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The Economic Consequences of the Opium War: Spatial Dimensions*

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Abstract

This paper uses the West’s intervention in 19th century China to study the impact of colonialism that is geographically limited to certain parts of an economy. Employing a storage cost model to obtain data at the prefectural-year level, we quantify Western impact by estimating geographic spillovers from treaty ports and consulates, which were under direct colonial rule. It is shown that Western intervention reduced capital costs at up to 450 kilometers from the ports. Even though there were only about three dozen treaty ports in 19th century China, colonial rule influenced the large majority of China’s regions. More generally, we provide new evidence that without accounting for spillovers the impact of geographically targeted policies will be underestimated.

Keywords: Semi-Colonialism, Geographic Spillovers, Treaty Ports, Extraterritoriality

JEL Codes: F54, R11, N15, P48

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1 Introduction

Oftentimes, colonization is limited to a few cities and trading outposts located along a country's coast because trading interests are the key driver of colonialism. For example, the Straits Settlements in South East Asia, founded in 1826, were four individual port settlements hundreds of kilometers apart from each other on the Malay Peninsula, and in Africa, the British Empire annexed the port of Lagos in the year 1861 while Nigeria's hinterland became a colony only four decades later. Despite this common pattern, the economic effects of such colonization policies are not well understood. This paper seeks to make progress by estimating geographic spillovers from Western outposts established in China in the aftermath of the First Opium War (1839-42).

We define semi-colonialism as colonialism limited to trading ports and coastal areas.¹ China is an ideal case to study because its era of semi-colonialism lasted far longer (from the 1842 Treaty of Nanjing to the 1940s) than in other countries, and China's relatively large size means there are hardly any constraints to the estimation of geographically far-reaching spillover effects. Key to the analysis is a storage cost model in the spirit of Hotelling (1931) and others which generates novel information on annual capital costs at the relatively disaggregated prefectural level.

A priori, there are reasons to believe that semi-colonialism has a relatively small impact. In China, concessions for trade access at ports ('treaty ports') and extraterritorial legal systems limited to certain cities allowed the country to retain sovereignty over most of its territory. Even if the roughly three dozen Chinese treaty ports of the 19th century were *de facto* fully under colonial control, that would amount to less than 10% of China's GDP at the time (So, Yip, Shiroyama, and Matsubara 2011). Indeed, historians of China have long painted a picture according to which Western colonial rule ultimately left a very limited impact on China's economy as a whole (Dernberger 1975, Fairbank 1978, and Feuerwerker 1983). Treaty ports were geographically small enclaves, merely "a fly on the back of an elephant" (Murphey 1974). Over time, research on colonialism has distinguished the rule by a colonial state on the one hand, from the process of imposition of Western forms of power and knowledge on the other hand. Our geographic spillover

¹Though usage in the literature varies, the concept of semi-colonialism goes back at least to J.A. Hobson (1858-1940) and Vladimir Lenin (1870-1924); the latter saw semi-colonialism as the "transitional stage" before full colonial rule; see Reinhardt (2018) for a discussion.

analysis presents quantitative evidence on this.

The analysis exploits regional and temporal variation in treaty ports and consulates before and after China’s defeat in the First Opium War. Specifically, we compare capital costs and the presence of Chinese-owned industrial firms in prefectures subject to Western ports and consulates with their levels in prefectures not subject to such Western influence. We present new evidence for positive industrialization and capital market effects in the immediate vicinity of the ports. Regions in which treaty ports and consulates were located had lower capital costs, and Chinese-owned industrial firms were more common.

The main finding is that colonial policy also impacted regions beyond the treaty ports and consulates. We find that even at distances of 450 kilometers away from the port areas, capital costs—measured by interest rates—were substantially lower compared to other regions. We also find that foreign influence increased the chance that there were Chinese-owned industrial firms at distances of up to 300 kilometers away from the areas under direct colonial control. This is new evidence that semi-colonialism can have important effects throughout an economy, considerably larger than what is implied by direct colonial rule. Accounting for geographic spillover effects, we find a capital cost-lowering effect of Western colonial policies in most of China’s prefectures.

This paper also provides evidence on mechanisms. We show that lower interest rates are more closely related to Western consulates than to the ports of trade. This is consistent with gains in terms of security and lower risk through the extraterritorial legal system. Furthermore, Western influence on capital costs was less pronounced in regions with relatively high levels of social unrest, suggesting that the economic impact of colonialism interacts with domestic state capacity. In contrast, market access gains via trade and technology learning in treaty ports are important for Chinese industrialization.

The analysis recognizes that port areas were selected by colonial powers to serve their trade interests, and the analysis adjusts for differences in the likelihood of selection using regression weights. We also estimate specifications that condition on common support in the likelihood that prefectures would be directly exposed to foreign influence by the placement of treaty ports and consulates, finding similar results. Omitted variable bias due to regional differences are addressed

by employing regional fixed effects as well as differential trends across regions. Balance tests and event study analysis show that regions that eventually experienced direct foreign influence were not exceptionally promising or different from other regions ex-ante.

Even though virtually all episodes of colonialism include a stage of semi-colonialism, most of what is known to date concerns cases in which full-scale colonialism has integrated entire countries into European empires (such as British India, French Africa, or Dutch Indonesia). The Western reach through spillovers in China is striking considering how geographically small the areas under direct influence were. The results also speak to the literature on other geographically delineated policies designed to advance economic development. This includes so-called special economic zones (Brussevich 2023, World Bank 2021), charter cities (Romer 2009), and place-based policies more broadly (Brookings 2024, Kline and Moretti 2014). In each of these settings the reach of geographic spillovers is of central importance because the efficacy of the policies turns on the magnitude of geographic spillovers.²

At a broader level, we contribute to the economic analysis of colonialism (Acemoglu and Robinson 2017), especially in the context of Western trade interests (O’Rourke 2019). Our focus on transport infrastructure and market access shares some similarity with research on colonial India (Donaldson 2018), however, China was semi-colonized while India was fully colonized. The historical setting of China’s treaty ports has yielded interesting work on the impact of different legal origins (Levine, Lin, Ma, and Xu 2023) as well as on the economics of trademark protection (Alfaro, Bao, Chen, Hong, and Steinwender 2022). Another set of papers examines possible long-run implications of the West’s 19th century intervention (Keller, Li, and Shiue 2011, Jia 2014, Bo, Liu, and Zhou 2020, and Gan 2023). This literature does not consider the question of geographic spillovers from the intervention studied here.

The following section 2 provides necessary background to the setting of 19th century China. Data employed in this paper is described in section 3, with more information given in the Appendix. Section 4 introduces the estimation framework and discusses threats to identification. Our main results are presented in section 5, with further analysis showing that results are robust to selection,

²Geographic spillover results in the present setting are mixed (Li and Han 2019, Kung 2020).

heterogeneous effects, and other factors in the Appendix. Section 6 contains a discussion of the mechanisms behind our findings, and section 7 concludes.

2 The Opium War: Historical Context

In the decades before the First Opium War, China limited Sino-Western trade to a single port, open for only part of the year, in the south of China at Canton (Guangzhou). British traders gained increased access to China after provoking a war over the destruction of foreign opium, which had been smuggled illegally into China. After China's defeat in the First Opium War, the Treaty of Nanjing (1842) liberalized trade and opened four additional ports, and additional ports followed in subsequent years (Fairbank 1978).

Significant changes were introduced in especially two areas: trade policy and legal jurisdiction. Trade policies were tied to the opening of ports for foreign trade, with low tariff rates. Starting in the 1850s, Western nationals ran China's customs system, with the first Chinese Maritime Customs (CMC) service customs house opened in Shanghai in the year 1854. The tariff revenue was transferred to the Qing court after deducting the CMC's costs of tariff collection, which improved the fiscal stance of Qing China (Horowitz 2006). In 1949, the CMC split into services operating in the Republic of China (Taiwan) and the People's Republic of China.

The treaties stipulated that foreigners were subject to the legal jurisdiction of their own country rather than to Chinese laws (extraterritoriality). By 1847, 19 countries had extraterritoriality provisions with China. The consulate was key to extraterritoriality, with the consular court typically being the court of first instance, and by the end of the 19th century there were more than 250 foreign consulates in China. Consulates were often located near treaty ports, though over time, trade and legal dimensions evolved to become more distinct. While there are many accounts of China's treaty ports during this period, less is known on extraterritoriality in China, and section B provides additional background.

International market access, facilitated through the establishment of new ports, may have been a mechanism of Western influence as it affects patterns of specialization, and treaty ports

may have been the entry points for new technological knowledge (see Keller and Shiue 2022). Organizational innovations were also imported into China – for example, the first stock exchange in China, the Shanghai Share Broker’s Association, was introduced in 1891 by foreign business residents (Goetzmann, Ukhov, and Zhu 2007). The West’s intervention also increased the supply of public goods. In particular, the CMC service built lighthouses and wharves, dredged harbors, modernized postal services, and fought smuggling in China.

Extraterritoriality not only increased the incentives of Western firms to do business in China—the British company Jardine, for example, extended loans to Chinese merchants secured with stock deeds to obtain contracts familiar to British banking firms—but landholding rights included in the treaty provisions also benefited Chinese property owners. Since disputes related to property registered to foreigners would be heard in Western courts, many Chinese placed their land under foreign protection indirectly by leasing the property to foreigners (Willoughby 1920). Consulates and treaty ports may also have provided an increased level of security from rebel and pirate activity through the presence of military units; this may have benefited economic activity at the same time when the very visible loss of sovereignty may have reduced state capacity of the Qing rulers.

3 Data

This study utilizes annual data with a sample period from 1821 to 1899. The grain price data source starts in the year 1821, and we conclude the analysis before 1900 because given the Qing dynasty entered into its final years the nature and quality of the data changes (the dynasty ended in the year 1911).

Foreign Influence Beginning with our measures of foreign influence in China during this period, Figure 1 shows the location of treaty ports with customs houses of the Chinese Maritime Customs (CMC) service. Consistent with Western trade interests, many of the ports are located on the coast, as well as along the Yangzi and Pearl rivers (near Hankow (Wuhan) and Canton (Guangzhou), respectively). This is typical in the setting of semi-colonialism. Figure 2 describes the evolution of foreign influence in China based on the number of prefectures that had (1) one or more treaty port

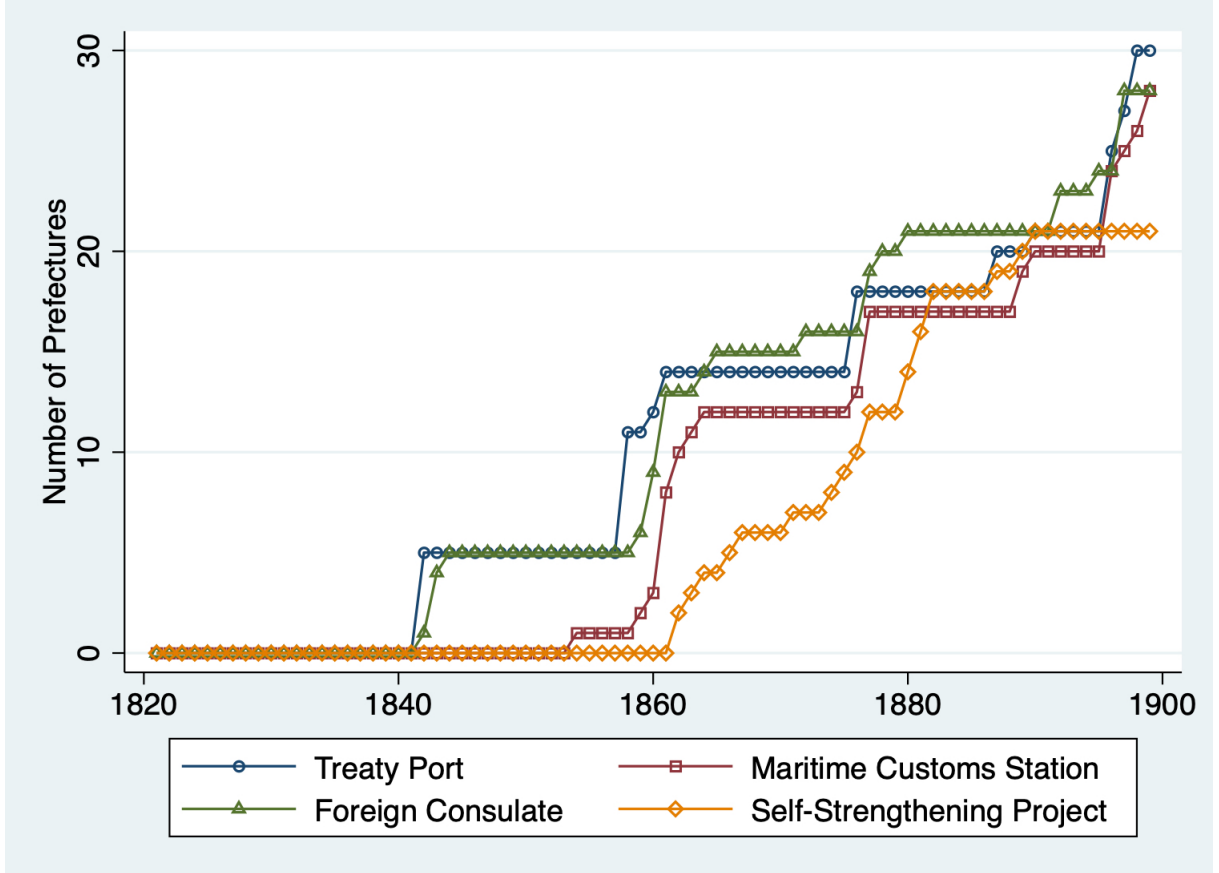
Figure 1: Treaty Ports with Chinese Maritime Customs Stations



Notes: Figure shows location of major treaty ports that had Chinese Maritime Customs (CMC) stations by the year 1899.

and (1) one or more foreign consulates. We see that the evolution of foreign influence in terms of treaty ports and consulates proceeded in distinct waves. Both regionally and temporally, treaty port and consulate variation in China is similar, with a sample correlation of 0.84. Because of this, we will also consider foreign influence from either treaty port or consulate in the analysis below.

