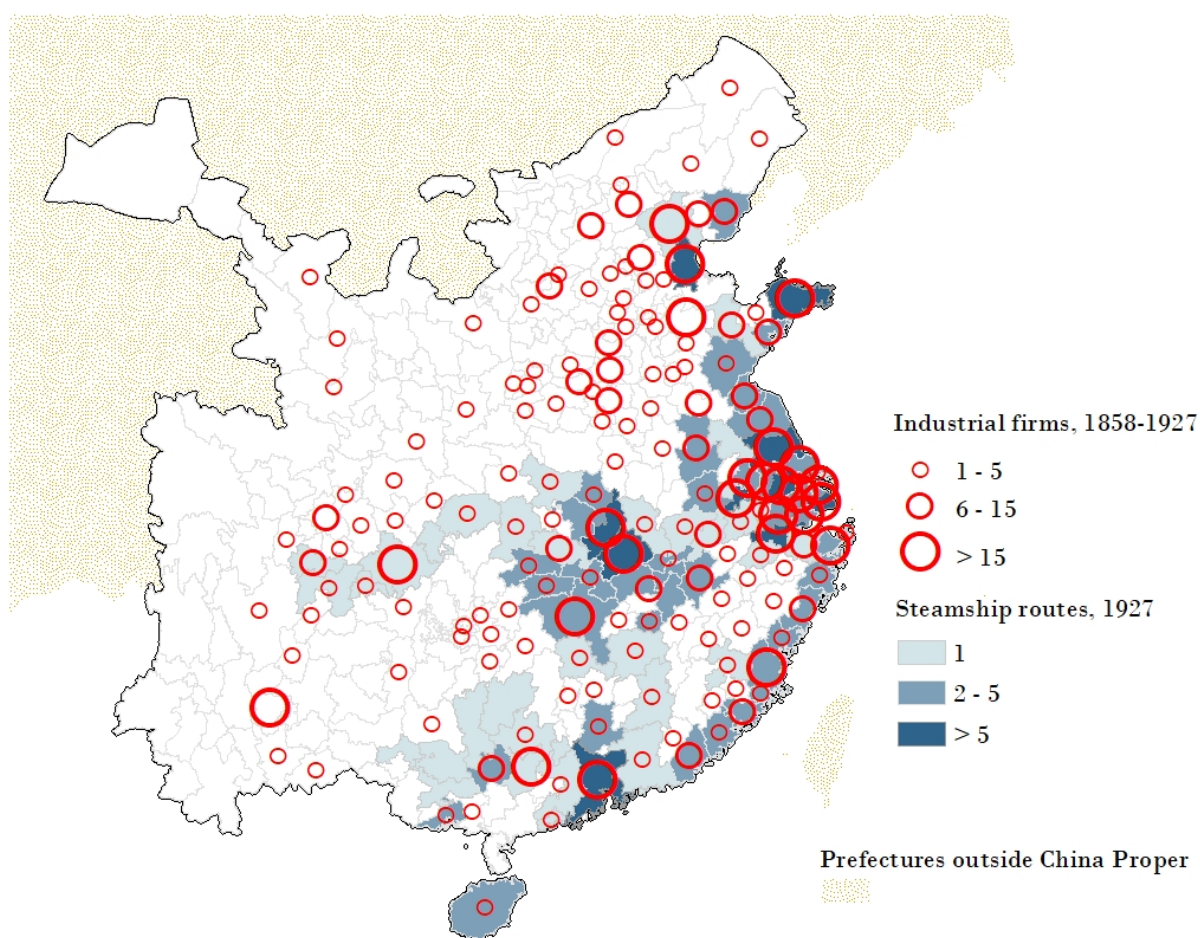
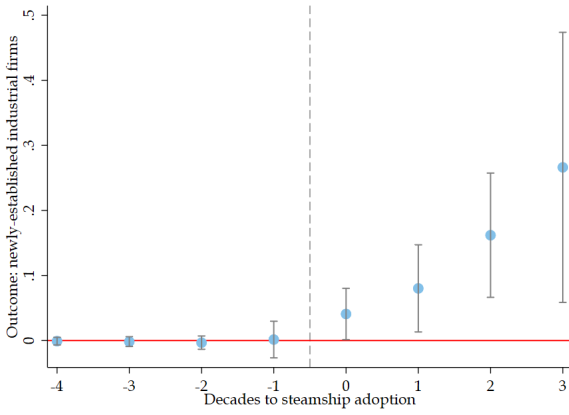
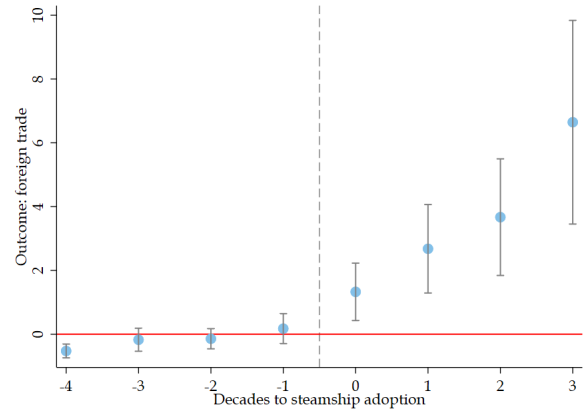


