Public- versus Private-led Industrialization in Meiji Japan, 1868-1912 *

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Abstract

Weak institutions, capital scarcity, and risk aversion may motivate the state to lead industrialization in developing economies. Nevertheless, it is unclear whether public-led industries differ systematically from those led by private investors. Using a new dataset of firm establishment from pre-war Japan, I compare the development of industries pioneered by either the government or entrepreneurs. I find public investment was directed toward capital-intensive industries and in less populated regions, suggesting both capital market failure and market fragmentation. Private-led industries, despite modest capital requirements, had lower rates of entry among startup firms, which may indicate high risk aversion among entrepreneurs.

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1 Introduction

To the leaders of the Meiji Restoration, a modern Japan meant a centralized government, a strong military, railroads and telegraphs, a credible currency and banking system, and factories producing textiles and machinery. Less obvious were the means to achieve these ends, and over the next five decades, a group of industrialists, financiers, and intellectuals known as the *genro* embarked on an ambitious modernization program. The relative backwardness of the economy and paucity of private investment during the political transition meant the Meiji government bore the onus of creating a modern state. It purchased western technologies and equipment, employed skilled foreign labor, and founded schools, research institutes, and model factories throughout the country. On the eve of the first world war, Japan had won a colonial empire through military conquest, adopted the gold standard, and flooded world markets with merchandise carried by domestic-built steamships.[1]

In particular, it has been argued that the government's seeding of particular industries like textiles and shipbuilding provided the catalyst for economic growth.[2] Consistent with theories of late development, it appears that in the turbulence following the political transition the Japanese state alone was able to amass sufficient capital to acquire foreign technology and invest in long-term industrial projects.[3] Factors like the alignment of managerial and ownership interests and production coordination further highlight the suitability of public leadership in industrial ventures.

Nevertheless, while many attribute the country's economic success to public policies and investments, little research exists to substantiate claims of their efficacy.[4] This is primarily due to a lack of data from the

[1] Japan formally annexed the Ryukyu Islands (formerly a protectorate) in 1879. From its victories in the wars with China (1895) and Russia (1905), Japan acquired Taiwan and the southern half of the Sahkalin island, respectively. Japan later annexed Korea, previously a Chinese protectorate, in 1910.

[2] Most scholars and historians agree that until the 1880s, the Japanese government was the most important contributor to industrial development. A financial breakdown from Rosovsky (1961) of public and private sector capital formation in the Meiji Period supports this conclusion; see Table 3.

[3] See Rostow (1990) and Gerschenkron (1962). The breadth of its industrial activities meant that the government could better bear the risk of failed investments, much as *zaibatsu* conglomerates were thought to have done later in the period; see Tang (2007).

[4] Rosovsky (1961) says that "although scholars generally share the view that government influence was widely felt throughout the economy...the opinions are not backed by macro-economic facts–one can believe almost what one chooses, tending toward either one extreme or the other."

Meiji Period, particularly at the firm level, when the foundation for Japan's industrialization was laid.[5] Some scholarship even contests the need for government involvement in catalyzing industrialization, arguing that the privatizations of public enterprises in the 1880s at fire-sale prices were indicative of mismanagement and inefficiency.[6] Other arguments that undermine the government's beneficent role include its militarization policies, which may have distorted industrial development and ultimately led to economic and political crisis, and the contributions of the private sector.[7] In particular, many important industries were pioneered by *zaibatsu* conglomerates and much of the country's foreign exchange was earned through household production of raw silk.[8]

Uncertainty about the government's industrial leadership and interest in understanding non-western economic development motivate this research. Specifically, this study compares public-led sectors with those pioneered by the private sector, looking at three characteristics: factor intensity, rates of entry, and spatial distribution. If weak capital markets failed to provide funding to entrepreneurs, this should be reflected in the type of industries (ie, capital vs labor intensive) that the government and private sector entered. Similarly, besides financial constraints, if there were other barriers to entry like risk aversion or technology adoption that inhibited private investors, then sectors pioneered by the government would probably have greater rates of entry since the initial risks were borne by public enterprises. Finally, if the government placed market integration at a higher priority than profit maximization, this may be revealed through the regions that were targeted for industrial investment (eg, prefectures with lower population density or lacking coastlines).

To test these hypotheses, I employ cross-sectional and times series econometric techniques as well as non-parametric comparisons. My analysis uses a new dataset of firm establishments collected from corporate genealogies dating back to the nineteenth century.[9] Encompassing the entire industrial spectrum, the data

[5] Ohkawa and Rosovsky (1973) claim that the first "long swing" of modern industrial development occurred between 1888 and 1897.

[6] Hirschmeier and Yui (1975). A prominent example is the first modern silk reeling facility, the Tomioka Filature, which the government built according to French design in 1872 and incurred significant losses before selling it to private investors.

[7] Tipton (1981).

[8] See Morikawa (1992) and Nghiep and Hayami (1979), respectively.

[9] Yagura and Ikushima (1986). Supplemental sources include Smith (1974) and Yushodo (1966).

include firm entry dates, establishment location, and ownership type.[10]

Intuitively, I find that the government led entry into heavier industries while the private sector pioneered lighter industries in early part of the Meiji Period, suggesting capital market failure for large-scale investment. Natural resources also appear to contribute to industrialization, which makes sense for an economy developing manufacturing and energy-intensive sectors. However, average establishment rates for startup firms were higher in government-led sectors, suggesting that financial entry barriers were not the primary deterrent to entrepreneurs. Instead, it may be that risk aversion was more influential in determining whether private investment flowed into certain sectors, and that after the government reduced uncertainty by leading entry, private capital followed. Furthermore, establishments in public-led sectors, while fewer in number than those led by private entrepreneurs, are more equitably distributed across the country. This appears both in greater geographic dispersion earlier in the period and in larger variation of local population densities, both of which may have helped to spread the effects of industrialization to remote or underserved locations.

At first glance, it may seem that government leadership in heavy industries is inconsistent with greater entry rates among public-led sectors (since high capital requirements plausibly act as an entry barrier). These two findings, however, occur in parallel: the small number of light industries (ie, textiles) pioneered by the government quickly emerge as the dominant sectors in the economy, with large numbers of private entrepreneurs then taking advantage of the newly opened markets. Along with its geographically dispersed industrial investments, these results show how the government simultaneously addressed three of its main objectives: to substitute domestically produced capital goods for imports; to earn foreign exchange via light manufactures; and to consolidate its political and economic authority across the country.[11]

The remainder of the paper is as follows: Section 2 explores the historical context and describes the industries targeted by the government, while Section 3 presents the data and methodologies used. I provide the results in Section 4, and discuss possible extensions and conclude in Section 5.

[10] See the section on data for more detail.

[11] Smith (1974). Investing across multiple industries also provides supporting sectors and linkages along the production chain (ie, intermediate goods) on which the targeted industries rely.

2 Public Enterprise in the early Meiji Period

Having been largely closed to international exchange until the arrival of a fleet of American battleships in 1853, Japan possessed virtually no modern industries, infrastructure, or institutions at the beginning of the Meiji Period (1868-1912).[12] To rapidly modernize its economy, the new Meiji government made substantial investments in some strategic industries: transport and communications; metal and coal mining; metal processing and manufacture; shipbuilding and machinery; armaments; chemicals; and textiles.[13] These were chosen for a number of reasons, such as to encourage domestic production of capital goods; to earn foreign exchange; to ease commercial transactions and extend political control; and to increase military power.[14]

Underlying these aims was the recognition of weak capital markets, the scale and skill required for industrial startup, and risk aversion to unfamiliar technology.[15] In absolute terms, government expenditure to promote industry was modest, totaling 32 million yen between 1870 and 1885 (or less than 20 percent of the government budget).[16] However, the government sought to encourage private enterprise by leading entry into targeted sectors with its pilot factories, acquiring and demonstrating new technologies, and supporting the opening of new markets.[17]

To get a sense of the contribution of the government, I briefly describe some of key industries it helped to pioneer. These range from services (rail and shipping) to manufacturing (shipbuilding), from capital-intensive sectors (mining and metals processing) to lighter ones (textiles).