Figure 2: Evolution of Foreign Influence in China



Notes: Figure shows for different years the number of prefectures in which treaty ports, consulates, and self-strengthening projects were located. Authors' computations.

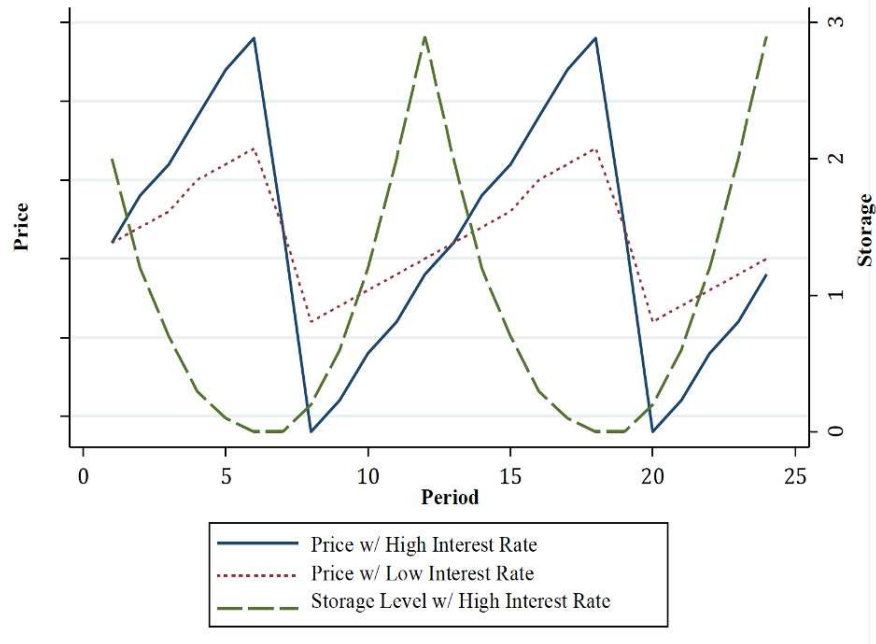
Figure 2 also records the number of prefectures in which there was an open Maritime Customs station. The number of customs stations lags the number of treaty ports, especially in the early years, because it took some time to set up the customs houses. In addition, in a number of smaller ports, customs houses were never established. Information on the timing of treaty port openings is based on CMC (1938), while the dating of foreign consulate openings is from Yunglong (1986).

³We abstract from Chinese ports that were opened unilaterally by China ("self-opened" ports) because given a different origin their implications for China's economy could be quite different.

Economic Outcome Variable I: Interest Rates Interest rates, as a proxy of the costs of capital, are constructed from price changes over the harvest cycle at the level of year, prefecture, and grain. Grain price changes provide information on interest rates because in an equilibrium with storage, the price of grain reflects the local interest rate as part of storage costs (Hotelling 1931, Kaldor 1939, Working 1949, and Samuelson 1957). All else equal, if the price gradient during storage is high, this indicates a high interest rate, while if the price of grain rises less the interest rate is lower. This result is shown in Figure 3, which presents a simulation of a simple model of commodity storage along the lines of Williams and Wright (1991).

Beginning with the solid-line price series, upon arrival of the new grain from the harvest, the price falls, reaching a minimum in period 8.

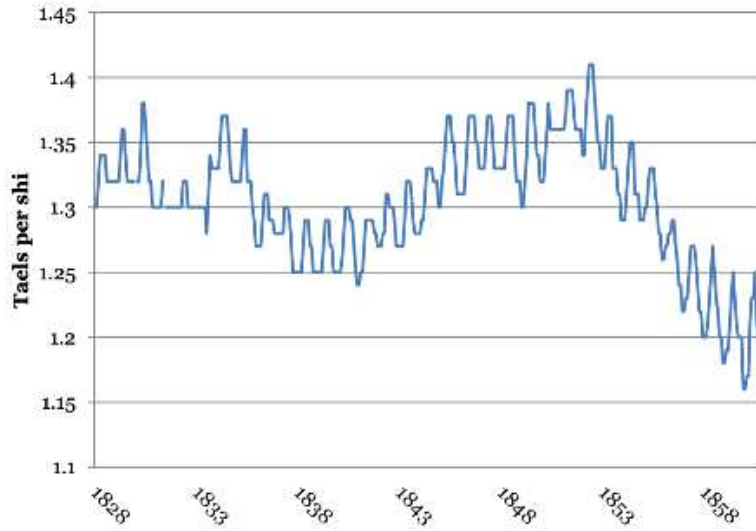
Figure 3: Simulation of Grain Prices and Different Interest Rates in a Storage Model



Notes: Simulation of a storage model along the lines of Wright and Williams (1991). Source: Keller, Shiue, and Wang (2021).

The price of grain increases gradually until the following harvest, with a new minimum price in period 20. Importantly, the gradient of the price increase is increasing in the cost of storage, which includes the interest rate. Figure 3 shows the equilibrium price behavior with a lower interest rate, all else equal, as the dashed series.

Figure 4: Cyclical Movements in the Price of Grain



Notes: Monthly rice price in Guilin prefecture, 1828 - 1860; from Keller, Shiue, and Wang (2021).

Do actual Chinese grain prices during the Qing exhibit such cyclical behavior? It is well-known anecdotally that Chinese farmers at this time engaged in grain storage as well as the buying and selling grain forward. Figure 4 shows three decades of raw monthly grain prices for the prefecture of Guilin as an example. The price pattern is cyclical, not unlike those of the optimal storage model shown in Figure 3. It is also apparent that the gradient of the price change over the seasonal cycle varies from year to year, consistent with the gradient providing information on interest rates.

Annual interest rates are computed from monthly grain prices by first identifying the months during which grain prices are typically increasing. These are taken to be the storage months, which vary by grain and by region of China. The interest rate for a particular year, grain price series, and prefecture is simply the average of the month-to-month changes during storage months. We winsorize for the central 99 percent interval to reduce the influence of outliers.

The price of grain in a given harvest year is influenced also by factors other than interest rates. A key factor is arbitrage through interregional trade. Shiue (2002) examines the roles of intertemporal and intratemporal arbitrage in a unified analysis of trade and storage in Qing China, and the relation between price gradients and intratemporal arbitrage in 18th-19th century Britain and China is discussed in Keller, Shiue, and Wang (2021). The validity of the grain-price based approach has been studied through a comparison of bank interest rates and grain-price based

interest rates in 19th century United States (Keller, Shiue, and Wang 2020). Across U.S. cities, it is not only shown that typical bank and grain-price based interest rates are comparable in size (average of 5.70% versus 7.25%, respectively), but also that cities with high bank interest rates tend to be markets with high grain-price based interest rates, and vice versa (correlation just under 0.80).

There are a large number of factors affecting interest rates based on the storage cost approach, including climate, supply and demand shocks, omitted variables, as well as data collection and sampling (Keller, Shiue, and Wang 2020, 2021). Generally, this creates challenges for estimating interest rate *levels* in relatively small samples. At the same time, a large sample of interest rates that is consistently derived from high-frequency grain price data will be informative on *differences* in interest rates, as shown in Keller, Shiue, and Wang (2020).

In the present analysis, the inclusion of fixed effects is equivalent to taking such differences. In particular, prefecture fixed effects account for time-invariant regional characteristics affecting intratemporal trade, such as coastal or navigable river location. The specification also accounts for regional changes in intratemporal trade opportunities (other than through the opening of treaty ports or consulates) by including fixed effects at the province by year level. In addition, climatic shocks are controlled for by allowing weather to influence interest rates differently in every province-year combination, while shocks affecting interest rates across province boundaries are accounted for by including fixed effects for a 3 x 3 grid in latitude and longitude across China and allowing it to vary over time. In addition, a number of robustness checks are provided below. See section A.1 for more on the underlying assumptions of this approach, as well as on the underlying price data.

Economic Outcome Variable II: Industrialization We use the presence and the number of Chinese-owned industrial firms in a given prefecture-year as a proxy for industrialization, from Du (1991). This is a large historical firm-level compilation titled “List of Domestically Established Civil Industrial, Mining, Shipping, and Modern Financial Enterprises (1840–1927)”. It is designed as a quantitative reference list of modern enterprises in China for this period. A defining trait of “modern” is the usage of steam power and mechanization, such as in form of steam-powered

hydraulic presses. Another characteristic of modern enterprises applied by Du (1991) is large-scale labor, specifically the employment of hundreds or thousands of hired wage workers. Also covered are infrastructure and utilities such as heavy shipyards equipped with steam-powered lathes, dry docks, and massive lifting cranes, as well as mining operations.

By ownership, the compilation distinguishes private Chinese ownership, Qing government ownership, and foreign ownership. Of these three, we add the first two categories and drop the third as we are interested in industrialization with Chinese ownership. The data imposes a minimum capital threshold for firms to be included. Du (1991) is not original fieldwork or a complete census but a systematic reconstruction from historical sources. Sources range from government statistical publications, customs and trade reports, newspapers and journals, company records, and archival material. While errors undoubtedly remain, the collection method was designed to ensure reliability through triangulation of sources, and it also takes account of changes in ownership.

Du (1991) is a carefully curated, rules-based, albeit imperfect historical dataset of larger Chinese-owned modern enterprises. To reduce the influence of misclassification and bias, we employ only the count of these enterprises, as well as an indicator that there is at least one industrial firm in a given prefecture-year. Additional information is given in section A.2.

Other Variables The empirical analysis below employs a measure of foreign-owned firms in each treaty port. Initially, these firms were primarily trading companies. Shipping-related industries such as supplies and shipyards followed before manufacturing firms became more common towards the end of the 19th century. During the sample period, foreign firms originated primarily from Britain, the U.S., Germany and France. We employ the simple count of foreign firms from all countries. Shanghai had the highest number of foreign-owned firms. The source of this data are the Decennial Reports of the Chinese Maritime Customs (CMC 1933).

To obtain more information on the banking sector, we utilize information from Jiang (2014). Providing a standardized reference work from a large amount of scattered bank information, Jiang (2014) covers different forms of native local banks (such as *qianzhuang* and *piaohao*), Chinese-owned banking institutions, including the names of important banking personalities, as well as

foreign-owned banks. To keep the data requirements low, the present analysis focuses on location and number of foreign-owned banks.

Information on social unrest in China for our mechanisms analysis comes from the Veritable Records of the Qing Dynasty (*Qing Shilu*). The *Qing Shilu* is the most comprehensive source on unrest in China during this period, though its mere size poses a challenge since standard editions contain more than 1,200 volumes. We identify temporal and regional dimensions of unrest intensity based on a supervised machine-learning approach as employed by Keller, Shiue, and Yan (2025). Utilizing the well-known work on Qing social unrest by Chen et al. (1989) as training sample, the machine-learning approach achieves an accuracy of 97 percent in classifying *Qing Shilu* entries into social unrest or not unrest.⁴ See section A.3 for more information on the social unrest data.

One consequence of China’s military defeats in the opium wars was a set of domestic reforms called the Self-Strengthening Movement (SSM). SSM projects were primarily in the areas of military technology and shipbuilding, but industrial and mining projects were also common. Figure 2 shows the timing of the SSM. Western colonialism in China during the 19th century. Data comes from Qian and Tan (1995), as reported by Elleman and Paine (2019).⁵ Table 1 summarizes the definition and sources of the variables.

⁴Accuracy is defined as $A = \frac{TP+TN}{TP+TN+FP+FN}$, where TP (TN) are True Positives (True Negatives), while FP (FN) are False Positives (False Negatives).

⁵For one project in the year 1874 we only know the province, Yunnan, and code this to be located in the capital city. This does not qualitatively affect our results.