Figure 4. **Steamship routes and industrial establishments, 1858–1927**

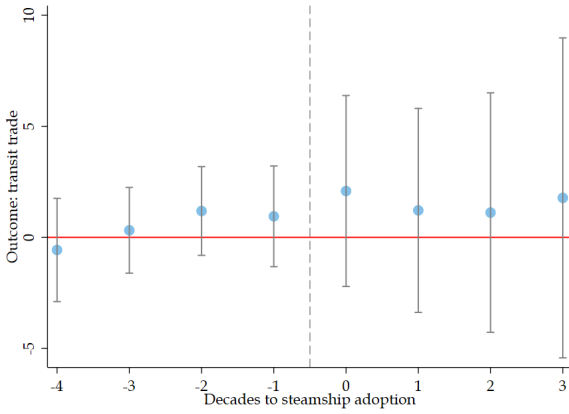
Note: This figure shows the number of steamship routes serving each prefecture in 1927 (indicated by color) and the cumulative number of industrial firms established from 1858 through 1927 (represented by bubbles).



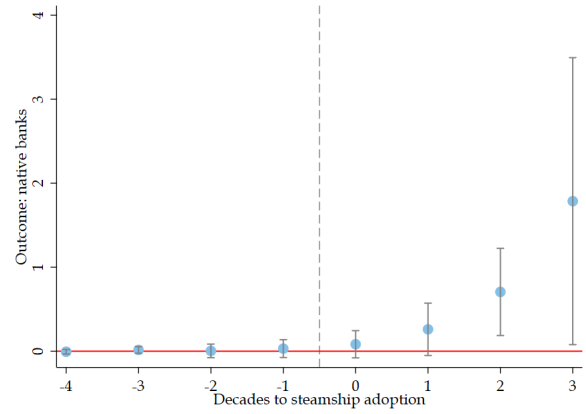
(a) Panel (A): modern industrial firms



(b) Panel (B): foreign trade value



(c) Panel (C): inland transit trade value



(d) Panel (D): native banks

Figure 5. **Staggered steamship adoption and outcome dynamics**

Note: This figure reports event-study estimates with 95% confidence intervals around first steamship adoption, omitting the decade before adoption. Panels A–D show effects on industrial entry, foreign trade, inland transit trade, and native banks, respectively. All four panels are estimated over the common 1850–1927 window using the same adoption-cohort definition and never-treated comparison group.