[12] Prior to this, Japan maintained limited trading relationships with the Dutch and Chinese in the port city of Nagasaki. On 31 March 1854, Japanese officials signed the country's first foreign trade agreement, opening the two port cities of Shimoda and Hakodate to American commerce; U.S. Navy (2007). While a number of regional governments, and ultimately even the national government, invested in modern sectors toward the end of the Tokugawa Period (1617-1868), these were one-off projects and remained small-scale; Smith (1974).

[13] Rosovsky (1961), Smith (1974).

[14] *Ibid.*

[15] Despite some wealth accumulation by merchants, private individuals remained largely in the fields of commerce and not manufacturing industries. Smith (1974) notes that the private sector was more effective in manufacturing industries, but even then they were "least active in heavier branches."

[16] This figure excludes, however, the non-negligible expenses paid to foreign experts; see Hirschmeier and Yui (1975).

[17] Rosovsky (1961). Smith (1974) writes "[g]overnment mills had served as models for private enterprise, working out technical difficulties and problems of plant organization."

2.1 Transport and Communications

The first railroad in Japan was laid by the government in 1872, connecting Tokyo to Yokohama, while a second line followed two years later, connecting Kobe to Osaka. Until 1881, all railroads were financed by the public sector, totaling 76 miles in length.[18] Private sector activity took on a bigger role in the 1880s, with a group of aristocrats putting up 20 million yen to establish the Nippon Railway Company, which was the largest establishment at the time.[19] Nevertheless, even after private investors began to build railways, they were offered subsidies and guaranteed returns for their undertaking. Notwithstanding its meager mileage, the railway system was intensively used, which in turn provided a source of technical and managerial knowledge for industrial development at large.[20] The related telegraph industry was adopted more rapidly, extending throughout the main islands of Honshu, Shikoku, and Kyushu by the mid 1880s.[21] The government also prohibited private ownership of the main telegraph lines and maintained a monopoly throughout the Meiji Period.

The other major, and arguably more important, form of transportation was shipping. The government, fearing foreign takeover of coastal routes and wanting to increase exports, sought to create a domestic shipping industry. However, after an early attempt at direct management of the Kaiso Shipping Company, which operated liner service between Osaka and Tokyo, the government recognized its inefficiency and began to indirectly support the sector's development.[22] This included leasing ships to the Mitsubishi Trade Company, which transported government troops to Taiwan in 1874.[23] Domestic ship operators received exclusive rights to certain routes and subsidies for postal and trade activities, like the 1896 Navigation Promotion Law. This act, amended in 1910, provided increasing subsidies for ships of large size and high speed.[24]

[18] Smith (1974).
[19] Hirschmeier and Yui (1975).
[20] *Ibid.*
[21] *Ibid.*
[22] Chida and Davies (1990).
[23] See Tang (2007) for a description of Mitsubishi's role in the development of the shipping industry.
[24] At least 1,000 gross tons and 10 knots per hour; see Travis (1945).

2.2 Shipyards and Machinery

Like the shipping industry, shipbuilding was underdeveloped in the early Meiji Period due to the isolationist policy of the previous shogunate government. The shipbuilding sector took longer to develop, however, due to its large financial and technological costs as well as the absence of supporting industries like metal processing and machinery.[25] Of the three main shipyards (Yokosuka, Nagasaki, Hyogo) in the country, all were owned by the government at the start of the Meiji Period and produced machinery like marine engines and boilers in addition to ships.[26] By the 1880s, however, the government decided to privatize its enterprises due to the high cost of operation and inefficient production.[27] After its withdrawal from direct operations, the government subsidized shipyards with the Shipbuilding Promotion Law in 1896, although private producers remained small in scale until the even of the Russo-Japanese War a decade later, when demand for both repairs and construction due to military conflict aided the industry's growth.

2.3 Mining and Metal Processing

While there were numerous private coal and ore mines throughout the country, they were small and used traditional extraction techniques.[28] Furthermore, none employed foreigners or could afford foreign equipment like mechanical drills or steam power.[29] In contrast, the government owned nine mines that used modern machinery, of which six collectively produced approximately half of Japan's mining output by value in the 1880s.[30] Domestic production as a whole, however, was insufficient to meet demand, where at least half the tonnage of iron and steel was imported throughout the period.[31]

One of the largest investments the government made was the Kamaishi Iron Works, completed in 1878 at

[25] Chida and Davies (1990).

[26] For example, the (private) Kawasaki shipyard also produced Japan's first locomotives and rail coaches in 1907; see Hirschmeier and Yui (1975).

[27] *Ibid.* Thus, the first steel steamship was built in 1895 by the Mitsubishi *zaibatsu*, which had bought the Nagasaki shipyard from the government; Smith (1974).

[28] Smith (1974).

[29] *Ibid.*

[30] *Ibid.* This figure obscures the fact that government-owned mines were the primary producers of precious metals while private mines produced most of the country's copper and coal.

[31] Yonekura (1994). The figures for domestic production may be underestimated because they exclude small indigenous producers using the Tatara method to produce pig iron.

a cost of 2,376,625 yen.[32] This facility was plagued with operational problems, including low quality ore and a lack of adequate fuel supplies, and was sold in 1882 to private investors for 57,000 yen. A commissioned report on Kamaishi's failure revealed broader difficulties of managerial disorganization, low demand, and inadequate technological expertise. Nevertheless, the Kamaishi experience served the government's purposes by "[providing] a model of investment for the private sector to imitate," "absorbing unavailable initial costs and losses that private entrepreneurs could hardly be expected to bear," and "[helping] overcome certain technological difficulties that previously had been considered insurmountable."[33]

2.4 Cotton and Silk Textiles

It is hard to underestimate the contribution of textiles to early Japanese industrialization, not only because of the foreign exchange the industry earned, but also for its introduction of mechanized labor to an agrarian economy. While the country began exports of raw silk and silkworms a decade before the Meiji Period, it was not until the late 1800s, with technological advances as well as government-instituted quality measures and factory production, that the industry took off.[34] The country's first modern manufacturing factory, the Tomioka Silk Filature, was built in 1872 by the government to promote mechanized reeling of silk (as opposed to hand-reeling). The Tomioka plant, with its French design and utilization of the latest equipment, operated at a loss for many years, until the government privatized it in 1893. Despite its inauspicious start, the success of the industry was clear by the end of the Meiji Period, when Japan had become the largest silk textile exporter in the world.

The cotton textile industry, on the other hand, was initially viewed with skepticism, given negligible domestic production of raw cotton and unfamiliarity with spinning technology. Although Japan's first cotton-spinning mill was built in 1867 by officials in Kagoshima prefecture, it was only after cotton textiles reached nearly a third of all imports during the 1870s did the government react with substantial investment.[35] Two additional public mills were built in Hiroshima and Aichi prefectures, each equipped with 2,000 spindles,

[32] *Ibid.*
[33] *Ibid.*
[34] See Nghiep and Hayami (1992) and Tang (2004) for discussions of the silk industry and the role of technology.
[35] Fletcher (1996).

but were sold off in 1882 and 1886 due to their inefficiency and cost. The government also provided loans and spindles to entrepreneurs to encourage private factories. These independent firms had greater success, notably the Osaka Spinning Mill established by Shibusawa Eiichi in 1882 with 10,500 spindles. By the mid-1890s, Japan was exporting over four million pounds of cotton yarn.