Table 1: Summary of Data and Sources

Data	Source
A. Causal-effects Estimation (Equations 1, 2, and 3)	
Interest Rate	Authors' computation based on Chinese Academy of Sciences (2009)
Number of Industrial Firms	Du (1991)
Industrial Firms Indicator	Du (1991)
Treaty Port Indicator	CMC (1938)
Consulate Indicator	Yunglong (1986)
Latitude of prefectural capital	Harvard CHGIS https://chgis.fas.harvard.edu/
Longitude of prefectural capital	Harvard CHGIS https://chgis.fas.harvard.edu/
Treaty Port Indicator (0, 150km], (150, 300km], and (300, 450km]	CMC (1938), Harvard CHGIS for latitude/longitude, and authors' computation
Consulate Indicator (0, 150km], (150, 300km], and (300, 450km]	Yunglong (1986), Harvard CHGIS for latitude/longitude, and authors' computation
Weather categories	China Historical Society (1981)
B. IPWRA Estimation	
Population levels and growth	Cao (2000)
Longitude	Harvard CHGIS https://chgis.fas.harvard.edu/
Latitude	Harvard CHGIS https://chgis.fas.harvard.edu/
Other Geography Variables (Northern Coast, Southern Coast, Grand Canal, Yangzi Delta, Yangzi River, Pearl River)	Harvard CHGIS https://chgis.fas.harvard.edu/
C. Robustness and Mechanism Analyses	
High International Trade	CMC (annual reports), various years
High Foreign Direct Investment	CMC (1933)
High Self-Strengthening Movement	Elleman and Paine (2019), Qiang and Tan (1995)
High Social Unrest	Keller, Shiue, and Yan (2025) based on the Veritable Records of the Qing (<i>Qing Shilu</i>)
High Foreign Banks	Jiang (2014)
Japanese and Russian Consulates	Yunglong (1986)

Notes: We employ the 1820 prefectural boundaries of Harvard China Historical GIS (CHGIS). Individual variables for particular prefectures and years are missing due to incomplete sources. In particular, there are $N = 252$ prefectures in the IPWRA regression, see Table A.4; missing prefectures assigned average IPRWA. High Social Unrest based on 3 highest mean numbers of unrest by province from Keller, Shiue, and Yan (2025).

Table 2: Summary Statistics

	N	Mean	Standard Deviation
Panel A: Industrial Development Sample (Prefecture by Year)			
Number of Chinese-owned Industrial Firms	24,727	0.114	1.727
Chinese-owned Industrial Firm Indicator	24,727	0.032	0.175
Panel B: Interest Rate Sample (Prefecture-Grain by Year)			
Interest Rate	70,015	8.830	17.253
Treaty Port Indicator	70,015	0.056	0.229
Consulate Indicator	70,015	0.049	0.215
Treaty Port or Consulate Indicator	70,015	0.060	0.237
Treaty Port Indicator (0, 150 km]	70,015	0.166	0.372
Treaty Port Indicator (150, 300 km]	70,015	0.324	0.468
Treaty Port Indicator (300, 450 km]	70,015	0.369	0.483
Consulate Indicator (0, 150 km]	70,015	0.165	0.371
Consulate Indicator (150, 300 km]	70,015	0.316	0.465
Consulate Indicator (300, 450 km]	70,015	0.390	0.488

Notes: Panel A: Number of Industrial Firms is the number operating in Chinese-owned firms in prefecture i and year t ; Industrial Firm Indicator is indicator variable that in a given prefecture and year, there is one or more Chinese-owned industrial firm. Panel B: Interest rate is derived from grain prices as part of the costs of storage, see text and section A.1. Treaty port Indicator and Consulate Indicator are indicator variables for the presence of at least one treaty port or at least one foreign consulate in prefecture i and year t . Treaty Port Indicators and Consulate Indicators by distance band are indicator variables for at least one treaty port (or at least one consulate) at a particular distance range outside of prefecture i itself, using the location of prefectural capitals for distance measurements from Harvard CHGIS. Source of industrial firms data is Du (1991); interest rates are authors' computations based on grain price data in Chinese Academy of Social Sciences (2009).

In the case of industrial firms, there is variation prefecture by year, and the baseline sample size is $N = 24,727$ (313 prefectures times 79 years). The analysis of interest rates has $N = 70,015$ observations. This number is higher because for a given prefecture-year combination, we have multiple interest rates—one rate for each grain price series. Interest rates based on all available grain price series are employed, however, grain price data is missing for some regions of China; the number of prefectures is 245 in the interest rate sample. Summary statistics are shown in Table 2.

Chinese-owned industrial firms are not common, accounting only for 3.2 percent of the observations (Table 2). This granularity means not only that employing an industrial firms indicator—any number of industrial firms—is likely fruitful but also that industrialization might not vary smoothly

in geographic space. Interest rates average 8.8 percent per year with a considerable amount of variation. We also see that while 6 percent of observations have foreign influence in form of a treaty port or consulate in the prefecture itself, more than one third of observations are exposed to foreign influence in the 300 to 450 kilometers distance band.

4 Estimation

The approach relates a measure of industrial firms in prefecture i and year t , Y_{it} , to a foreign influence variable, FOR_{it} , by applying the Borusyak, Jaraval, and Spiess (2024) staggered difference-in-differences estimator to the following equation:

$$Y_{it} = \beta_1 FOR_{it} + \gamma' \Gamma + \delta_{p(i)t} + \theta_i + \varepsilon_{it}, \quad (1)$$

where FOR_{it} is an indicator that equals one if there is at least one treaty port in prefecture i and year t , and zero otherwise. Alternatively, FOR_{it} is defined as at least one foreign consulate, or it is defined as at least one treaty port *or* consulate in prefecture i and year t . The dependent variable Y_{it} , is defined as either the number of Chinese-owned industrial firms or as an indicator that in prefecture i and year t there is at least one Chinese-owned industrial firm. Equation (1) is a two-way fixed effects model, with θ_i and $\delta_{p(i)t}$ being the cross-sectional (prefecture) and time (year) fixed effects, respectively. Given China's size we generalize the year fixed effects to year-by-province fixed effects. We are primarily interested in the parameter β_1 , which under standard identification conditions, to be discussed in section 5.3, gives the average sample difference in terms of Y_{it} that is caused by the variable FOR_{it} .⁶

Province-year fixed effects pick up shocks to industrial development at the province-level, such as geographical advantages of coastal areas as transport technology changes, e.g. in favor of ship versus land transport. The vector Γ includes geo-trends that account for influences that

⁶Foreign influence in 19th century China should be viewed as primarily Western influence. Japan and Russia were not part of the treaty port trade organized by the Chinese Maritime Customs service, and the number of Russian or Japanese consulates was limited. See Table 7 for an analysis focusing on the influence of Western instead of all foreign countries in China.

cross province boundaries, defined as decadal fixed effects for nine macro regions of China (3 x 3 regions based on latitude and longitude). In addition, we apply regression weights that capture the predicted probability that a given region would become a foreign location based on pre-sample and geographic characteristics. The underlying regression results are presented in section C.2. The error ε_{it} in equation (1) is assumed to have mean zero. We account for possible heteroskedasticity by clustering at the prefecture level, which allows for arbitrary serial correlation of observations for the same prefecture. In addition, based on Cameron, Gelbach, and Miller (2011), we employ a second dimension of clustering at the year level, thereby allowing for dependence of observations in a given year across all of China.

To analyze foreign impact on Chinese interest rates, r_{igt} , we estimate

$$r_{igt} = \beta_1 FOR_{it} + \gamma' \tilde{\Gamma} + \tilde{\delta}_{p(it)t} + \theta_{ig} + \varepsilon_{igt}, \quad (2)$$

where the subscript g indexes the grain price from which a particular interest rate is derived. We employ the method of Borusyak, Jaraval, and Spiess (2024). Equation (2) differs from equation (1) in that the cross-sectional dimension is prefecture-grain rather than prefecture, given that we employ interest rates based on all grains that are available in the prefecture (θ_{ig} are the associated fixed effects). Moreover, since climate affects grain storage costs and therefore the interest rates, equation (2) allows the province-year fixed effects to vary for each of the five weather conditions.⁷

This difference-in-differences approach is extended to include spatial spillovers by adding foreign influence at some distance away. Similar to Feyrer, Mansur, and Sacerdote (2020, 2017), James and Smith (2020), circular bands are formed at certain distances around prefecture i to obtain spillovers from foreign influence. The interest rate specification, equation (2), becomes

$$r_{igt} = \beta_1 FOR_{it} + \sum_d \beta_{2l} \left[\sum_{j \neq i} 1_{ij} \{l = d\} \times FOR_{jt} \right] + \gamma' \tilde{\Gamma} + \tilde{\delta}_{p(it)t} + \theta_{ig} + \varepsilon_{igt}, \quad (3)$$

where d indicates a certain distance bracket in kilometers, such as three brackets of 150 kilometers

⁷See Table A.1 for the influence of weather on measured interest rates.

width each, from zero to 450 kilometers, $d = \{(0, 150], (150, 300], (300, 450]\}$, and 1_{ij} is an indicator function on the distance between prefectures i and j . The term in hard brackets in equation (3) is an indicator that in a particular distance band d surrounding prefecture i there is a foreign consulate, or treaty port, in a particular year. As before, the coefficient β_1 gives the causal impact of FOR_{it} on interest rates; to the extent that $\beta_{2l} \neq 0$ for any distance d there is evidence that foreign influence affects interest rates in prefecture i from some distance away. Spillover specifications analogous to equation (3) are estimated also for industrialization outcome variables.

A central identification assumption of this approach is that in the absence of treatment, outcomes in treatment and control regions would have followed parallel trends. In the case of the spillover specifications, the definition of treatment and control regions changes depending on the particular spillover terms that are introduced. Specifically, with the inclusion of a distance band of zero to 150 kilometers, treated regions are those of distances up to 150 kilometers, while control regions are those at distances above 150 kilometers. Wooldridge (2021) discusses difference-in-differences estimation of geographic spillovers using a two-way fixed effects approach. We assume for now that the parallel trends assumption holds, and return to the issue in section 5.3.

5 The Impact of the West on China’s Economy

5.1 Local Influence

We begin by examining the role of treaty ports and foreign consulates for China’s local capital markets (see Table 3). In the first interest rate regression, the coefficient is negative at -2.76 for the consulate indicator (column (1)), which provides evidence that influence from foreign consulates lowers capital costs in the local region (prefecture). Furthermore, given the mean interest rate is about 8.8 (Table 2), the consulate coefficient is consistent with a quantitatively important effect (-2.76/8.8 means a 31 percent reduction relative to the mean). While treaty ports lower capital costs as well, the point estimate is somewhat lower (see column (2)). Omitted variable bias is a concern when employing either consulate or treaty port variable by itself; as noted above, the two variables are positively correlated. Column (3) of Table 3 shows results from including both

Table 3: Local Western Influence and China's Capital Markets

	(1)	(2)	(3)	(4)
Consulate	-2.760** (0.903)		-2.859** (1.252)	
Treaty Port		-1.871** (0.534)	0.137 (1.235)	
Treaty Port or Consulate				-2.221** (0.775)
Fixed Effects				
Prefecture-Grain	Y	Y	Y	Y
Year	Y	Y	Y	Y
IPWRA	Y	Y	Y	Y
N	70,015	70,015	70,015	70,015

Notes: Dependent variable is interest rates. Estimation of equation (1) using Borusyak, Jaraval, and Spiess (2024) estimator. All specifications include province-by-year-by-weather fixed effects as well as decade-specific geographic fixed effects (3 x 3 in latitude and longitude). Two-way clustered standard errors following Cameron, Gelbach, and Miller (2011) at the prefecture-by-grain and year levels in parentheses; **/*/+ indicates significance at the 1%/5%/10% level.

variables in the regression.⁸ The consulate coefficient is negative and similar in size to before, while the treaty port estimate is now close to zero. This suggests that while both treaty ports and consulates capture a capital cost-lowering effect in local markets, it is more closely related to legal channels captured by consulates than to trade channels reflected in the treaty port variable. Employing the consulate or treaty port indicator gives a coefficient of about -2.2 (column (4)). We will separate the treaty port from the consulate effect in the spillover analysis below.

Turning to foreign influence on Chinese industrial firms, we begin with the number of industrial firms, see Table 4, on the left. The consulate point estimate estimate is positive, indicating that foreign consulates increase the number of local Chinese-owned industrial firms. Quantitatively, the coefficient of 0.667 is larger than the overall mean number of industrial firms (just under 0.1, see Table 2); it is also sizable compared to the mean in the subsample with industrial, which is 3.6. The corresponding specification with treaty ports also yields a positive coefficient, see Table 4, column (2), and when both variables are included, the treaty port coefficient remains positive and comparable in size to before while the consulate coefficient is close to zero (column (3)). This

⁸In this specification, first consulate opening is considered the treatment while the opening of treaty ports is treated as a time-varying control variable.