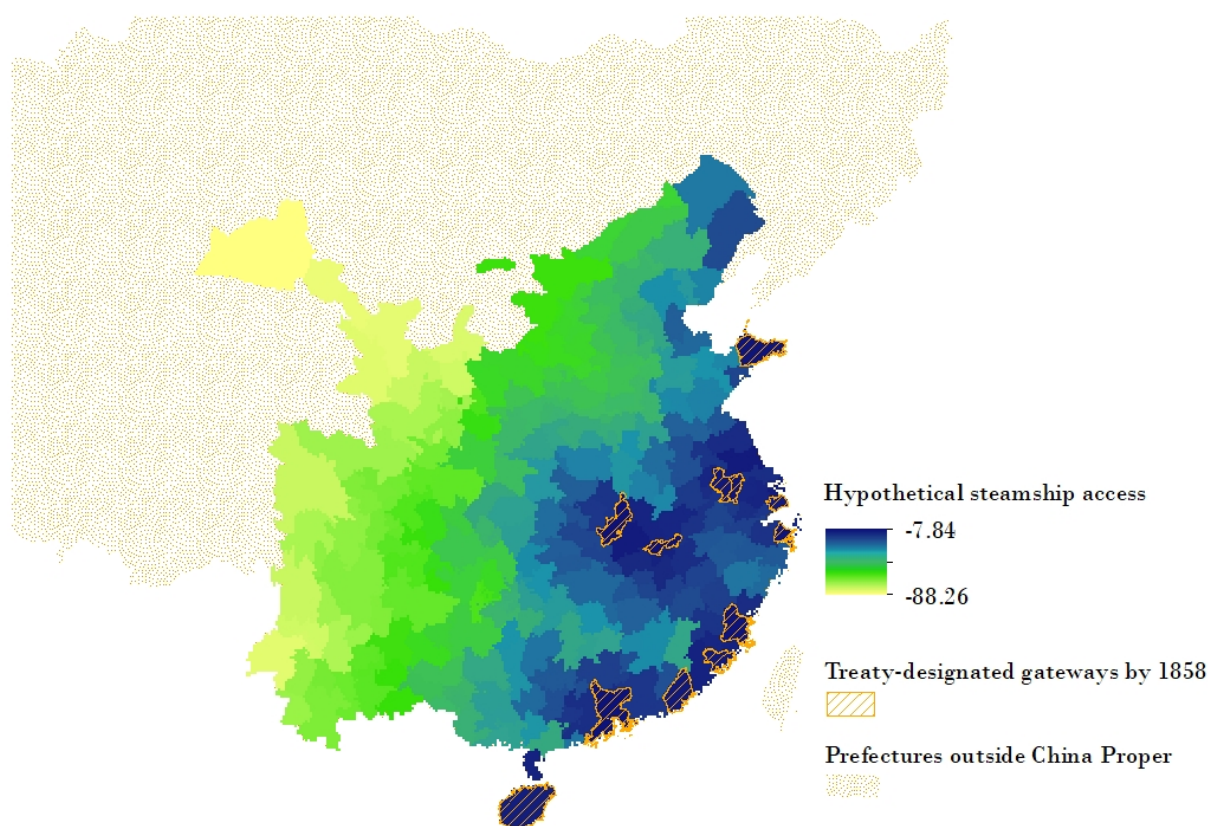


Figure 6. **Hypothetical steamship-navigable access to treaty-designated gateways by 1858**

Note: This figure maps the cross-sectional exposure component of the shift-share instrument: each prefecture's negative shortest distance to treaty-designated gateways as of 1858 through a hypothetical steamship-navigable waterway network. Hatched areas mark prefectures hosting the 1858 treaty ports.