3 Research Design

3.1 Data

To analyze differences between public- and private-led industries throughout Japan's economic development in the Meiji Period, I use a new firm-level dataset collected from corporate genealogies. Of the 2,231 establishments with identifiable industries founded between 1868 and 1912, there are 56 in agricultural and other primary industries, 560 in manufacturing ranging from food processing to miscellaneous machinery, and the remaining 1,615 in service sectors like banking and retail sales. These startup firms represent 162 different industries at the 3-digit classification level, which I group together more broadly as modern, heavy, and light sectors.[36] Having an industry code also allows me to calculate the factor intensity (capital-labor expenditure ratio) for all manufacturing establishments.[37] Besides a date of establishment and an industry code, each establishment may also provide the type of ownership (government versus private) and the location of establishment (prefecture).[38] Because not all entries have this information, the respective numbers of establishments with ownership and location are 1,822 and 1,009. Table 1 presents some descriptive statistics.

Knowing the ownership and date of entry of a firm enables me to determine whether the government or an entrepreneur led entry into an industry. This, in turn, allows me to classify industries as being either public- or private-led.[39]

[36]The modern sector comprises chemicals, metal processing, machinery, utilities, textiles, and transportation and communication. Heavy industries include the first four groups in the modern group, while light industries include textiles, food processing, woodwork and papermaking, and miscellaneous manufacturing. The latter two groupings are based on Rosovsky (1961).

[37]I create capital-labor expenditure ratios by dividing operating costs (materials and energy) by labor wages, using contemporaneous industry data collected by the U.S. Census Bureau (1907).

[38]Private ownership can be further subdivided into unlisted firms (eg, sole proprietorships, limited and unlimited liability partnerships and mutual associations) and listed firms (eg, limited and unlimited liability joint stock firms).

[39]More detail is in the following subsection. Given the typical fanfare accompanying public-sponsored first entrants, it is

Location identification makes it possible to control for differences in natural resource endowment, geographic features, and population density. I indicate the availability of four different types of resources: timber, coal, petroleum, and metal ores.[40] While no figures exist for the initial size of each resource deposit by prefecture, these categorical indicators may provide exogenous explanations for industrial development. Differences in prefecture geography are measured continuously, and include average annual temperature and rainfall, latitude and longitude coordinates, length of coastline, and area covered by water.[41] These features may serve as proxies for agricultural production suitability (ie, climate, surface water), which may compete with manufacturing industries for both labor and capital; lower transportation and transaction costs; and availability of hydropower used in industries like millwork and paper production. Finally, population density may correspond to market demand and proximity, with urban areas also having better infrastructure and greater financial capital.

3.2 Hypotheses and Methodology

While this dataset provides sufficient information to test hypotheses on the role of industrial policy, there remain some conceptual and framing clarifications. A crucial question is whether the definition of government intervention is limited to enterprises it had set up (eg, model factories) and financial assistance of any form or if it should also include the broader industrial impact issuing from its policies.[42] While the former may be more easily measured, it seems the latter is a more realistic description of development, given the government's long-term social planning and the knock-on effects of initial investments.[43]

Asserting the latter position leads to the difficulty of measurement, which this study addresses with the new dataset and the assumption that industries selected by the government differ in character and

plausible that industries pioneered by the government are adequately identified. I further refine industry entry order with the genealogical records.

[40] Trewartha (1945).

[41] Annual measures are approximated with modern figures; Weather Channel (2007). See Japan Statistical Association (1987) for physical geography measurements.

[42] The definition of "assistance" remains controversial even today, such as in the debate on whether American government contracts awarded to the airplane manufacturer Boeing are implicit subsidies (compared to the explicit funding provided by European governments to Boeing's competitor Airbus).

[43] Aubrey (1954) writes: "[t]he importance of government expenditures for economic development is inadequately expressed by investment figures, for they are the nucleus of further progress in which private investment can participate more prominently."

developmental paths from those pioneered by the private sector. This assumption is plausible because limited resources force public leaders to choose among many investment opportunities, and ostensibly the interest of the government is in long-term national welfare, not short-term profit maximization.[44] With this in mind, I consider the any industry that the government was the first entrant to be "public-led" for the whole of the Meiji Period. This applies even if the government had exited prior to the period's conclusion, as was the case with its privatizations in the 1880s. Similarly, industries initiated by private entrepreneurs, even if subsidized, are designated as "private-led." This public-private delineation allows me to compare industrial development over time as well as examine industry-wide characteristics like capital intensity and firm entry.

Based on this distinction, I can test a number of hypotheses that compare industry characteristics. One hypothesis is that the government led entry in capital-intensive industries while the private sector led those that were labor-intensive. This may occur if private capital is weak and few financial intermediaries exist, suggesting difficulties in mobilizing funding for scale-oriented and high fixed-cost industries.[45] I test this with a discrete choice probit model, using whether an establishment was public-led or not as the binary dependent variable.

The primary independent variable is factor intensity, which is the ratio of capital to labor expenditures for a 3-digit JSIC industry. This assumes that the government had knowledge of an industry's capital intensity prior to entry, which is consistent with the theory of late development. In addition, I control for population density, indicators for natural resources, and geographic features, and interact factor intensity with each of these to account for shared effects. I interpret positive coefficients on these variables as indicating an increased likelihood of public sector first entry.

Another hypothesis is that rates of entry into industries pioneered by the government are higher than those led by private entrepreneurs. It is likely that besides possible capital market failure, unfamiliarity with technology and risk aversion may inhibit industry formation and that government entry into an industry is

[44]This latter point is challenged by some political economists, but typical examples of self-interested leaders do not involve extra-national actors like imperialists, which may align the interests of leaders with the collective welfare.

[45]Smith (1974).

an implicit vote of confidence in the industry's long term development.[46] This signal may arguably be more credible than that given by private individuals considering the relatively greater expertise and resources that the government possessed.[47]

To see if different entry rates exist, I compare the means and standard deviations of the average number of establishment for the two series. If the average number of public-led industrial establishments is larger, *ceteris paribus*, I interpret this as revealing the existence of fewer entry barriers (eg, setup cost) in those sectors.[48] Besides first moments, I can also assess second moment properties, ie, whether there are trends in either the public- or private-led industrial series and if they differ. For this, I use standard unit root tests for stationarity. The existence of a positive trend (ie, greater entry) over time may indicate decreasing barriers to entry like imitative competition or lower risk aversion.[49]

Finally, I look at the spatial dispersion of establishments by sector affiliation. The government may have a greater interest in spreading the effects of industrialization to less densely populated markets and over a greater geographic area, unlike a profit-maximizing private firm. Similar to the above approach with entry rates, I compare means and standard deviations to determine whether there were differences in population densities between affiliated sectors.

4 Results

The descriptive statistics in Table 1 indicate that establishments in public-led industries (224 out of 251) were over-represented in manufacturing compared to private-led industries (336 out of 1971); however, the proportions are nearly reversed for service industries.[50] This corresponds to anecdotal evidence that private

[46] Of course, the government's presence may also deter private competitors because it may not behave like a rational agent and pursue profit maximization.

[47] The government both sponsored foreign travel for students and officials as well as employed costly foreign workers to introduce new technology; see Hirshmeier and Yui (1975) and Jones (1980).

[48] Arguably, *ceteris paribus* does not hold because of likely differences in industry selection and factor intensity. This favors my hypothesis, however, since capital-intensive industries (presumably public-led) should see less entry.

[49] Negative trends could indicate anticompetitive behavior or market saturation, although this interpretation may be problematic since the current dataset contains only startup entry and not exit.