Table 4: Local Influence and China’s 19th Century Industrialization

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Number of Industrial Firms				Industrial Firms Yes/No			
Consulate	0.667** (0.317)		−0.141 (0.089)		0.095** (0.038)		−0.029 (0.025)	
Treaty Port		0.834** (0.383)	0.950** (0.391)			0.136** (0.036)	0.160** (0.042)	
Treaty Port or Consulate				0.611+ (0.314)				0.093** (0.029)
Fixed Effects								
Prefecture	Y	Y	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y	Y	Y
IPWRA	Y	Y	Y	Y	Y	Y	Y	Y
N	24,727	24,727	24,727	24,727	24,727	24,727	24,727	24,727

Notes: Dependent variable in columns (1) to (4) is number of Chinese industrial firms, and in columns (5) to (8) it is an indicator that the number of Chinese firms is positive. Estimation of equation (1) using Borusyak, Jaraval, and Spiess’s (2024) estimator. All specifications include province-by-year fixed effects as well as decade-specific geographic fixed effects (3 x 3 in latitude and longitude). Two-way clustered standard errors following Cameron, Gelbach, and Miller (2011) at the prefecture and year levels in parentheses; **/*/+ indicates significance at the 1%/5%/10% level.

is evidence that local foreign influence on Chinese industrialization is more closely tied to treaty ports than to consulates. A reason for this may be that the emergence of industrial firms during the 19th century is related to trade activity. Results for an indicator of at least one consulate or at least one treaty port indicate also a positive impact (Table 4, column (4)).

Recall from the summary statistics above that many prefecture-year observations have zero industrial firms. It may be useful to examine the extensive margin, which is whether for a given prefecture-year combination there are any industrial firms (Chen and Roth 2024). We see that these extensive-margin results are broadly similar to earlier results with the number of industrial firms (Table 4, columns (5) to (8)). In particular, prefectures with more foreign influence are more likely to have Chinese-owned industrial firms; this is true both for consulates and for treaty ports. And as before, the influence from treaty ports appears to be stronger than from consulates (column (7)). Quantitatively, with at least one consulate or one treaty port in the prefecture, the probability that there are Chinese industrial firms increases by just under ten percent (column

(8)).⁹

Taken together, the evidence in Tables 3 and 4 indicates that foreign influence both lowered local capital costs and it increased the rate of local industrialization. Moreover, our findings suggest that legal channels matter relatively more for capital market conditions while trade channels affect more strongly the process of industrialization.

5.2 Spatial Spillovers

This section examines the geographic extent of the Western economic impact by extending the analysis to include spillover terms (see equation (3)). The first column of Table 5 repeats earlier results, as in Table 3, column (4). We begin by adding separate indicator variables for treaty ports and consulates at distances larger than 0 and up to 150 kilometers from the prefecture.¹⁰ Both variables enter with negative coefficients (Table 5, column (2)). This indicates that the no spillover result of column (1) is not the total effect. Rather, foreign influence after the Opium War extended beyond the prefectures in which the consulates and treaty ports were located. Also notice that the own-prefecture point estimate increases with the inclusion of the two spillover variables, from -2.2 to just under -3.0.

Adding further spillover variables for distances from 150 to 300 kilometers yields more negative point estimates, see Table 5, column (3). The estimate for treaty ports at this distance range is about -2.5 although it is not precisely estimated. Also notice that the own-prefecture point estimate rises further in absolute magnitude.

Including spillover terms for the next 150 kilometers yields the results shown in column (4) of Table 5. In this specification, the own-prefecture estimate has risen further, to -4.013. Column (4) shows that compared to regions without Western influence, treaty ports reduce local interest rates at distances of up to 300 kilometers and consulates at distances of up to 450 kilometers.

⁹We have also considered pseudo poisson maximum likelihood (PPML), which in the presence of many zeros has advantages over OLS with a log plus one (or inverse hyperbolic sine) specifications (Santos Silva and Tenreiro (2006)). PPML generally confirms these findings; however, the Borusyak, Jaraval, and Spiess (2024) estimator turns out to be computationally more robust than PPML; this may be because our setting combines staggered treatment, multiple sets of fixed effects, and in the case of interest rates an unbalanced sample.

¹⁰These distance bands do not include treaty ports or consulates in the prefecture itself.

Table 5: The Spatial Extent of Western Influence

	Interest Rates				Industrial Firms			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
					Number of Industrial Firms		Industrial Firms Yes/No	
Treaty Port or Consulate	−2.221** (0.775)	−2.991** (0.808)	−3.854** (0.819)	−4.013** (0.827)	0.611+ (0.314)	0.611+ (0.314)	0.093** (0.029)	0.093** (0.027)
TP Indicator (0, 150 km]		−3.051** (1.216)	−3.507** (1.244)	−3.710** (1.246)		−0.026 (0.049)		0.001 (0.020)
Consulate Indicator (0, 150 km]		−2.690** (1.153)	−2.733** (1.134)	−2.909** (1.156)		−0.050 (0.055)		−0.037 (0.029)
TP Indicator (150, 300 km]			−2.487+ (1.403)	−2.639+ (1.373)		0.097+ (0.057)		0.042* (0.022)
Consulate Indicator (150, 300 km]			−1.636 (0.455)	−2.105+ (1.193)		−0.039 (0.059)		−0.010 (0.031)
TP Indicator (300, 450 km]				−0.696 (0.986)				
Consulate Indicator (300, 450 km]				−1.793+ (0.970)				
Fixed Effects								
Prefecture-Grain	Y	Y	Y	Y				
Prefecture					Y	Y	Y	Y
IPWRA	Y	Y	Y	Y	Y	Y	Y	Y
N	70,015	70,015	70,015	70,015	24,727	24,727	24,727	24,727

Notes: Dependent variable is interest rate in columns (1) to (4), the number of industrial firms in columns (5) and (6), and an indicator variable for the presence of industrial firms in the prefecture in columns (7), and (8). Estimation of equation (2) in columns (1) to (4), and of equation (1) in columns (5) to (8), using the Borusyak, Jaraval, and Spiess (2024) estimator. TP stands for treaty port. All specifications include decade-specific geographic fixed effects (3 x 3 in latitude and longitude). Province-by-year-by-weather fixed effects included in columns (1) to (4), and province-by-year fixed effects included in columns (5) to (8). Two-way clustered standard errors following Cameron, Gelbach, and Miller (2011) reported in parentheses, at the prefecture-grain and year level in columns (1) to (4), and at the prefecture and year level in columns (5) to (8); **/*/+ indicates significance at the 1%/5%/10% level.

Above 450 kilometers no significant effects are estimated. This indicates that Western influence in this setting of semi-colonialism went beyond the immediate vicinity of the points of foreign location. Furthermore, allowing for dispersed spatial effects yields a larger impact than would be obtained without spillovers. Similar inferences result using standard errors consistent with spatial dependence proposed by Conley (1999).

The patterns in Table 5 also yield insights on the nature of the effect. Specifically, we estimate spatial decay in the impact of Western influence on interest rates in China's regions. The effect is strongest in the port areas themselves, and it becomes weaker as the distance to port areas increases. This is not the pattern that one would expect if the West's impact had led to a reallocation of capital. Notably, there is no evidence that treaty port or consulate prefectures benefit from lower capital costs at the expense of higher capital costs in other prefectures. If the West's intervention had triggered the influx of capital from other Chinese regions, one would expect that the negative Treaty Port and Consulate coefficient is accompanied by positive coefficients in prefectures that are nearby. However, we do not find a mix of negative and positive coefficients.

Rather, the pattern of declining spillover estimates is consistent with positive externalities that decline with distance. For one, capital market transactions become less frequent as distance increases. Costs rise because transportation, time, and food costs rise with distance. Geographic barriers also mean that lower risk of transactions in a consulate prefecture will benefit agents less if they live at higher distances away. Furthermore, lower interest rates might lead to the diffusion of ideas as agents travel to locations of low interest rates from elsewhere, bringing back new ideas to their points of origin. The difference in the patterns of point estimates for consulates and treaty ports—of -2.7, -2.1, and -1.8 at (0, 150], (150, 300], and (300, 450] kilometer distances for consulates, respectively, compared to -3.7, -2.6, and -0.7 for treaty ports—suggests that the influence of legal channels on China's capital markets is more spatially diffuse than the influence of trade channels.

Putting these estimates of treaty port and consulate effects on a map summarizes the geographic scope of Western influence in China, see Figure 5. In this figure, darker shades indicate stronger effects. The results are consistent with conventional wisdom that Western influence was relatively strong in the coastal regions of China's Southeast and the Yangzi delta. However, the figure also

shows that Western influence reached far beyond coastal and port areas; in fact, eighty-seven percent of all Chinese regions in the sample are significantly affected. Only a minority of regions, mostly in China’s Northwest, were not subject to Western influence. Furthermore, frequently Western influence lowered interest rates by a quarter or more.¹¹ In this sense, despite the semi-colonial setting, the West’s intervention in the aftermath of the Opium War affected most of China.¹²

Spillover results for industrialization outcomes are shown on the right side of Table 5. With the number of industrial firms as the dependent variable, the point estimate for the local effect of at least one consulate or treaty port is -0.611 (Table 5. Including spillover variables for consulates and treaty ports at distances (0, 150] and (150, 300] kilometers yields evidence for a positive spillover effect in at distances between 150 and 300 kilometers, but not at shorter distances of up to 150 kilometers (column (6)). A similar finding is obtained for the extensive margin of Chinese-owned industrial firms, see Table 5, column (8). One possibility is that limited variation in the industrial firms variable creates a challenge to identify these spillovers.¹³ While this issue cannot be fully resolved, we conclude that, generally, results suggest that industrialization spillovers are more limited in geographic scope compared to capital market spillovers, and appear to be more closely related to trade than to legal channels.

Putting the industrialization spillover results into a heat map—Figure 6—illustrates the more limited geographic extent of industrialization spillovers. For example, the foreign impact on industrialization is absent in some coastal prefectures according to Figure 6, and this is not the case in the case of interest rates (see Figure 5).¹⁴

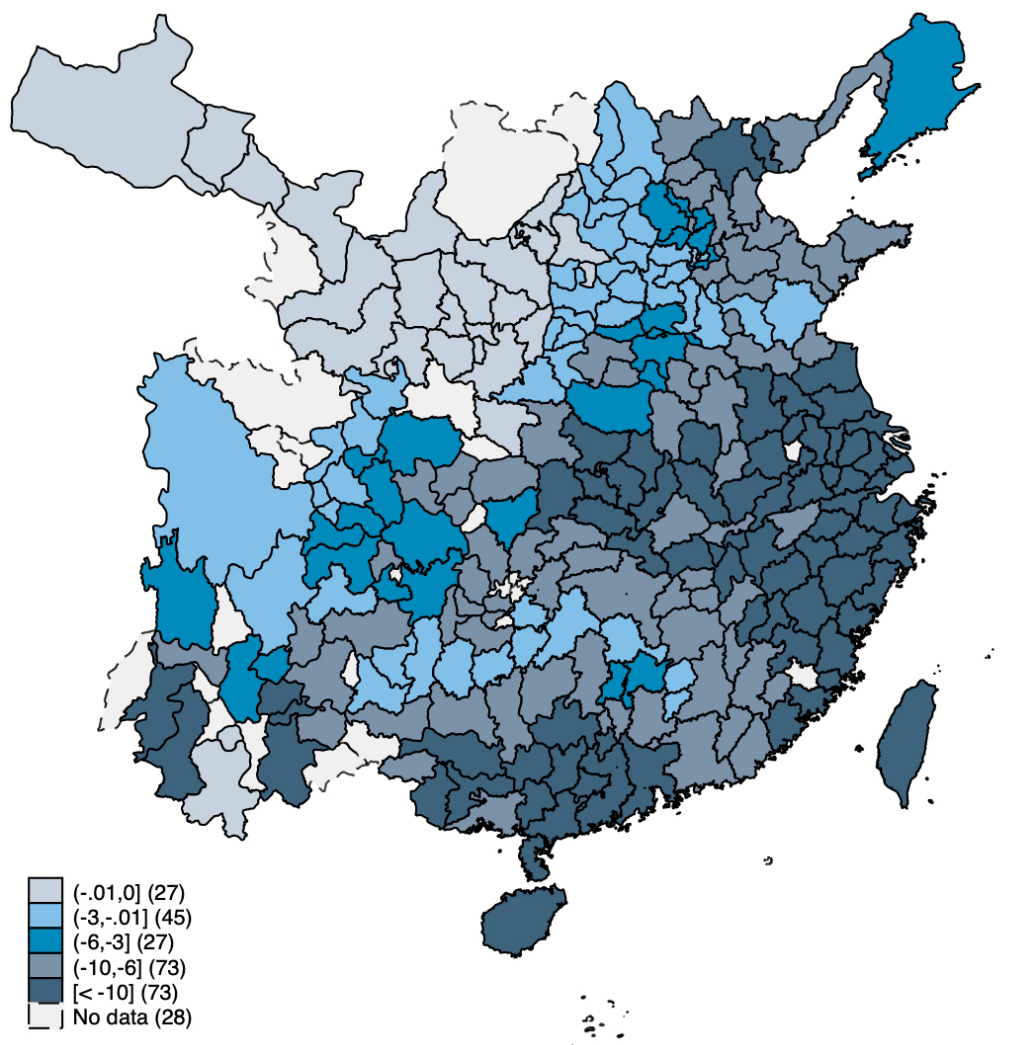
¹¹In 146 out of 245 prefectures (a share of 60 percent), the predicted interest rate effect is larger than two percentage points, almost one quarter of the typical interest rate level during our sample period. Unfortunately, we are not aware for suitable data to estimate the impact of foreign influence on China’s GDP.