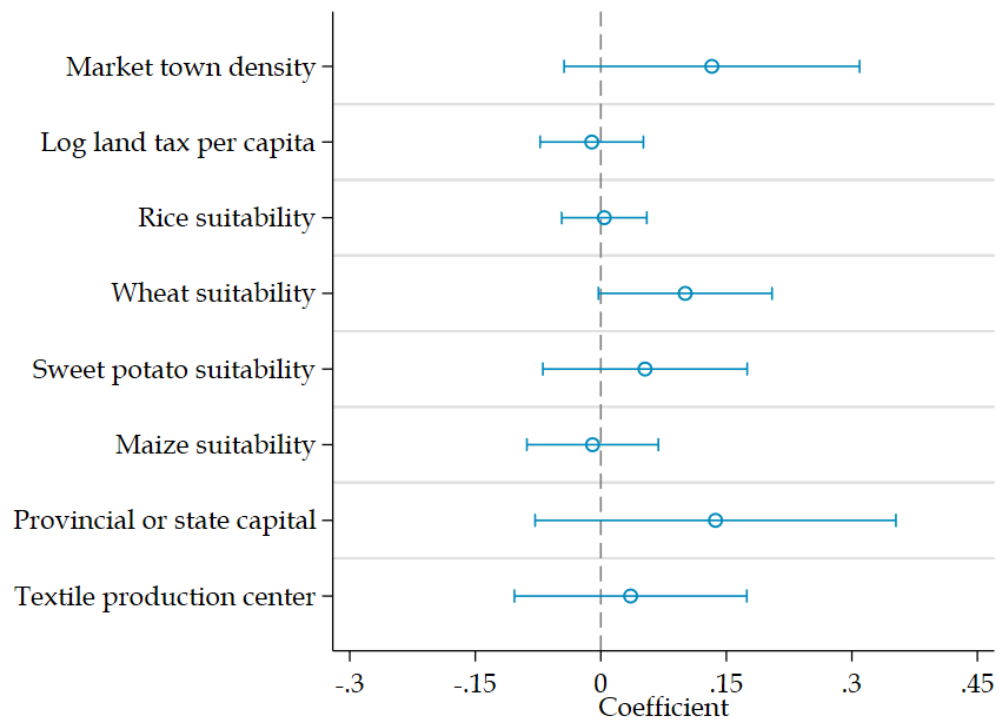


Figure 7. **Pre-opening correlates of hypothetical steamship-navigable access**

Note: This figure reports coefficients and 95% confidence intervals from regressions of standardized pre-opening characteristics on hypothetical steamship-navigable access to treaty-designated gateways as of 1858. Regressions control for ruggedness, river distance, and coastal distance.

Table 1. **Summary statistics**

Variable	Obs	Mean	SD	Min	Max
Industrial firms, 1840–1927	2,556	1.038	8.253	0	273
Steamship routes	2,556	0.266	0.881	0	8
Population (1,000 persons)	2,556	1,388.29	1,325	16.58	8,386.2
Treaty ports	2,556	0.085	0.324	0	4
Railway stations	2,556	0.216	0.890	0	8
Telegraph stations	2,556	0.802	1.446	0	11
Postal stations	2,556	1.595	2.729	0	18
Wars	2,556	0.589	1.871	0	24
Foreign trade values (1,000 silver taels), 1850–1927	2,272	520.1	4,987	0	171,838.8
Transit trade values (1,000 silver taels), 1850–1927	2,272	1,396.8	10,781.4	0	293,822.1
Merchant and artisan guilds, 1840–1910	1,988	0.262	1.907	0	48
Native banks, 1840–1927	2,556	5.485	17.538	0	220
Area (km ²)	284	14,267.5	14,121	229.07	133,814
Terrain ruggedness	284	233.47	188.11	4.421	972.47
Distance: major rivers	284	63.66	73.24	0.028	606.26
Distance: coastline	284	501.48	364.54	2.186	1,614
Provincial or state capital	284	0.063	0.244	0	1