[50] Note that the figures for service industries may be less reliable than those for manufacturing. This is because establishments providing services probably had fewer capital assets to pass on, and thus may be missing from the genealogies. Given the focus of this paper on industrial development, which was oriented toward manufacturing, possible sample bias does not invalidate the results (especially those using the light and heavy industry group series).

entrepreneurs were reluctant to engage in manufacturing due to the scale of investment, technical and organizational difficulty, and technological conservatism.[51] Nevertheless, the number of private-sector startup establishments in heavy industries (234) exceeds that for light industries (186), which appears at odds with the previous result. An explanation for this may lie in the role of financial conglomerates in leading the development of scale-oriented and capital-intensive industries, as well as the dramatic growth of light sectors seeded by the government.[52]

Looking at changes over time, however, suggests a more complicated story. Figures 1 to 3 break down public- versus private-led establishments by various industrial series. For startups in modern industries, there appears to be little difference in growth rates between public- and private-led sectors. Separating by factor intensity indicates that before the 1880s, private capital was much more likely to pioneer and develop light industries (Figure 2) while sectors seeded by the government were relatively capital intensive (Figure 3). For both industrial series, the growth rates of public- and private-led industrial startups appear to move counter-cyclically, which may reflect dysfunctional capital markets in the early part of the Meiji Period and the need for public investment in heavier sectors.

After the 1880s, public- and private-led startups grow in similar fashion, although light sectors established by the government grew more rapidly and heavy industries owed their growth primarily to private capital. Greater entry in government-led light industries suggests the efficacy of model factories and other industrial policies to induce private investment. Furthermore, a more mature financial system in the second half of the Meiji Period is correlated with growing economic importance of private-led industries.

4.1 Correlations

Simple pairwise correlations, like summary statistics, provide a useful reference for more rigorous analysis. As shown in the top panel of Table 2, industries pioneered by the public sector are negatively correlated with the capital-labor ratio and positively correlated with all three industrial series. In particular, between light and heavy industries, the public sector is five times more strongly correlated with the former, and is weakly

[51] Smith (1974).
[52] Tang (2007).

correlated with prefectures that have longer coastlines. This is consistent with the descriptive statistics and suggests the success of government-seeded light industries like textiles, forming the foundation of the period's growth. Other relationships correspond with historical evidence, such as the positive correlations among population density, coastline length, and heavy industries. These may be due cities located typically along the coastal plains, providing ready supplies of labor and capital required by heavy industries.[53]

However, like the descriptive statistics, these correlations lack a sense of temporal change as documented by the earlier figures plotting startup activity over the entire period. To see if different results obtain for smaller periods of time, I divide the dataset into pre- and post-1893 samples, with the year 1893 chosen because it both occurs near the midpoint of the Meiji Period and was the year when a commercial code for joint stock incorporation was promulgated.[54] Since earlier Japanese governments typically had low regard for property rights and financial note legitimacy, this legal institution arguably eased private access to investment funding and signaled a milestone in financial system development.[55]

The results for the first half of the Meiji Period (Table 2, middle panel) show that sectors pioneered by the government are positively associated with heavier industries. This relationship is no longer significant for the second half of the period (Table 2, bottom panel). These findings correspond to the earlier summary statistics that show significant contrasts between startup activity in industries led by either the public or private sectors. Labor-intensive industrial startups are strongly represented in the modern series for the second half of the Meiji Period, indicated by the negative correlation between modern industries and the capital-labor ratio. Also notable is the positive relationship between coastline length, a proxy for openness to commerce and trade; and modern industries in the latter half of the period, when Japanese textile exports dramatically increased.

[53]Trewartha (1945).

[54]Loenholm (1906).

[55]According to Confucian tradition, which the Japanese drew heavily on to justify their class system, merchants were the lowest of the four occupational groups (aristocracy, warriors, craftsmen, merchants) and loan obligations were routinely annulled by government decree; see Hirschmeier and Yui (1975).

4.2 Differences in Capital Intensity

A major shortcoming of correlation analysis is that it does not include other explanatory influences. Results from the probit analysis, given in Table 3, show a positive coefficient on factor intensity. I interpret this as indicating that higher capital intensity increases the likelihood of being a public-led industry.[56] This makes sense given the relative immaturity of the financial system and risk aversion of private capital for a large part of the period. In addition, higher population density lowers the probability of having had public leadership, shown by the negative coefficient on the variable (and something I elaborate on later in the results). This may imply the government's interest in developing regions that had less access to investment capital or infrastructure.

Among natural resource variables, industrial establishments in petroleum-endowed prefectures are less likely to be public-led. However, if these industries are capital intensive, then the probability increases. Annual rainfall also increases the likelihood of a sector having had public leadership, which makes sense considering the prevalence of textile industries (largely seeded by the government) located in agricultural prefectures. This may also explain the association between both public-led industries and lower population (since agricultural prefectures were mostly rural) as well as with surface water area (which I use to proxy for irrigation availability).

I test for functional form and omitted variable bias with a specification link test. This test takes the fitted values of the residual from the original regression and squares them, then reinserts them into the model as an additional variable. The modified model is regressed to check for significance in the new variable. The null is that the model has no omitted variables, and if correctly specified, the squares of the residuals should not be significant. Aside from the first specification in Table 3, the remaining specifications all fail to reject the null at least to the five percent level, from which I conclude that the model is correctly specified. I also cluster the standard errors by 3-digit industry to allow for correlation in errors within industries, and report Eicker-White standard error estimates that are robust to data heteroskedasticity.

All together, these regression results corroborate earlier findings and theories of late development that at

[56] That is, the numerator in the capital-labor ratio increases.

an early stage of industrialization, the government is likely to take the initiative to develop capital-intensive industries.

4.3 Differences in Entry

To better understand the relationship between public sector leadership and an industry's revealed ease of entry, I test the hypothesis that industries pioneered by the government see greater entry than those led by the private sector. If public-led industries have greater startup activity, this is consistent with the premise of capital market failure and the need for public intervention to overcome initial investment costs and technological risks. In addition, greater entry in public-led sectors also suggests profit potential and the implicit long-term support of the government in its viability.

I also examine whether the difference between the average number of startup establishments for both public-led versus private-led industries is stable over time. If a difference exists, it may indicate technological entry barriers.[57] That is, when two series begin with different rates of entry that converge over time, there may be decreasing costs to entry. On the other hand, divergent entry rates may indicate monopolistic or predatory behavior on the part of incumbents or other persistent entry barriers. Stable rates suggest the absence of differential technological impediments between the two sectors.

To test these hypotheses, I first compare the means and trends between public-led and private-led industry startups. If one series has a larger mean for the average number of startups per industry in a given year compared to the other, then the former is revealed to have fewer barriers to entry. I then use standard unit root tests to determine if either series has a dynamic trend, and if so, test for cointegration to see if the two series share a long-term relationship.

As shown in Figures 4 through 6, public-led sectors have larger means in both modern and light industry series compared to the private-led sectors, but are similar in the heavy industry series. There do not appear to be trends that last for the whole of the period, although public-led sectors grow more rapidly in the first two industrial series before the mid 1890s. Table 4 has the overall means and standard deviations, which

[57] I use the average number of startup establishments per 3-digit industry instead of total number of startups to reduce distortions from industry outliers.

corroborate the trends in the figures. Larger means indicate greater entry rates in public-led sectors, which may reflect lower entry barriers. Thus, it may be the case that risk aversion rather than financial constraints was the primary obstacle to industrial development. The government was able to overcome the former by being the first entrant. Moreover, the higher volatility in entry for these sectors may be attributed to higher growth rates.[58]

These two findings together appear paradoxical since government-led industries have both higher rates of entry and greater capital intensity, which presumably means greater barriers to entry and thus lower entry. The data indicate, however, that the two findings occur in parallel: while one would expect the government to choose heavy sectors given its ability to mobilize financial capital, its few forays into light industries (eg, textiles) were successful in catalyzing private investment and industry growth.[59]

To see if technological entry barriers existed, I test the public- and private-led industry series each for stationarity, using the augmented Dickey-Fuller (ADF) and the Philips-Perron (PP) unit root tests with a time trend. The ADF test includes both lags of the variable in question as well as lags of its difference; as a further refinement, the PP test uses Newey-West standard errors to control for heteroskedasticity and serial correlation. Both tests include a constant term, considering the two series appear to have non-zero means, and allow for the constant to trend over time. The number of lags is selected based on a sequence of likelihood ratio tests testing the null hypothesis that the coefficients on the pth lags are zero.[60] The results for the two series are given in Table 5.