¹²We have also explored alternative spillover band definitions, such as widths of 100 instead of 150 kilometers, finding similar patterns.

¹³In particular, cases when there is foreign influence in a prefecture itself and a treaty port in the (150, 300] band but not also in the (0, 150] band are rare, accounting only for 0.2% of the sample.

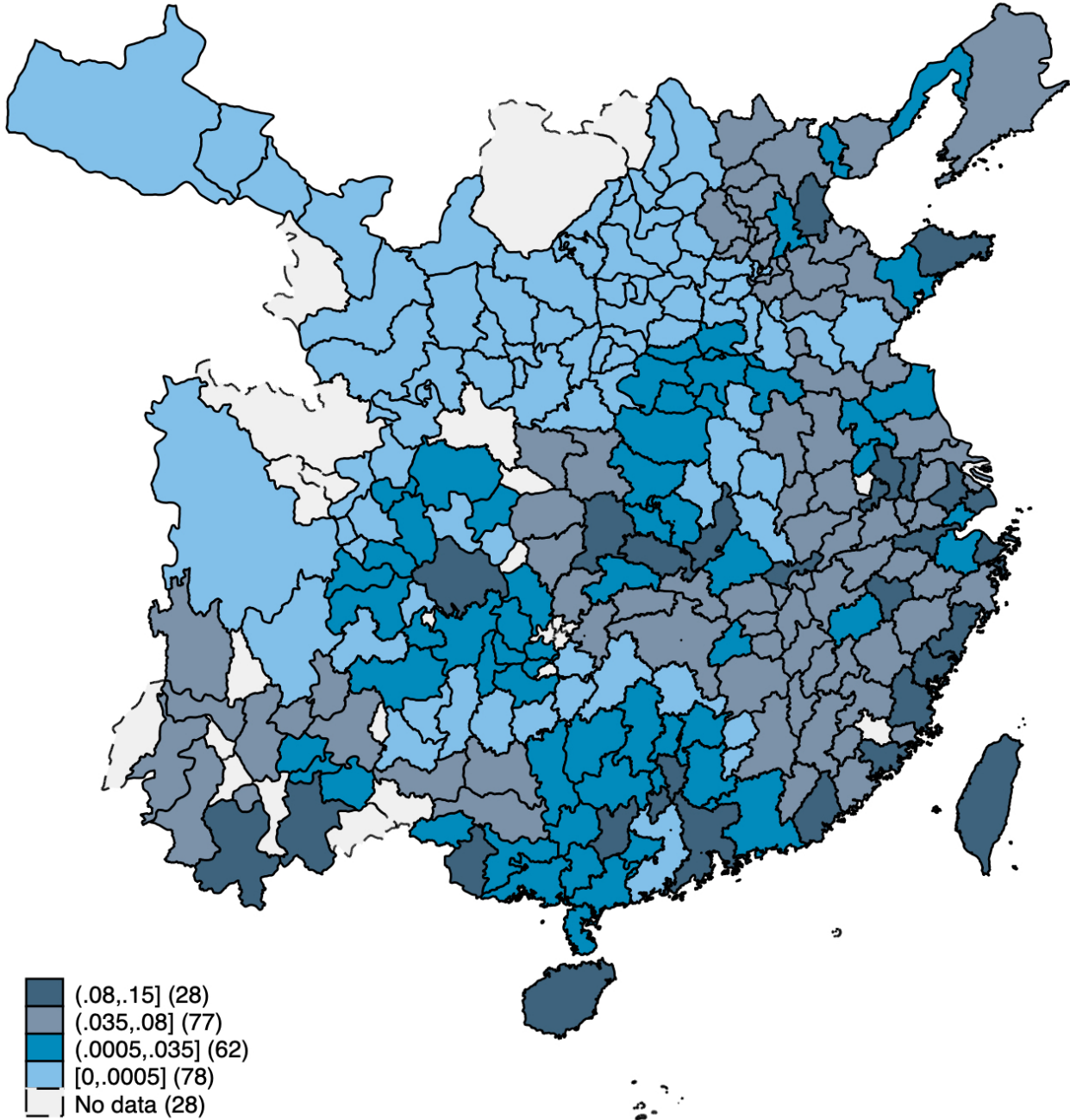
¹⁴Figures 5 and 6 show the same set of prefectures for comparability.

Figure 5: Western Influence and Chinese Capital Markets in the late 19th Century



Notes: Figure 5 gives predicted effects in the prefecture of the specification underlying Table 5, column (4) for the latest possible sample year (typically in the 1890s). First parentheses gives the range of the interest rate reduction (in percentage points), second parentheses reports the number of prefectures in the particular bin. Lightest color indicates no data.

Figure 6: Western Influence and 19th Century Industrialization Spillovers



Notes: Figure 6 gives predicted effects in the prefecture of the specification underlying Table 5, column (9) for the latest possible sample year (typically in the 1890s). First parentheses gives the range of the interest rate reduction (in percentage points), second parentheses reports the number of prefectures in the particular bin. Lightest color indicates no data.

5.3 Identification

An ideal setting for estimating causal effects would have treaty ports and consulates randomly allocated, as this would ensure parallel trends. However, foreign locations in China were chosen purposefully, not randomly. At the same time, the historical record shows that locations were not chosen because they were most promising in terms of rate of industrialization or capital market development, but rather, they were chosen for the trade access they provided. The chief concern is that the areas in which foreigners located their treaty ports and consulates were the ones that would have performed better even in the absence of the foreign intervention. The following addresses this by performing balance checks and event-study analysis. We turn to the balance checks first.

Table 6 compares treatment and control regions in the pre-treatment period for interest rates, both levels and growth rates. Panel A shows that interest rates in regions that were eventually subject to direct foreign influence were similar to interest rates in other regions. Moreover, differences in interest rate growth between treated and control regions are relatively small and not significant (Panel B). If anything, interest rate growth in the pre-treatment period was higher in subsequently treated compared to not treated regions.

We extend this pre-trend analysis to an earlier pre-treatment period using population data. In particular, we compare population growth in 1776-1820 among prefectures that eventually experienced foreign influence in form of treaty ports or consulates, versus those that did not. For both definitions of treatment, population growth in the treatment regions tends to be lower than in the control regions (Panel C). Thus, to the extent that population growth is a sign of economic promise, this suggests that locations of foreign influence are negatively selected (not significantly different). The finding that treaty ports appear to be not positively selected is not surprising in the light of the cities of Hangzhou and Shanghai, for example. The former has a long tradition of being important, e.g., generating a sizable share of China's top officials in the civil service examinations year after year over centuries. In comparison, Shanghai, which would become the most strongly Western-influenced Chinese city, was backwater (also noted in Fairbank 1978). And yet, Shanghai was one of the first treaty ports opened in 1842, whereas Hangzhou became a treaty port only in 1896, and Shanghai generated many times the customs revenue that Hangzhou generated (CMC

Table 6: Pre-Treatment Characteristics of Treated versus Control Regions

	Years 1821-1842						Years 1776 - 1820		
	A. Interest Rate Level (%)			B. Interest Rate Growth			C. Population Growth		
	Treated	Control	Difference	Treated	Control	Difference	Treated	Control	Difference
Treaty Port	6.690 (2, 918)	6.625 (18, 645)	0.065 [0.802]	0.753 (2, 860)	0.520 (17, 796)	0.233 [0.346]	0.227 (33)	0.317 (222)	-0.090 [0.535]
Consulate	6.720 (2, 666)	6.621 (18, 897)	0.099 [0.715]	0.781 (2, 605)	0.519 (18, 051)	0.262 [0.309]	0.280 (33)	0.310 (222)	-0.030 [0.839]

Notes: Sections A. and B. give statistics separately for ever treated versus control observations based on the estimation sample underlying Table 3, column (4) but limited to the pre-treatment period 1821 to 1842. Section A. gives average interest rate levels, while section B. gives average annual interest rate growth rates. Treated defined as ever during the sample period having an open treaty port or consulate. Number of observations in parentheses, and p-value of test of equality in hard brackets. Section C gives average population growth from 1776 to 1820 for ever treated versus not prefectures. Source of interest rates is authors' computations, see section A.1. Population data from Cao (2000).

1899).

Next, we use event-study analysis to examine the evidence for differential pre-trends. This evidence comes from generalizing equation (1) to an event-study in which one coefficient for each period v relative to treatment time –the treatment cohort–is estimated:

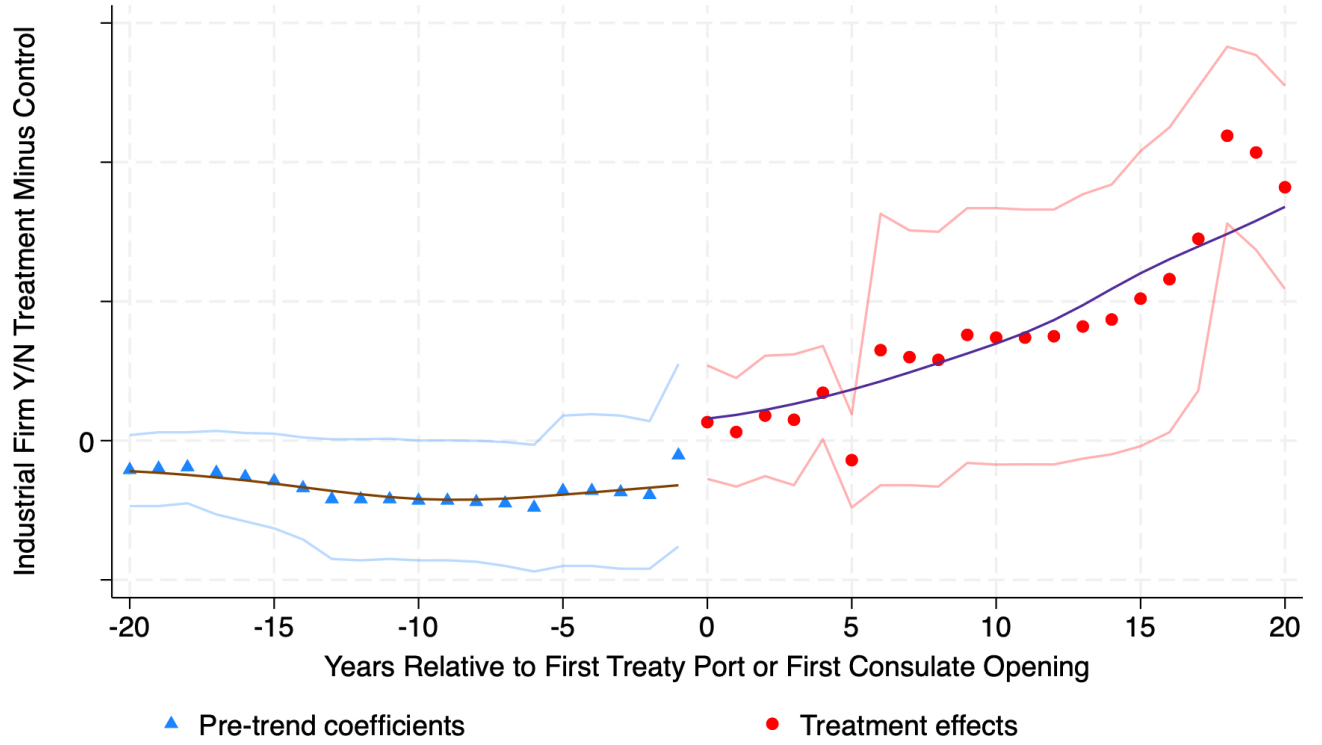
$$Y_{it} = \sum_v \beta_v 1\{t - \widetilde{FOR}_i = v\} + \beta' \Gamma + \delta_{p(i)t} + \mu_t + \theta_i + \varepsilon_{it}, \quad (4)$$

where the year when prefecture i receives a particular binary treatment is $\widetilde{FOR}_i$, and $v = t - \widetilde{FOR}_i$ is the year relative to treatment. We begin with industrialization, employing the indicator variable for any number of such industrial firms.