Table 2. **Baseline results: steamship routes and industrial entry**

	Industrial firms (per 100,000 population), 1840–1927							Water-adj.
	Full sample							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
L. Steamship routes	0.157** (0.062)	0.127** (0.061)	0.127** (0.060)	0.099** (0.049)	0.096** (0.046)	0.069*** (0.024)	0.075*** (0.025)	0.105** (0.048)
L. (log) Population density			0.015 (0.019)	0.015 (0.019)	0.027 (0.022)	0.050** (0.020)	0.039* (0.020)	0.030 (0.035)
L. Treaty ports				0.192** (0.094)	0.207** (0.101)	0.198** (0.090)	0.194** (0.092)	0.204* (0.119)
Prefecture FE + Decade FE	Y	Y	Y	Y	Y	Y	Y	Y
Baseline controls $\times$ Decade FE		Y	Y	Y	Y	Y	Y	Y
Agricultural potential $\times$ Decade FE					Y	Y	Y	Y
Commercial potential $\times$ Decade FE						Y	Y	Y
Skinner macroregion $\times$ Decade FE							Y	Y
Observations	2,556	2,556	2,556	2,556	2,547	2,547	2,547	1,269
Number of prefectures	284	284	284	284	283	283	283	141
Mean of outcomes	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.068
Adjusted R^2	0.336	0.340	0.340	0.353	0.367	0.415	0.401	0.388

Note: The dependent variable is newly established industrial firms per 100,000 residents (1851 population). Columns (1)–(4) use all 284 prefectures; columns (5)–(7) exclude Cha'har Ting, for which 1820 land-tax data are unavailable. Column (8) restricts the sample to water-adjacent prefectures; Maogong Ting, the sole prefecture in its macroregion, is dropped as a singleton when macroregion $\times$ decade fixed effects are included, leaving 141 prefectures. Baseline controls: terrain ruggedness, (log) distance to rivers and the coast, and provincial- and state-capital status. Agricultural-potential controls: (log) 1820 land tax per capita and suitability for wheat, rice, maize, and sweet potato. Commercial-potential controls: 1820 market-town density and pre-1840 textile-center status. Standard errors clustered by prefecture are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

Table 3. Accounting for alternative technologies and shocks

	Industrial firm density, 1840–1927					Excl. treaty ports	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
L. Steamship routes	0.080*** (0.024)	0.087*** (0.028)	0.084*** (0.026)	0.089*** (0.027)	0.085*** (0.026)	0.034*** (0.012)	
L. 1(having steamship access)							0.050** (0.021)
L. (log) Population density	0.080** (0.033)	0.086** (0.034)	0.090*** (0.034)	0.084** (0.033)	0.076** (0.033)	0.055*** (0.017)	0.053*** (0.018)
L. Treaty ports	0.193 (0.121)	0.217 (0.133)	0.213* (0.129)	0.216* (0.130)	0.193 (0.121)		
L. Railway stations	0.084** (0.037)				0.083** (0.038)	0.032*** (0.011)	0.033*** (0.011)
L. Telegraph stations		0.001 (0.017)			−0.020 (0.025)	−0.002 (0.008)	0.001 (0.008)
L. Postal stations			0.013 (0.011)		0.012 (0.014)	−0.003 (0.005)	−0.004 (0.005)
L. Wars				0.007 (0.005)	0.005 (0.004)	0.001 (0.002)	0.001 (0.002)
Baseline controls × Decade FE	Y	Y	Y	Y	Y	Y	Y
Agricultural potential × Decade FE	Y	Y	Y	Y	Y	Y	Y
Commercial potential × Decade FE	Y	Y	Y	Y	Y	Y	Y
Skinner macroregion × Decade FE	Y	Y	Y	Y	Y	Y	Y
Prefecture FE + Decade FE	Y	Y	Y	Y	Y	Y	Y
Observations	1,269	1,269	1,269	1,269	1,269	963	963
Mean of outcomes	0.068	0.068	0.068	0.068	0.068	0.029	0.029
Adjusted R^2	0.413	0.397	0.399	0.398	0.413	0.460	0.454