Based on the ADF and PP tests, I reject the hypothesis that there is a unit root in the two series. Stationarity implies the existence of and reversion to a mean as well as a lack of integration, which means it is unnecessary to test for cointegrating relationships between the public- and private-led sectors series. In other words, there do not appear to be any substantive technological differences in the development of either the public- or private-led industries, which is plausible given that both the government and entrepreneurs

[58]Possibly from reliance on external factors (ie, foreign demand, agricultural conditions) than those industries (presumably led by the private sector) catering solely to the domestic market. With its priority of earning foreign exchange, the government may have chosen precisely those industries with higher profit potential and commensurately higher risk.

[59]The highly competitive nature of light industries may also owe to foreign competition in export and domestic markets.

[60]Kennedy (1998).

had access to the same technology and that the latter group was financially heterogeneous.

4.4 Geographic Differences

The final area this study examines is differences in geographic establishment, with spatial distribution serving as a gauge of industry promotion and market integration. On this premise, it appears that public-led industries failed to have a nationwide presence, with government-seeded industries being found in 35 of the 47 prefectures compared to the private sector in 45. On the other hand, by looking at the average number of prefectures entered annually by either public- or private-led industries, one notices that government-seeded light industries expanded into slightly more prefectures per year, as shown in the top panel of Table 6.

Alternatively, one can use population density to assess economic integration of underserved areas. Earlier correlations already indicated that population density decreases the likelihood for public sector entry, which suggests that the government may have wanted to encourage development in the periphery. Based on average population density of prefectures, government-led industries indeed tended to be in less densely populated areas. The discrepancy is particularly pronounced for heavy industries (Table 6, bottom panel), where the difference in prefecture density is over 326 inhabitants higher for private-led industries. Thus, although government-led industries may have tended to locate in fewer areas, these locations were less urban and presumably in greater need of industrial development.

5 Discussion and Conclusion

How well did the government succeed in its modernization program? The above results showed that the government was more likely to invest in capital-intensive industries than the private sector, which may indicate capital market failure for large-scale investments early in the Meiji Period. Nor did the government ignore light industries, with those that it pioneered becoming major contributors to economic growth. Since these sectors did not require substantial financing, it may be that private entrepreneurs had risk aversion, and the government's initiative did much to allay doubts about the viability of foreign technology and market potential. Finally, the government also succeeded in spreading the effects of industrialization across the

country to more sparsely populated and remote areas. Whatever the metric, its broad-based policies paid off with per capita GDP increasing 5.1 percent annually between 1875 and 1912, over twice the rate of the United States in the same period.[61]

The government's industrial policies did much to improve its international position as well. Japan repeatedly demonstrated its martial prowess over its neighbors, thereby convincing western powers to relinquish extraterritorial rights and to return tariff autonomy by 1911. As mentioned earlier, the country's adoption of technology and heavy industrial growth benefited considerably from military demand. Thus, it may be of interest to study to what extent investment (public or private) in military goods stimulated the domestic economy. Notwithstanding the availability of public expenditure data on military budgets, the current dataset of firm establishment may provide an alternative perspective by tracing the expansion of commerce and manufacturing in Japanese colonies.

In addition, the government actively encouraged international trade to acquire technology and capital. As shown in Table 7, exports increased more rapidly than imports, easing the burden of capital goods imports and underwriting the development of domestic industries to substitute for foreign production. Less clear is how trade impacted small independent firms and domestic market integration. One may be able to assess how non-tradable goods and services were affected by foreign technology and infrastructural improvements induced by foreign commerce by comparing industrial growth between regions. It may be possible as well to examine the extent to which Japan transferred technology (as embodied in firm activity within more advanced industries) to surrounding nations that were even less developed (eg, those in the Greater East Asia Co-Prosperity Sphere).

That said, it would be misleading to consider trade as the primary engine of Japanese development. While exports helped to finance Japan's industrialization, the ports, ships, and merchandise themselves were the issue of careful policymaking and well-functioning institutions, both domestic phenomena. The success of the government's modernization program lay in the mutual reinforcement of its various efforts to substitute imports, earn foreign exchange, consolidate political authority, and increase military strength. Within this

[61] Japan Statistical Association (1987).

broader framework, even the privatizations of its failed public enterprises in the 1880s can be viewed as a sign of progress that the private sector was ready to take the reins of economic growth.

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Table 1: Descriptive Statistics[a]

	Total	Public-Led	Private-Led
Total Number of Establishments	2231	260	1971
Ownership identifier	1822	218	1604
Location identifier	1009	190	819
Factor-intensity	562	224	338
By Sector			
Primary	56	23	33
Secondary	560	224	336
Tertiary	1615	13	1602
By Industrial Series			
Modern industry[b]	632	209	423
Light industry[c]	352	166	186
Heavy industry[d]	298	58	234
By Ownership			
Government-owned	56	18	38
Listed private establishment	1513	146	1367
Unlisted private establishment	253	34	219
By Location[e]			
Urban	813	157	656
Rural	182	31	151

[a]: Based on the 3-digit JSIC code level.

[b]: Includes textiles, chemicals, metals, machinery, utilities, and transport/communications.

[c]: Includes food/beverage manufacturing, textiles, paper/wood products, stoneware and ceramic manufacturing, and miscellaneous manufacturing.

[d]: Includes chemicals, metal processing and manufactures, machinery, and utilities.

[e]: Limited to domestic establishments. Urban is defined as over 386 people per square kilometer.

Table 2: Correlations

	Public	K-L	Modern	Light	Heavy	Density
Meiji Period, 1868-1912						
Public-Led Sector	1.000					
Capital-Labor Ratio	-0.338*	1.000				
Modern Industry	0.420*	-0.161*	1.000			
Light Industry	0.479*	-0.087*	0.192*	1.000		
Heavy Industry	0.099*	0.094*	0.617*	-0.168*	1.000	
Population Density	-0.010	0.039	0.153*	0.018	0.208*	1.000
Coastline Length	0.071*	-0.038	0.062*	-0.014	0.137*	0.266*
Pre-1893 Subperiod						
Public Sector	1.000					
Capital-Labor Ratio	-0.321*	1.000				
Modern Industry	0.495*	-0.075	1.000			
Light Industry	0.419*	-0.089	0.262*	1.000		
Heavy Industry	0.252*	0.092	0.542*	-0.187*	1.000	
Population Density	0.060	0.064	0.151*	0.091	0.146*	1.000
Coastline Length	0.086	0.078	0.001	-0.093	0.157*	0.355*
Post-1893 Subperiod						
Public Sector	1.000					
Capital-Labor Ratio	-0.322*	1.000				
Modern Industry	0.388*	-0.199*	1.000			
Light Industry	0.507*	-0.069	0.159*	1.000		
Heavy Industry	0.039	0.078	0.646*	-0.159*	1.000	
Population Density	-0.008	-0.008	0.156*	0.005	0.224*	1.000
Coastline Length	0.060	-0.119	0.098*	0.035	0.128*	0.251*

Significance level: * 5 percent.