Figure 7 shows results on the probability of Chinese-owned industrial firms in the prefecture when treatment is defined as either an open treaty port or consulate in the prefecture itself, and spillover terms are included (Table 5, column (8)). We see that the cohort-specific estimates before treatment are not far from zero, which is consistent with the absence of pre-treatment effects. After treatment there is a tendency to positive cohort-specific estimates, in line with the positive overall treatment effect shown in Table 5, column (8).¹⁵

¹⁵Year-specific coefficients and the associated standard errors are shown in Table A.2.

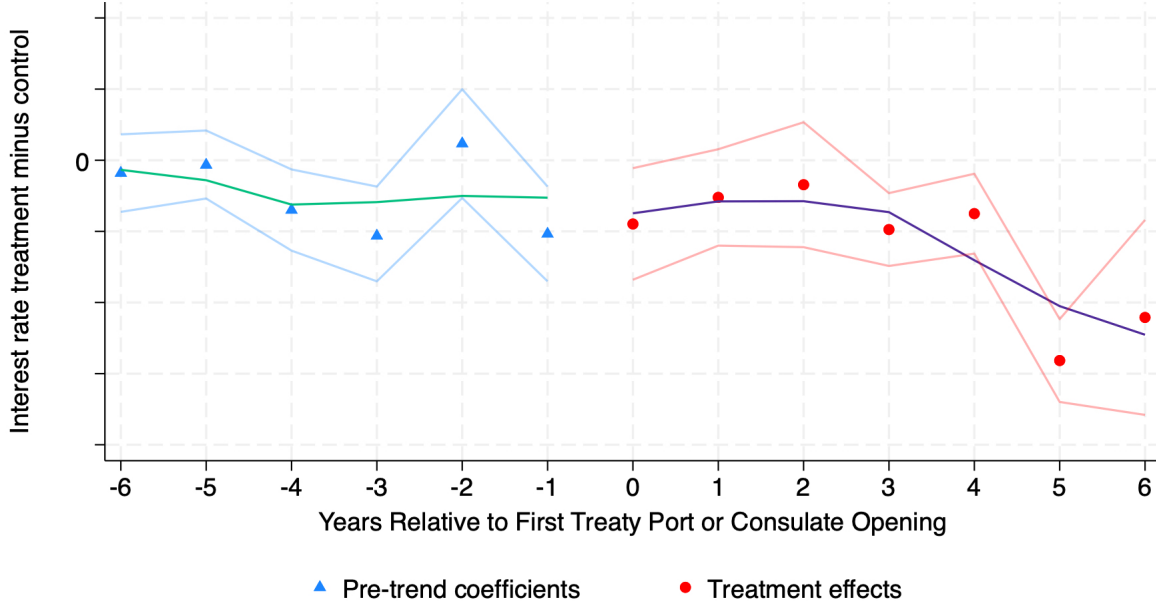
Figure 7: Presence of Industrial Firms and Foreign Influence



Notes: Dependent variable is indicator of Chinese-owned industrial firms in the prefecture. Treatment defined as treaty port or consulate in prefecture itself, with spillovers from both treaty ports and consulates at distances $(0, 150]$ and $(150, 300]$ kilometers are controlled for. Estimation employs Borusyak, Jaraval, and Spiess (2024). Estimates and standard errors reported in Table A.2.

Event-study results on the foreign influence on local interest rates controlling for spillover effects are shown in Figure 8. As is the case of industrial firms, there is no strong evidence for differential trends before treatment. At the same time, there are some differences.

Figure 8: Interest Rates and Foreign Influence: Controlling for Spillovers



Notes: Dependent variable is indicator of Chinese-owned industrial firms in the prefecture. Treatment defined as treaty port or consulate in prefecture itself, with spillovers from both treaty ports and consulates at distances (0, 150], (150, 300], and (300, 450] kilometers are controlled for. Estimation using Borusyak, Jaraval, and Spiess (2024). Point estimates and standard errors reported in Table A.3.

One is that the impact of foreign influence on interest rates manifests itself within a couple of years, whereas the impact on the presence of Chinese-owned industrial firms takes ten or more years to build (see Figures 8 and 7, respectively). This is consistent with technology learning of Chinese industrial firms taking longer compared to risk-reducing effects captured by local capital costs. Second, there is generally more noise in the cohort-specific treatment estimates for interest rates than for industrial firms. This is because the extent of measurement error in capital costs derived from historical grain prices is larger than in our measure of industrial firms (see the discussion in section 3). Event studies for other specifications from Tables 3, 4, and 5 generally yield similar results to those in Figures 7 and 8, and they do not show evidence for major differential pre-trends.

5.4 Robustness

This section addresses the most salient remaining issues. One question is whether the regions that attracted foreign influence in 19th century China are similar enough to Chinese regions that did not attract such influence to identify the true causal effect. While propensity score weights are employed in all specifications, this section presents a treatment-control comparison for regions that are more similar *ex-ante*. A second point is to assess the role of the non-Western countries Japan and Russia for the impact of foreign influence in China. A third concern is that our analysis be missing time-varying factors at a low spatial scale that are correlated with treatment, such as changes in transportation or storage technology. This section addresses these concerns, see Table 7. Results for interest rates are on the left, while estimates for industrialization are on the right.

Table 7: Robustness

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Interest Rates				Industrialization			
		Overlap	Japan & Russia	Time- Varying Factors		Overlap	Japan & Russia	Time- Varying Factors
TP or Consulate	-2.221** (0.775)	-3.283** (0.957)	-1.886** (0.812)	-3.276** (1.183)	0.093** (0.029)	0.088** (0.030)	0.074** (0.029)	0.086** (0.030)
Fixed Effects								
Prefecture-Grain	Y	Y	Y	Y	Y	Y	Y	Y
Prefecture	Y	Y	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y	Y	Y
N	70,015	41,319	64,493	70,015	24,727	15,089	23,463	24,727

Notes: Dependent variable is interest rate. Estimation of equation y using Borusyak, Jaraval, and Spiess (2024). TP stands for Treaty Port. All specifications include decade-specific geographic fixed effects (3 x 3 in latitude and longitude) and province-by-year fixed effects, which for specifications (1) to (4) vary by weather (five categories). Two-way clustered standard errors following Cameron, Gelbach, and Miller (2011) reported in parentheses, by prefecture-grain and by year in columns (1) to (4), and by prefecture and by year in columns (5) to (8); **/*/+ indicates significance at the 1%/5%/10% level.

We begin by imposing the constraint of common support in terms of foreign influence propensity. Employing the min-max approach, we only employ observations that have a higher propensity of ever having a treaty port and a consulate than the larger of the minima in treatment and control samples, and a lower propensity of ever having a treaty port and a consulate than the smaller of the maxima in treatment and control samples.¹⁶ We see that while the interest rate point estimate is somewhat higher in absolute value than before, and the industrialization estimate lower, there is no evidence that the estimates are primarily driven by observations outside of the common support range (columns (2) and (6) of Table 7).

Next, we consider the role of Japan and Russia for the results. Both Russia and Japan established consulates in China, as did Western countries, but given that the policy goals pursued by these countries might have differed this could be important for our results.¹⁷ Table 7 presents results in which prefectures that ever hosted one or more Japanese or Russian consulates are dropped. We see that results are similar to before sample (see column (3) for interest rates and column (7) for the presence of industrial firms).

We also examine the role of time-varying influences other than treaty ports and consulates for the results. To allow in a flexible way for impacts at a relatively small scale, we add a geographic grid of 100 cells, 10 by 10 in latitude and longitude, and allow for separate coefficients before and after the end of the First Opium War (1842). Results do not qualitatively differ upon the inclusion of these fixed effects (see Table 7, columns (4) and (8) for interest rates and presence of industrial firms, respectively). This suggests that given the set of controls employed so far, the remaining influence of changes in transport technology that impact inter-regional trade, or advances in storage technology that affect the construction of interest rates, is limited.

¹⁶This drops 36% of the prefectures from the estimation sample.

¹⁷Neither Russia nor Japan participated in the Chinese Maritime Customs system of the treaty ports. After the First Sino-Japanese war ending with the Treaty of Shimonoseki (1894), Japan played a major part in China's North (Manchuria). Given the timing and the regional concentration of this, it does not affect the analysis in a major way.

The following section discusses mechanisms of Western influence on industrialization and capital markets in 19th century China.

6 Mechanisms

We begin by exploring the mechanisms of industrialization. Improved international market access has the potential to speed up industrialization because it might allow to produce at a sufficiently high scale to pay for any fixed costs of exporting and because participation in international trade might generate positive knowledge spillovers through learning by exporting, for example (Melitz 2003 and van Biesebroeck 2005, respectively). During the sample period, Shanghai, located in Jiangsu province, was the most important port for international trade. Allowing for a differential treatment coefficient for the area of Shanghai, the point estimate is found to be positive and above 0.2 (Table 8, column (2)). This is consistent with international trade being a channel through which foreign influence contributed to China's industrialization beginning in the 19th century.¹⁸

¹⁸Unfortunately, data limitations prevent us from separating the scale from the knowledge spillover channel of international trade.

Table 8: Industrialization Mechanisms

	(1)	(2)		(3)		(4)	
	All	International Trade High		Foreign Direct Investment High		Self-Strengthening High	
TP or Consulate	0.093** (0.029)	0.082** (0.029)	0.231** (0.033)	0.057+ (0.029)	0.287** (0.049)	0.048+ (0.027)	0.402** (0.068)
Fixed Effects							
Prefecture	Y	Y		Y		Y	
Year	Y	Y		Y		Y	
Provinces		Jiangsu		Guangdong, Jiangsu, Zhili		Guangdong, Hubei	
Treaty Ports		Shanghai		Shanghai, Canton, Tientsin		Canton, Hankow	
N	24,727	24,727		24,727		24,727	

Notes: Dependent variable is an indicator that there is one or more Chinese-owned industrial firms in prefecture i and year t . Estimation of equation (1) augmented with a separate treatment effect for all observations belonging to the provinces indicated using Borusyak, Jaraval, and Spiess (2024). TP stands for Treaty Port, Self-Strengthening stands for projects of the so-called Self-Strengthening Movement. High International Trade, High Foreign Direct Investment, and High Self-Strengthening are based on measures at the treaty port; the specific ports, and the provinces to which they belong to, are given in the table. All specifications include decade-specific geographic fixed effects (3 x 3 in latitude and longitude) and province-by-year fixed effects; IPWRA applied; two-way clustered standard errors following Cameron, Gelbach, and Miller (2011) at the prefecture and at the year level reported in parentheses; **/*/+ indicates significance at the 1%/5%/10% level.

The opening of the treaty ports did not only increase international trade with China, but Western countries also established their firms in the treaty ports. The highest number of these were in Shanghai, Canton (Guangzhou), and Tientsin. Because there is evidence that such foreign direct investment (FDI) might generate knowledge spillovers (Keller 2021), we allow for a separate treatment effect for these high-FDI areas. The point estimate is positive at 0.287, consistent with the hypothesis that spillovers from foreign-owned firms stimulated Chinese industrialization during this period (Table 8, column (3)).

Projects of China's so-called Self-Strengthening Movement were most important in the areas of Canton and Hankow, located in Guangdong and Hubei provinces, respectively. Allowing for

a separate treatment effect for prefectures in Guangdong and Hubei, we obtain a positive and relatively high point estimate of 0.4 (see Table 8, column (4)). This is consistent with what the knowledge spillover literature calls absorptive capacity effects, the idea that own technology investments are critical to be able to learn from the technology developed by others (Cohen and Levinthal 1990).

Turning to mechanisms that might shape the impact of foreign influence on capital markets, we examine the roles of domestic social unrest and of foreign banks. Table 9 gives the results.

Table 9: Mechanisms: Capital Markets

	(1)	(2)	(3)
	All	Social Unrest High	Foreign Banks High
TP or Consulate	−2.221** (0.775)	−2.756** (0.857)	1.350 (0.950)
Fixed Effects			
Prefecture-Grain	Y	Y	Y
Year	Y	Y	Y
Provinces		Henan, Jiangsu, Hebei	Hubei, Jiangsu
N	70,015	70,015	70,015

Notes: Dependent variable is interest rate. Estimation of equation (2) augmented with a separate treatment effect for all observations for the indicated provinces using the estimator of Borusyak, Jaraval, and Spiess (2024). TP stands for Treaty Port. Specification (2) allows for a separate effect by number of social unrest events based on the analysis of Keller, Shiue, and Yan (2025). Provinces with High Social Unrest are Henan, Hebei, and Jiangsu. Specification (3) includes a separate treatment coefficient for provinces with the highest number of foreign banks based on Jiang (2014); they are Hubei and Jiangsu. All specifications include decade-specific geographic fixed effects (3 x 3 in latitude and longitude) and province-by-year-by-weather fixed effects; IPWRA applied. Two-way clustered standard errors by prefecture-by-grain and by year following Cameron, Gelbach, and Miller (2011) reported in parentheses; **/*/+ indicates significance at the 1%/5%/10% level.