Note: This table relates lagged steamship routes to industrial entry in the 141-prefecture water-adjacent sample used in Column (8) of Table 2; Columns (6) and (7) exclude the 34 ever-treaty-port prefectures; Column (7) replaces route count with a binary indicator of steamship access. Specifications progressively add competing technologies and war and retain the baseline controls, pre-opening agricultural and commercial potential, and Skinner macroregion-by-decade fixed effects. Standard errors clustered by prefecture are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 4. Shift-share IV estimates

	Lagged steamship routes, 1850–1927	Industrial firm density, 1850–1927		
	(1)	(2)	(3)	(4)
L. Hypothetical access $\times$ national tonnage	0.097*** (0.020)			
L. Steamship routes		0.146** (0.064)	0.142** (0.065)	0.182* (0.093)
L. Treaty ports	Y	Y	Y	Y
L. (log) Population density	Y	Y	Y	Y
Baseline controls $\times$ Decade FE	Y	Y	Y	Y
Prefecture FE + Decade FE	Y	Y	Y	Y
L. Alternative technologies and wars	Y	Y	Y	Y
Agricultural potential $\times$ Decade FE	Y	Y	Y	Y
Commercial potential $\times$ Decade FE	Y		Y	Y
Skinner macroregion $\times$ Decade FE	Y			Y
Observations	1,128	1,136	1,136	1,128
Number of prefectures	141	142	142	141
Kleibergen–Paap rk Wald F statistic		36.366	39.913	24.695
Adjusted R^2	0.742			

Note: This table reports 2SLS estimates using the lagged interaction between hypothetical access to treaty-port gateways designated by 1858 and national steamship tonnage as an instrument for lagged steamship routes. Because national steamship-tonnage data are unavailable for the 1840s, all specifications cover 1850–1927 (eight decades). Column (1) reports the first stage corresponding to the specification in column (4), while columns (2)–(4) report second-stage estimates. All specifications include lagged treaty-port status, population density, alternative transport and communication technologies, wars, prefecture fixed effects, decade fixed effects, and baseline controls interacted with decade fixed effects. Column (3) additionally controls for commercial potential interacted with decade fixed effects, and column (4) further includes Skinner macroregion-by-decade fixed effects. Maogong Ting is the sole prefecture in its macroregion and is therefore dropped as a singleton when macroregion-by-decade fixed effects are included, leaving 141 rather than 142 prefectures in Columns (1) and (4). Standard errors clustered by prefecture are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 5. **Heterogeneity across industrial sectors**

	Textile	Food proc.	Mach. & mat.	Mining	Chemistry	Infra. & util.	Misc.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
L. Steamship routes	0.043*** (0.013)	0.013** (0.006)	0.010** (0.004)	0.003 (0.002)	0.005** (0.003)	0.004 (0.003)	0.007 (0.005)
L. (log) Population density	0.015 (0.014)	0.007 (0.006)	0.004 (0.004)	0.008 (0.007)	0.003 (0.004)	0.015** (0.007)	0.006 (0.005)
L. Treaty ports	0.095* (0.054)	0.018 (0.020)	0.018 (0.017)	−0.003 (0.006)	0.015 (0.013)	0.008 (0.010)	0.034 (0.022)
L. Railway stations	0.035** (0.016)	0.016** (0.006)	0.008 (0.006)	0.007** (0.003)	0.005 (0.004)	0.003 (0.003)	0.009 (0.006)
L. Telegraph stations	−0.003 (0.011)	−0.005 (0.004)	−0.005 (0.004)	−0.002 (0.002)	−0.003 (0.003)	0.001 (0.003)	−0.003 (0.005)
L. Postal stations	0.002 (0.006)	0.003 (0.002)	0.001 (0.003)	0.000 (0.002)	0.002 (0.001)	0.001 (0.002)	0.003 (0.002)
L. Wars	0.001 (0.002)	0.000 (0.000)	0.001 (0.001)	0.001 (0.001)	0.000 (0.000)	0.000 (0.001)	0.001 (0.001)
Baseline controls × Decade FE	Y	Y	Y	Y	Y	Y	Y
Agricultural potential × Decade FE	Y	Y	Y	Y	Y	Y	Y
Commercial potential × Decade FE	Y	Y	Y	Y	Y	Y	Y
Skinner macroregion × Decade FE	Y	Y	Y	Y	Y	Y	Y
Prefecture FE + Decade FE	Y	Y	Y	Y	Y	Y	Y
Observations	1,269	1,269	1,269	1,269	1,269	1,269	1,269
Adjusted R^2	0.429	0.350	0.205	0.136	0.217	0.418	0.289