Table 3: Probit Results

Binary Dependent Variable: Public-Led Industry				
	(1)	(2)	(3)	(4)
Factor intensity (K/L)	-0.198**	-0.235***	1.393**	1.919**
	(0.081)	(0.087)	(0.625)	(0.916)
Population Density[a]		-0.294***	-0.299*	-0.304*
		(0.093)	(0.174)	(0.166)
Selected Control Variables[b]				
Petroleum		-1.636**	-3.435***	-2.697**
		(0.786)	(1.339)	(1.302)
Mean Annual Rainfall		0.214	2.293**	3.300**
		(0.397)	(0.943)	(1.560)
Surface Water Area		0.194	1.029*	1.247**
		(0.235)	(0.557)	(0.628)
K/L · Petroleum			0.616**	0.506*
			(0.242)	(0.266)
K/L · Ore			-0.311**	-0.325*
			(0.153)	(0.158)
K/L · Temperature			-0.043**	-0.051**
			(0.019)	(0.023)
K/L · Coastline			0.323	0.481**
			(0.199)	(0.200)
K/L · Rainfall			-0.740**	-1.082**
			(0.309)	(0.491)
K/L · Surface Water			-0.308**	-0.392**
			(0.141)	(0.165)
Year Dummies	no	no	no	yes
Observations	547	417	417	388
R-squared	0.120	0.199	0.214	0.276

Robust standard errors in parentheses.

Significance level: * 10 percent, ** 5 percent, and *** 1 percent.

[a]: 1000 people per square kilometer.

[b]: Insignificant terms not shown, but included in specification. See text for complete list of variables.

Table 4: Average Establishment per Industry

	Public-led	*Private-led*	
	(1)	(2)	(1)-(2)
Modern Industry	1.873	1.368	0.505
	(1.729)	(0.620)	
Light Industry	1.815	1.241	0.574
	(1.788)	(0.523)	
Heavy Industry	0.600	1.049	-0.449
	(0.673)	(0.652)	

Standard deviation in parentheses.

Table 5: Unit Root Tests[a]

	ADF	PP	Lags
Public-Sector Led			
Modern Industry	-4.769***	-4.821***	0
Light Industry	-3.270*	-4.206***	1
Heavy Industry	-7.311***	-7.280***	0
Private-Sector Led			
Modern Industry	-1.767	-5.530***	3
Light Industry	-6.910***	-6.966***	0
Heavy Industry	-3.643**	-4.741***	3

Significance level: * 10 percent, ** 5 percent, and *** 1 percent.

[a]: By average number of establishments per 3-digit industry.

Table 6: Geographic Representation

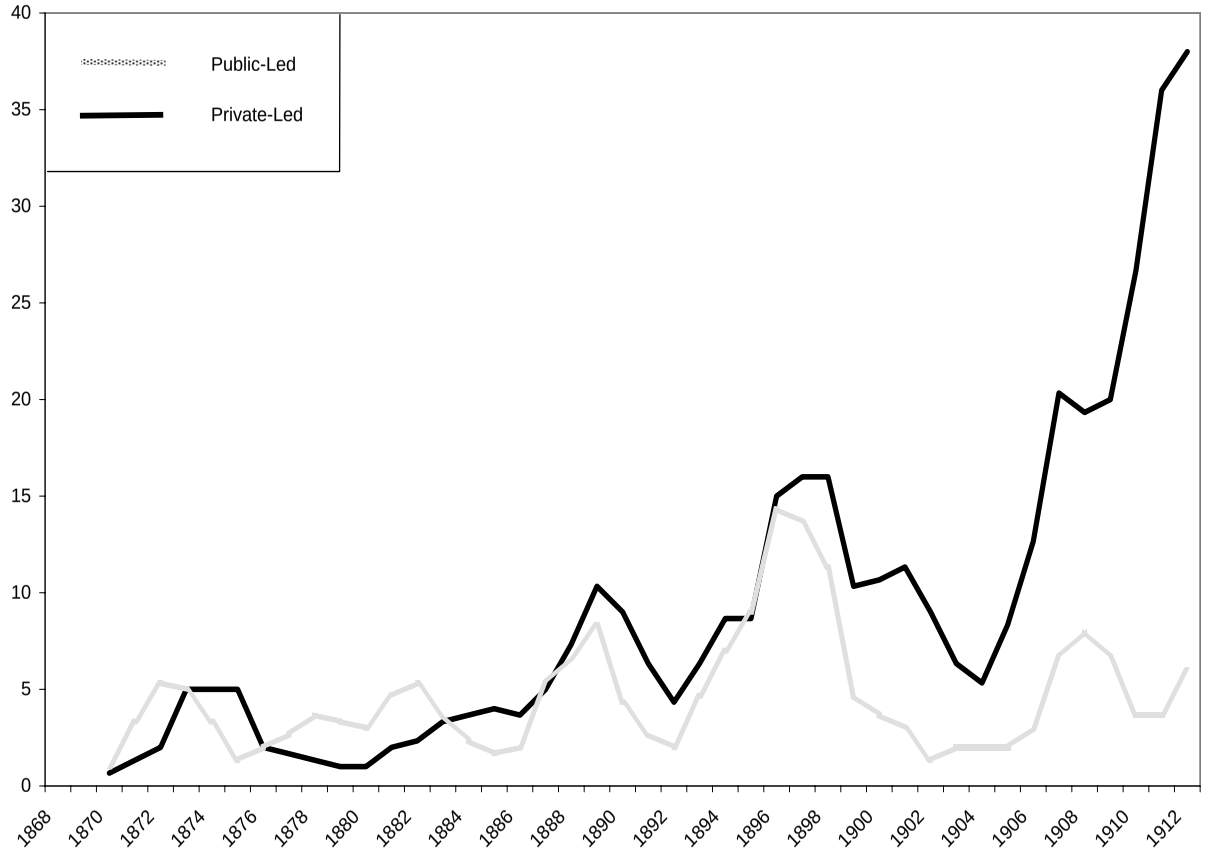
	Public-led	*Private-led*	
	(1)	(2)	(1)-(2)
Average Number of Prefectures			
Modern Industry	3.486	4.718	-1.232
	(3.061)	(3.634)	
Light Industry	3.441	3.179	0.262
	(3.377)	(1.985)	
Heavy Industry	0.811	3.128	-2.317
	(0.908)	(2.894)	
Average Population Density			
Modern Industry	1130.013	1137.076	-7.063
	(880.075)	(954.046)	
Light Industry	1146.802	1288.459	-141.657
	(832.977)	(1108.269)	
Heavy Industry	1144.961	1471.058	-326.097
	(962.447)	(1252.735)	

Standard deviation in parentheses.

Table 7: Annual Trade Growth

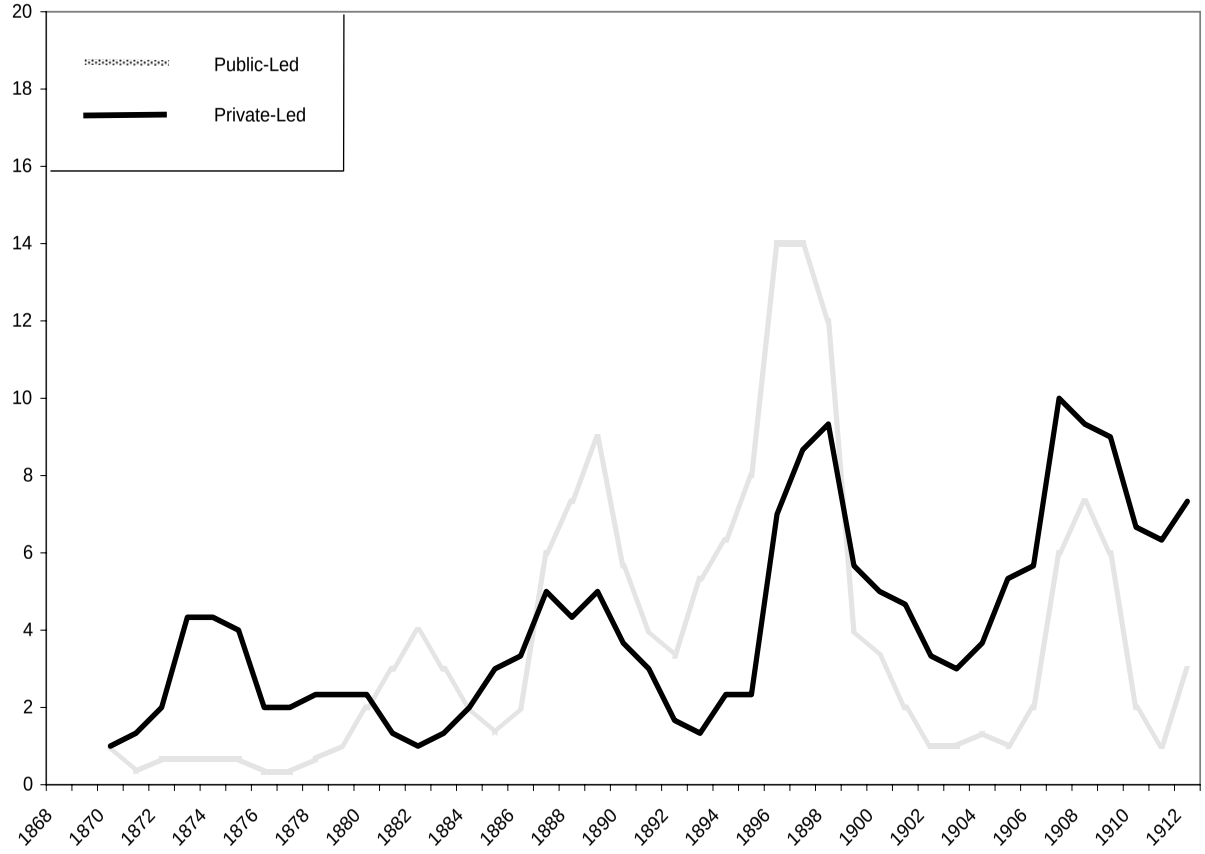
	Exports	Imports
1868-1880	6.7%	15.4%
1881-1895	10.5	11.8
1896-1912	11.7	10.3
1868-1912	*9.9*	*12.3*