In regions of China that exhibited the highest levels of social unrest did not benefit from foreign influence through lower capital costs, see Table 9, column (2). This is consistent with the hypothesis that while certain domestic developments might increase the economic benefits from foreign influence, domestic events can also reduce particular benefits that foreign influence might have brought to the Chinese economy otherwise. We also estimate that the capital-cost lowering

effect of foreign influence in 19th century China tends to be higher in areas where foreign banks were most prevalent (Table 9, column (3)), which is consistent with security spillovers from foreign banks.¹⁹

The mechanism analysis presented in Tables 8 and 9 has a number of limitations. One of them is that due to data availability it can not always discriminate between different mechanisms. For example, Canton is among the most important ports for both FDI and for Self-Strengthening movement project (Table 8). Another concern is that a particular provincial characteristic might not be orthogonal to treatment. Thus, while the mechanisms identified above are consistent with some results in the literature, a fully conclusive analysis requires additional research.

¹⁹It is also consistent with an increase in capital supply, however, the amount of capital brought into China by foreign banks was likely small relative to the domestic market.

7 Concluding Discussion

Most colonial policies commence with a stage in which colonial rule is limited to a number of trading cities, typically ports on the coast. How does such semi-colonialism compare with full-scale colonial rule, specifically, does semi-colonialism have the potential to be transformative to the host country? The case of 19th century China allows to address this question both because the era of semi-colonialism lasted several decades and China is a large enough country to allow for a comprehensive geographic spillover analysis. While it is well-understood that the West's foray into China after the Opium War increased the flow of international goods and firms, foreign law, and new technologies into China, did this matter for China's economy overall? To date most observers tend to be skeptical, noting that the part of China's economy under direct colonial rule was small.

We find regions under direct colonial rule exhibited a higher rate of growth of Chinese-owned industrial firms. Western locations also impacted China's economy by bringing down local interest rates. Importantly, Western impact was not limited to the immediate port areas. We estimate a positive impact on industrialization for distances of up to 300 kilometers, and a positive impact on capital markets at distances of up to 450 kilometers from the Western ports and consulates. Much of China's economy, perhaps the majority of its regions, was impacted by the West's semi-colonialism during the 19th century. This indicates that semi-colonialism can have far reaching geographic impacts.

In the case of China, industrialization is found to be more closely related to treaty ports than to consulates. This suggests that the treaty port mechanism involves technology transfer in addition to market access gains. Consulates, which were the primary location of the West's extraterritorial legal system in China, particularly led to lower capital costs. A plausible mechanism, consistent with existing evidence, is that the presence of consulates reduced transaction cost because it provided more security and lower risk.

While we find sizable positive effects, the analysis is limited to two indicators—industrial firms and capital costs— and an important question for future research is whether these findings continue to hold for other aspects of economic performance. Moreover, by infringing upon China's political

sovereignty, Western colonialism no doubt reduced China's state capacity, at least to some extent. That, in turn, might explain the relatively high incidence of social unrest in parts of China during the 19th century, which as we have seen tends to lower economic modernization effects. A complete assessment of the economic impact of colonialism may require to model the impact of colonialism on domestic state capacity.

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Online Appendix

The Appendix provides additional information on the data as well as supplementary estimation results.

A Data

We begin by providing additional information on constructing regional interest rates from grain price data, including key assumptions of the framework as well as key characteristics of the resulting interest rates. We also discuss the underlying grain price data.

A.1 Interest Rates Derived from Grain Price Data

In the storage cost approach, the interest rate is obtained from the gradient of the price movement over the harvest cycle. The gradient is informative because optimal storage requires that the price compensates for the storage costs of holding the commodity, of which the interest rate is a part. As noted in the text, this approach goes back to work in the 1930s, and among others it has been employed by McCloskey and Nash (1984) to estimate medieval interest rates in England.

Consider a merchant in region i at time τ who can buy $Q_{i\tau}$ units of grain from a farmer at price $P_{i\tau}$. The merchant can store the grain for one period and sell it at time $\tau+1$ at a price $P_{i\tau+1}$. Instead of buying the grain, they can also invest the outlays of buying the grain ($P_{i\tau}Q_{i\tau}$) in a risk-free asset and receive $(1 + \varrho_{i\tau})$ times $P_{i\tau}Q_{i\tau}$ at time $\tau+1$, where $\varrho_{i\tau}$ is the rate of return on a risk-free asset. The merchant and the farmer would contract on an agreement that specifies the merchant's purchase price from the farmer $P_{i\tau}$ as well as the price at which the farmer buys back the grain from the merchant, $F_{i\tau+1}^j$, where j denotes the particular transaction. The price $F_{i\tau+1}^j$ at which the merchant will store grain depends on the costs and benefits of grain storage.

We distinguish three types of costs. First, there is the opportunity cost of the risk-free rate, which is due to the fact that if the merchant does not buy grain from the farmer they have an income of no less than $(1 + \varrho_{i\tau}) P_{i\tau}Q_{i\tau}$ at time $\tau+1$, whereas if the merchant stores the grain for

one period, then no interest is earned. Second, when the merchant stores the grain the potential income is tied up in the granary and subject to risk. In particular, by storing grain the merchant faces the risk that the grain market between τ and $\tau+1$ does not perform as expected. We denote the interest rate inclusive of risk factors by $r_{i\tau}^j$, where $r_{i\tau}^j \geq \varrho_{i\tau}$. Third, grain does not store perfectly but is subject to spoilage (mold, mice, etc.). Per-unit storage costs are denoted by $c_{i\tau}$. Given $c_{i\tau}$ and $r_{i\tau}^j$, as well as the current price $P_{i\tau}$, for the merchant to be indifferent between storing and the alternative investment, the price $F_{i\tau+1}^j$ in the contract between merchant and farmer would have to be $F_{i\tau+1}^j = P_{i\tau} (1 + r_{i\tau}^j + c_{i\tau})$, or, the price has to be such that risk-inclusive interest and physical storage costs are covered.

For implementation, since individual transactions are not observed, we drop the superscript j and assume that price observations reflect the average rate, $r_{i\tau}$. Suppose that the forward price $F_{i\tau+1}$ is equal to the spot price of grain in period $\tau+1$, that is, $P_{i\tau+1}$, up to an expectation error, $F_{i\tau+1} = P_{i\tau+1} + \varsigma_{i\tau+1}$. The expectation error includes risk and other factors.

Under these circumstances, we can rewrite expression $F_{i\tau+1}^j = P_{i\tau} (1 + r_{i\tau}^j + c_{i\tau})$ as

$$\hat{p}_{i\tau} \equiv \frac{P_{i\tau+1} - P_{i\tau}}{P_{i\tau}} = r_{i\tau} + c_{i\tau} + \tilde{\varsigma}_{i\tau+1}, \quad (5)$$

with $\tilde{\varsigma}_{i\tau+1} = \frac{\varsigma_{i\tau+1}}{P_{i\tau}}$. Equation (5) says that in equilibrium up to expectation error, the rate of grain price change equals the interest rate plus storage costs, $r_{i\tau} + c_{i\tau}$.

The key advantage of this approach is that, in principle, it can be applied whenever commodities are stored and high-frequency price data are available. Grain prices, in particular, have been systematically recorded for centuries in world history, far predating the arrival of formal banks, let alone the systematic collection of bank interest rate data. Recent work has employed this approach in a comparison of China's and Britain's capital market development of the 18th and 19th century (Keller, Shiue, and Wang 2021). Furthermore, to specifically assess its reliability it was recently utilized in comparison to studying capital market developments using bank interest rates in the early 19th century United States (Keller, Shiue, and Wang 2000). These analyses indicate that interest rates derived from high-frequency grain price data indeed reflect a multitude of influences

beyond what arguably are the local costs of capital in a region. Among the most salient factors are weather shocks (supply), as well as the characteristics of the grain price collection (sampling). At the same time, provided there is consistent data collection (across regions and over time) and a sample size that is large enough, grain price-based interest rates are suitable for studying differences in the cost of capital in historical capital markets (see Keller, Shiue, and Wang 2000)

In the present case, there is a high degree of uniformity in the grain price collection because all series come from a national price collection system (Chinese Academy of Social Sciences 2009), and the introduction of fixed effects means that we take differences. Yet, the assumption of zero expectation error (that is, $F_{i\tau+1} = P_{i\tau+1}$) is strong, as it implies that there are no unexpected supply or demand shocks affecting the price of grain. Weather shocks are one source of such unexpected shocks; moreover, the opening of treaty ports or consulates may generate other expectation errors and therefore affect measured interest rates. To address these concerns, we include year fixed effects that vary geographically by province as well as by each of the five weather categories (very dry to very wet; see Table A.1 for more on the weather data). We also show that allowing for a shift in measured interest rates after the First Opium War does not change qualitative findings (Table 7). This is consistent with earlier findings that correlation analysis based on grain-price based interest rates is largely robust to the influence of price shocks (Keller, Shiue, and Wang 2020, Table 5).

Grain Price Data Turning to the underlying price data, by the beginning of the 18th century, an extensive network of grain price reports had become a routine aspect of the Qing bureaucracy. The government did not set prices, but it did compile price reports. Prices originally were collected at markets serving the county towns, where the county represented the lowest level of government. Price reports at the county level were made every ten days to a month (Chuan and Kraus 1975), and sent to the next higher level of administration, the prefecture, where prefectural officials summarized the county reports. Today the prefectural prices are the most disaggregated data available. Prefectural price reports give the highest and lowest prices for each grain in each prefecture, at lunar-monthly intervals. The prices were recorded in copper cash per *sheng* and converted to silver *taels* (*kuping liang*) and bushels (*shi*). Our source is the Chinese Academy of

Social Sciences (2009), where the price series start in the year 1821.

Historical analysis and empirical studies suggest that this data is generally of high quality. There are countless examples in the documentary evidence in which government officials refer to grain prices to infer regional supply and demand, or compare price levels within and across provinces. These statements would have been illogical if the prices would not be considered as reliable and comparable from region to region. Moreover, the price data was not only useful to Qing officials as an early warning system of areas of potential food crises, but another practical use of the price records was that since the government was a major buyer of grain, it desired to know where prices were relatively low. Studies that have employed the Qing grain price data include Chuan and Kraus (1975), Wang (1992), and Shiue (2002).

The present study employs monthly data for 14 different grain price series to compute the average within-harvest year price gradient. Our unbalanced sample covers 245 prefectures in 20 provinces of China during the period 1821 to 1899. The coverage and quality of the grain price data deteriorates towards the end of the Qing dynasty (in 1911), which is in part why we end the sample period before 1900. Regionally, the sample covers the major centers of residence and economic activity (Xinjiang province is not included). There is information on up to four types of grain in a prefecture, depending on what crops are indigenous for that region as well as data availability. Millet and sorghum are grown in the northern provinces, whereas rice is common in the central and southern provinces. Wheat is grown in many parts of China. Rice comes in 3 grades: high quality, standard, and low quality, and for one province (Zhejiang) our rice data is for early-ripening rice. We employ all available price data in the analysis. The sample has less coverage in some of the Northern areas of China; at the same time, exploratory analysis gives no reason to believe that this systematically affects the results.

The grain price gradient in a given year, equation (5), is computed as the average monthly gradient for each grain price series, prefecture, and year. The sample is restricted in the following ways. First, to focus on months in which there is storage, we drop months for which the typical price change is negative (in particular harvest times, see Figure 3). Second, we focus on the central 99 percent interval of one-month price changes to reduce the impact of outliers. This yields $N =$

70,015 observations which vary by prefecture, year, and the grain price series on which the interest rate is based.

Weather Data Information on historical weather is employed to separate price changes into the components of physical storage cost and risk-inclusive interest rates, see equation (5). Physical storage costs depend on weather because grain storage is sensitive to climatic conditions, especially extreme weather. Weather data come from State Meteorological Society (1981). This source gives annual tables and maps of dryness and wetness in 120 regions, each region of which corresponds to one or two prefectures in China. The degree of dryness and wetness is classified into 5 grades: grade 1 is very wet; grade 2 is wet; grade 3 is normal; grade 4 is dry; and grade 5 is very dry, normalized according to what is considered average for a particular region. For each of the prefectures and for each year, we take the weather, coded 1 to 5, of the nearest weather station of the 120 regions to be the weather of this prefecture in a given year. Table A.1 shows mean price gradients by climatic condition:

Table A.1: Weather Conditions and Measured Interest Rates

Weather Condition	Price Gradient		
	N	Mean	Standard Deviation
Very Wet	7,222	9.809	18.430
Wet	18,902	8.318	16.471
Normal	25,710	8.047	16.543
Dry	14,019	9.122	17.193
Very Dry	4,162	13.307	21.750
All	70,015	8.830	17.253

Notes: Authors' calculations.