Note: This table reports results using the one-decade-lagged number of steamship routes in each prefecture to predict sector-specific industrial entry, with the sample restricted to the 141 prefectures used in Column (8) of Table 2 and controls as in column (5) of Table 3. Standard errors clustered at the prefecture level are reported in parentheses. *, **, and *** indicate significance at 10%, 5% and 1%, respectively.

Table 6. Steamship connectivity, recorded trade flows, guild formation, and native banking

	ln(foreign trade values + 1), 1850–1927			ln(transit trade values + 1), 1850–1927			Guild density, 1840–1910	Native bank density, 1840–1927
	Total (1)	Import (2)	Export (3)	Total (4)	Inward (5)	Outward (6)	(7)	(8)
L. Steamship routes	0.745** (0.296)	0.742*** (0.273)	0.698** (0.288)	0.681* (0.370)	0.740** (0.367)	0.541 (0.362)	0.045*** (0.017)	0.105 (0.065)
L. (log) Pop. density	-0.314 (0.572)	-0.084 (0.492)	-0.376 (0.558)	-1.067 (0.977)	-1.133 (0.888)	-0.095 (0.967)	0.025* (0.014)	0.193 (0.159)
L. Treaty ports	5.775*** (1.158)	4.923*** (1.006)	5.626*** (1.139)	3.440*** (0.920)	3.090*** (0.917)	3.689*** (1.025)	0.034 (0.045)	0.498** (0.191)
L. Railway stations	0.054 (0.280)	0.086 (0.262)	0.041 (0.272)	0.246 (0.351)	0.353 (0.349)	0.041 (0.335)	-0.008 (0.011)	-0.015 (0.070)
L. Telegraph stations	0.099 (0.169)	0.137 (0.136)	0.093 (0.168)	-0.087 (0.283)	-0.068 (0.288)	0.060 (0.234)	0.007 (0.005)	-0.026 (0.070)
L. Postal stations	-0.160 (0.106)	-0.138 (0.095)	-0.160 (0.103)	0.213 (0.192)	0.199 (0.183)	0.174 (0.174)	-0.003 (0.009)	-0.014 (0.034)
L. Wars	0.023 (0.050)	0.016 (0.045)	0.022 (0.049)	-0.047 (0.063)	-0.054 (0.065)	-0.034 (0.046)	0.002** (0.001)	0.016 (0.012)
All controls & FEs	Y	Y	Y	Y	Y	Y	Y	Y
Observations	1,128	1,128	1,128	1,128	1,128	1,128	987	1,269
Adjusted R^2	0.792	0.801	0.789	0.620	0.616	0.467	0.472	0.478

Note: This table examines steamship connectivity, recorded goods flows (1850–1927, Columns (1)–(6)), merchant and artisan guild density (1840–1910, Column (7)), and native bank density (1840–1927, Column (8)), using the 141-prefecture sample and the same covariates and fixed effects as Column (5) of Table 3. Standard errors clustered at the prefecture level are in parentheses. *, **, and *** indicate significance at 10%, 5% and 1%, respectively.