Figure 1: Modern Industrial Startups



Based on three year moving averages.

Figure 2: Light Industrial Startups



Based on three year moving averages.

Figure 3: Heavy Industrial Startups

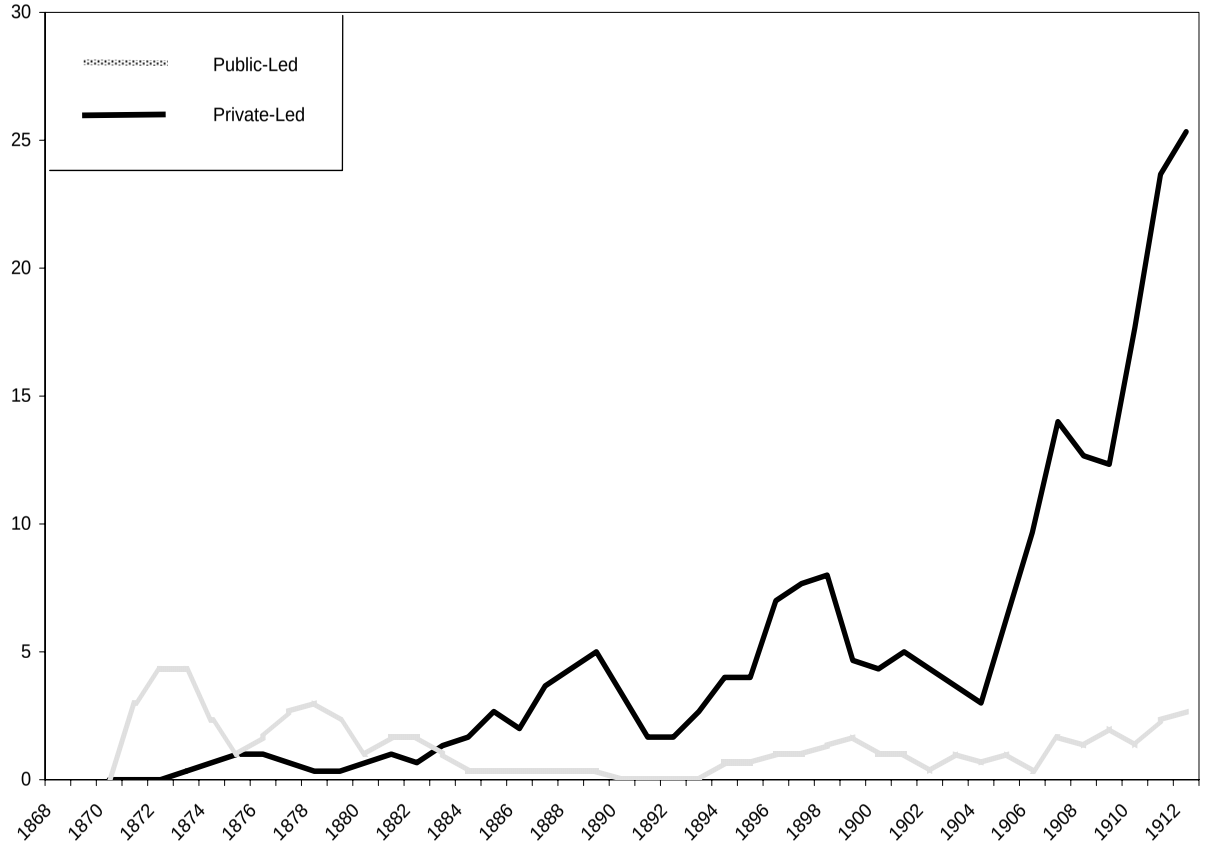


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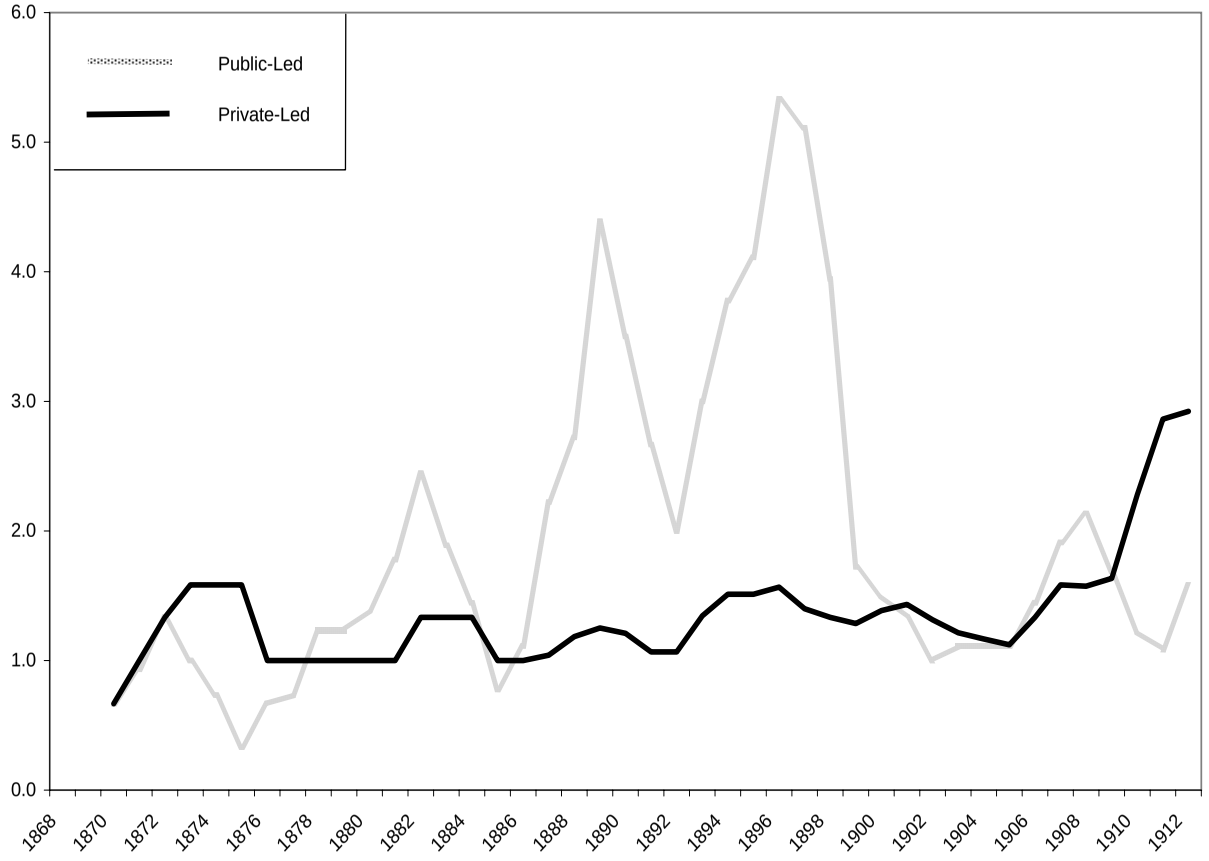