Table A.1 confirms the sensitivity of grain storage costs to extreme weather. While the means for moderate weather conditions are between 8 and 9 percent per year, for Very Wet weather the

mean is closer to 10 percent and for Very Dry weather the mean is above 13 percent per year. In the empirical analysis, we isolate the interest rate from physical storage costs by including province-year specific weather fixed effects on the right hand side.

A.2 Chinese Industrial Firms

Du (1991) is the source of this data, and it builds on work of Du’s PhD advisor, Wang Jingyu. As noted in the text, this is a compilation based on secondary sources. The main sources are (1) Customs Trade Reports, Decennial Customs Reports, and British Consular Commercial Reports, (2) contemporary press and newspapers, in particular *Shen Bao*, the *North-China Herald*, and *Yi Wen Lu*, (3) Port Gazetteers and Commercial Guides, as well as (4) official correspondence, personal papers, and retrospective histories. Many reports, particularly those in the *North-China Herald* and consular reports, are based on direct observation and inspection through physical visits at factory sites.

Du (1991) employs a specific methodology outlined in the “Editorial Notes”. It includes

1. Contextual Standardization: At the beginning of every entry, the editors inserted a bracketed note, [·], to explicitly identify date, location, and specific subject matter of the text, ensuring the raw data for properly contextualized for the reader.
2. Citation and Verifiability: The editors placed parentheses, (·), at the end of every single entry detailing the exact source name, volume number, and page number, allowing readers to independently trace and verify the original text.

Standard practices include (i) triangulation of sources (for example, a factory’s existence might be noted in a newspaper (*Shen Bao*) while its detailed financial status is verified by customs reports or official statistics), (ii) statistical auditing of lesser sources (e.g., newspapers) through official documents (e.g., customs and decennial reports), and (iii) transparency through public company announcements in prospectuses or dividend reports. Industrial operations distinguished are (1) machine silk reeling, (2) cotton ginning, (3) spinning mills, (4) flour milling, (5) match factories,

(6) paper making, (7) printing and publishing, (8) ship repair and machinery repair, and (9) public utilities including electricity and waterworks.

Du (1991) imposes a minimum size threshold of 10,000 yuan for industrial, mining, and shipping enterprises, and of 50,000 yuan for financial enterprises. This is the major limitation making this a non-exhaustive source. Entries concern firm events including founding, capital raised, employment, output, machinery imported, technical problems, and closing. The authors are transparent about missing some data due to limited search scope or because material could not be found. They refer to their work as a “preliminary collection”.

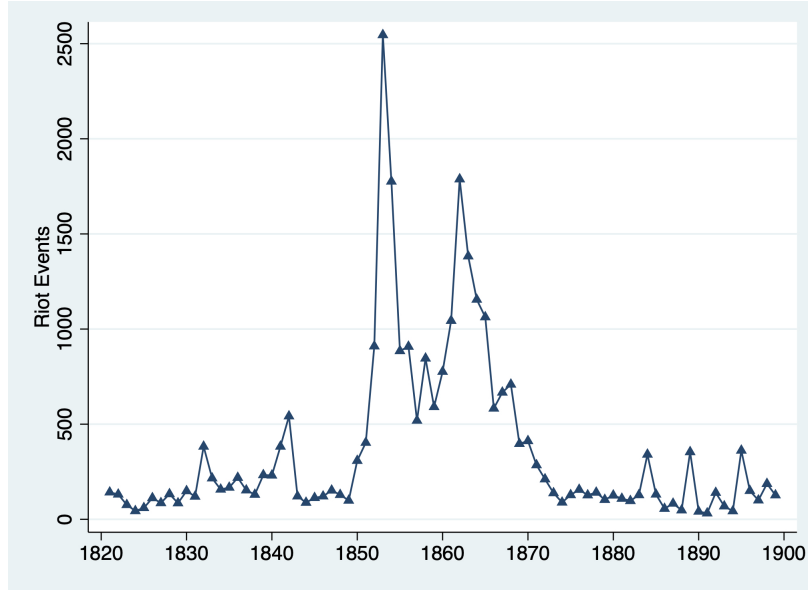
Overall, the source has all the ingredients to be a systematic and largely unbiased compilation of larger modern enterprises in China between 1840 and 1927.

A.3 Other Data

Data on social unrest draws on Keller, Shiue, and Yan’s (KSY; 2025) analysis of the administrative records of the Qing Dynasty (*Qing Shilu*). KSY adopt a supervised machine learning approach to classify each entry of the *Qing Shilu* into one that describes an unrest event, versus one that is not an unrest event. They begin with the 775 verified unrest-related entries listed in the seminal work by Chen et al. (1989), which is combined with an equal number of entries from the *Qing Shilu* that are not unrest-related. Following standard practice in the literature, KSY use 4/5 of this data to train their classifier, while the remaining 1/5 of the training data is used for out-of-sample testing. KSY examine the performance of a range of methods, from Naive Bayesian classifiers over neural network models to a BERT classifier trained on Chinese historical documents (GUWEN-BERT).

KSY’s results yield the highest level of accuracy, above 97 percent, with the GUWEN-BERT classifier. In addition, the machine-identified spells of unrest are positively correlated with known triggers of social unrest, such as extreme weather and high grain prices. Figure A.1 gives the national time series of social unrest from their analysis. A large share of unrest events occurred in the 1850s and early 1860s, during the Taiping Rebellion.

Figure A.1: Protest Event in 19th Century China



Notes: Sources are the Veritable Records of the Qing Dynasty (*Qing Shilu*) and Keller, Shiue, and Yan (2025).

KSY's analysis extracts the number of unrest events at the prefecture-year level. There is substantial variation across regions, and the largest numbers of unrest events during the sample period occurred in the provinces of Henan, Hubei, and Jiangsu.

B Consulates and Extraterritoriality in China

This section provides an overview of legal extraterritoriality in China.²⁰ Before 1842, the opportunities for friction between the Chinese and Western traders were limited by the fact that this trade was tightly controlled and limited to one port (Canton), where only specially designated members of the Chinese Co-hong merchant guild could interact with foreign traders. Almost immediately after the first additional ports of entry were opened in 1842, there arose the need for British and other foreign residents to have a way of resolving property disputes and conflicts of interest both with Chinese agents as well as amongst Western traders. After having rejected the legitimacy of the Chinese system of law and justice, there was a vacuum of legal administration in the case of disputes. To achieve their goal that foreigners in China would be subject to the jurisdiction of their

²⁰See Quigley (1926) and Cassel (2012) for additional information.

own country rather than to Chinese laws (extraterritoriality), Western countries had to introduce legal rules from their countries in China.

Already the earliest of the treaties, the 1842 Treaty of Nanjing, included extraterritorial rights through the stipulation that allowed the British Consular Service in China to handle cases involving British residents in China, and within a few years of the opening of the first Treaty Ports, Britain established the position of a consul who represented the interests of the British citizen in China in judicial matters. A similar set of rights of extraterritoriality was made explicit in the American treaty of 1844 between the U.S. and China. By 1847, 19 nations had extraterritoriality provisions with China. They were, in chronological order of treaty establishment: Russia, Great Britain, the U.S., France, Sweden, Norway, the German Customs Union (later: Germany), Denmark, The Netherlands, Spain, Belgium, Italy, Austria-Hungary, Peru, Brazil, Portugal, Japan, Mexico, and Switzerland. The influence of legal extraterritoriality from foreign countries was centered on consulates, since the first level of jurisdiction was typically a consular court where typically the consul himself served as judge.

There was a learning curve as Western nations tried to maneuver and establish new legal rules of engagement within China and with the nationals of other countries in China. Treaties marked the beginning of this process in which it was no longer the case that Westerners could consider themselves above the law. As a general rule, the laws that were applied in a case were those of the country of the defendant. Thus, the case of a British citizen accused of stealing from a Chinese national in Guangzhou would be brought before the British consular court. Western extraterritorial influence increased the incentives of Western traders to provide credit in China. Furthermore, the link between Western business practices and courts may have changed traditional ways of contracting, leading to efficiency gains through the reduction of risk premia, see case studies from Kirby (1995) and Chung (2010).

C Supplementary Empirical Results

C.1 Event-Study Coefficients and Standard Errors

Table A.2 presents point estimates and standard errors for the event shown in Figure 7.²¹

²¹We rely on one-way clustering by prefecture because two-way clustering by prefecture and by year does not guarantee positive variance estimates. Exploring the variance of average treatment estimates, however, e.g. in Tables 3 and 4, we generally find that estimates with one-way clustering and two-way clustering are similar. Inferences using Conley (1999) standard errors consistent with spatial dependences are similar.

Table A.2: Industrialization Event Study: Coefficients and Standard Errors

	Years Relative to Treat- ment	Coefficient (Std Error)		Years Relative to Treat- ment	Coefficient (Std Error)
Pre- Treatment	-20	-0.021 (0.013)	Treatment	0	0.013 (0.021)
	-19	-0.020 (0.013)		1	0.006 (0.020)
	-18	-0.019 (0.012)		2	0.018 (0.022)
	-17	-0.023 (0.015)		3	0.015 (0.023)
	-16	-0.026 (0.016)		4	0.034 (0.017)
	-15	-0.029 (0.017)		5	-0.014 (0.017)
	-14	-0.034 (0.019)		6	0.065 (0.050)
	-13	-0.042 (0.022)		7	0.060 (0.047)
	-12	-0.042 (0.022)		8	0.058 (0.047)
	-11	-0.042 (0.022)		9	0.076 (0.047)
	-10	-0.042 (0.022)		10	0.074 (0.047)
	-9	-0.043 (0.022)		11	0.074 (0.047)
	-8	-0.044 (0.022)		12	0.075 (0.047)
	-7	-0.045 (0.023)		13	0.082 (0.048)
	-6	-0.048 (0.023)		14	0.087 (0.049)
	-5	-0.036 (0.028)		15	0.102 (0.054)
	-4	-0.036 (0.028)		16	0.116 (0.056)
	-3	-0.037 (0.028)		17	0.145 (0.056)
	-2	-0.039 (0.027)		18	0.219 (0.032)
	-1	-0.011 (0.034)		19	0.207 (0.036)
				20	0.182 (0.037)

Notes: Results correspond to Figure 7. Robust standard errors based on clustering at the prefecture level in parentheses.

Coefficients and standard errors for the interest rate event study are shown in Table A.3.

Table A.3: Interest Rate Event Study Coefficients and Standard Errors

	Years Relative to Treatment	Coefficient	Standard Error
Pre-Treatment	-6	-0.903	1.391
	-5	-0.330	1.204
	-4	-3.495	1.455
	-3	-5.319	1.220
	-2	1.172	1.949
	-1	-5.183	1.699
Treatment	0	-4.476	2.000
	1	-2.614	1.729
	2	-1.719	2.240
	3	-4.866	1.307
	4	-3.754	1.433
	5	-14.080	1.485
	6	-11.047	3.494

Notes: Robust standard errors are based on clustering at the prefecture-grain level.

C.2 Probability of Becoming Treaty Port or Consulate Location

As is typical in semi-colonial settings, Western powers were mostly interested in trade access in China. Given lower transport costs of waterway shipping compared to overland shipping, coastal and river prefectures had a higher chance to be picked as locations for treaty ports or consulates. Estimation results of this paper account for this and other prefectural differences that affect the likelihood of direct foreign influence by employing regression weights (inverse probability weighted regression adjustment, denoted by IPWRA). These weights are based on a probit regression. The dependent variable in this regression is equal to one if a prefecture ever had at least one foreign

consulate or at least one treaty port, and zero otherwise. Regressors include a prefecture's latitude and longitude, indicators for waterway access (including coastal and river location), as well as pre-sample prefectural population as well as population growth. Table A.4 shows the results from this probit regression.

Table A.4: Placement of Foreign Locations

	Coefficient (Standard Error)
Log Latitude	-5.365** (1.144)
Log Longitude	-1.730 (3.424)
Log Population in 1776	0.654** (0.195)
Population Growth 1776 - 1820	0.210* (0.813)
Northern Coast	3.267** (0.681)
Southern Coast	0.301 (0.400)
Grand Canal	-0.435 (0.494)
Yangzi Delta	0.644 (0.511)
Yangzi River	0.904* (0.370)
Pearl River	-0.464 (0.673)

Notes: Dependent variable is one if a prefecture ever had one or more treaty ports or consulates, and zero otherwise. $N = 252$. Estimation by probit regression. Coastal and waterway access variables are indicators. Standard errors are heteroskedasticity-consistent; **/* means significant at a 1%/5% level.

We see that on average, prefectures in China's south had a higher probability of to be a treaty port or consulate location than northern prefectures. Similarly, prefectures with higher population during the pre-treatment period 1776 to 1820 were more likely to have treaty ports or foreign consulates. In the north of China, treaty ports and consulates were more likely to be found on the coast than inland. Moreover, treaty ports and consulates were significantly more likely along the Yangzi River, while other inland waterways play less of a role. Overall, these results are in line with other evidence.

Supplementary Files

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