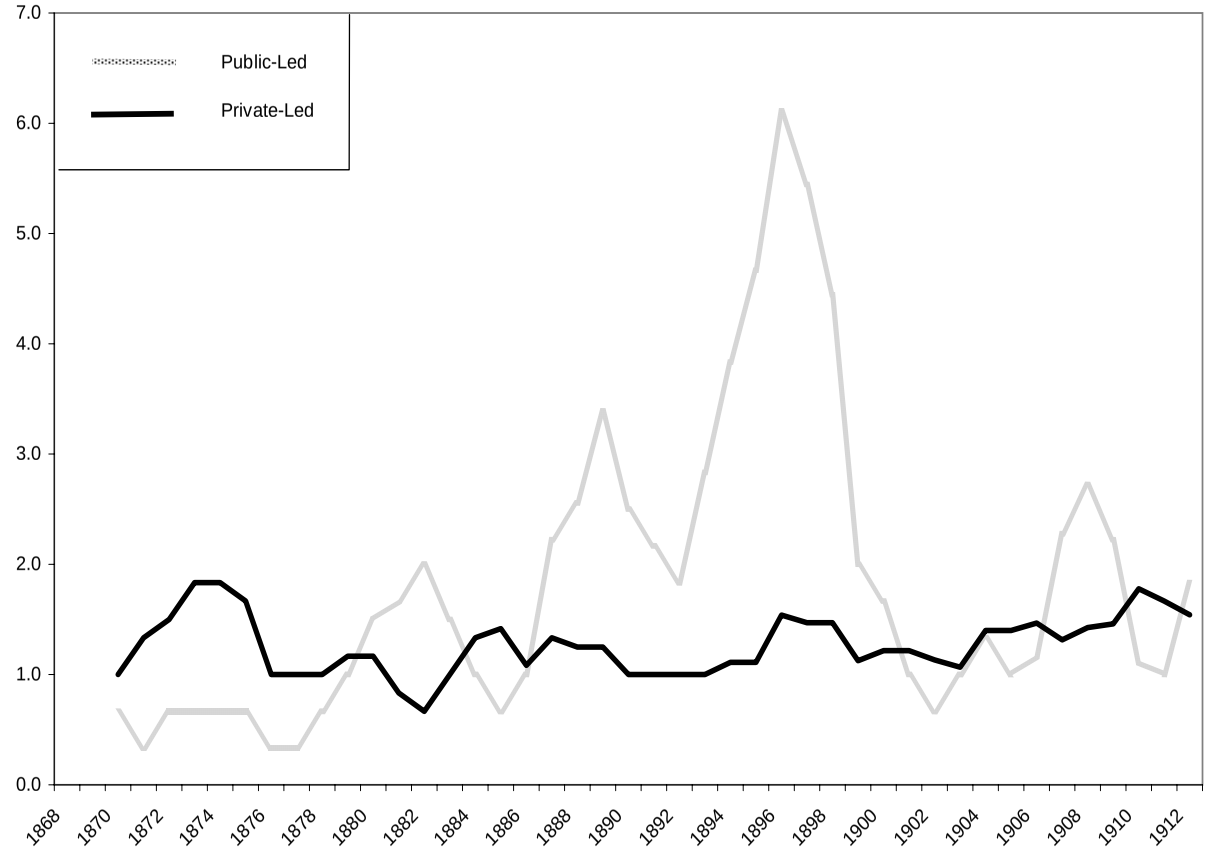
Figure 4: Average Establishments per Modern Industry



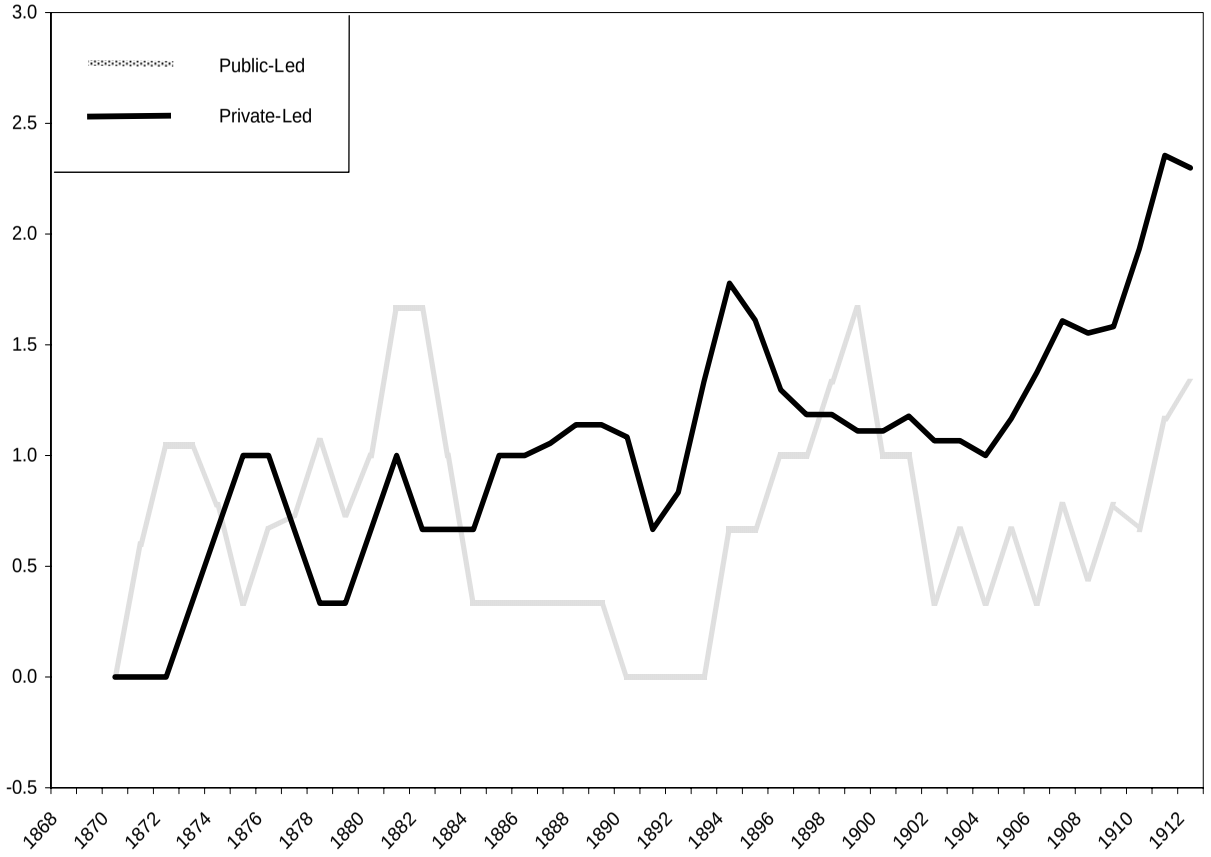
Based on three year moving averages.

Figure 5: Average Establishments per Light Industry



Based on three year moving averages.

Figure 6: Average Establishments per Heavy Industry



Based on three year moving averages.