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Financial Intermediation and Late Development: The Case of Meiji Japan, 1868 to 1912

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FINANCIAL INTERMEDIATION AND LATE DEVELOPMENT:

THE CASE OF MEIJI JAPAN, 1868 TO 1912

by

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Abstract

Was nineteenth century Japan an example of finance-led growth? Using a new panel dataset of startup firms from the Meiji Period (1868-1912), I test whether financial sector development influenced the emergence of modern industries. Results from multiple econometric models suggest that increased financial intermediation, particularly from banks, is associated with greater firm establishment. This corresponds with the theory of late development that industrialization requires intermediaries to mobilize and allocate financing. The effect is pronounced in the second half of the period and for heavy industries, which may be due to improved institutions and larger capital requirements, respectively.

Keywords: Financial intermediation, late development, industrialization, Japan

JEL Classification: N15, N25, O16

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1 Introduction

Japan's rapid industrialization in the late nineteenth century has been attributed in part to the precocious development of its financial system.[1] With financial institutions in place that could mobilize capital, coordinate investments, and monitor businesses, Japanese entrepreneurs were able to lower the risks and transaction costs involved in establishing modern enterprises.[2] This in turn laid the groundwork for technological catch-up with western nations and gave the economy an advantage in building capital-intensive industries and achieving economies of scale.

Whether this theory of finance-led industrialization is true has not only been subject to debate in the Japanese case.[3] Notable scholars, including Joseph Schumpeter and Alexander Gerschenkron, have suggested an instrumental, if not essential, role to financial intermediaries in an economy's technological and industrial development, owing to their functions mentioned above.[4] At the opposing end are those who, like Joan Robinson and Robert Lucas, dispute any causal relationship between financial institutions and growth, viewing their emergence as a consequence of development or coincident to it.[5] Both sides of the debate can draw support from the substantial literature on the finance-growth nexus.[6] Nevertheless, these studies, owing to the scarcity of detailed historical data, share the shortcoming of relying on aggregate figures of financial and economic development (in contrast to more recent literature that uses microdata). As a result, differences between industries, regions, and firm ownership in the early modern period are poorly understood. Furthermore, existing research has focused on the depth of the financial sector, neglecting the extensive growth of intermediaries throughout the economy.

Using a newly development dataset of startup firms from the Meiji Period, I am able to test more rigorously whether a causal link exists between financial system development and industrialization. In particular, I break down national figures by prefecture to create a panel dataset between the years 1868 and 1912, allowing me to examine financial sector development both in breadth and depth. I also control for major industrial groupings (eg, modern, light, heavy) as well as ownership type (eg, publicly-listed versus privately-held). Results from correlation analysis indicate that financial sector development, measured by the number of banks and other financial intermediaries established each year, is highly correlated with the development of manufacturing sectors (measured by the number of industrial firm startups), especially in modern industries. This is corroborated by dynamic general method of moments (GMM) regression analysis, which uses lagged values of multiple industrial and financial series as instrumental variables, and is robust to different estimation methods and model specifications.

Nevertheless, the GMM results show that financial intermediation has different effects depending on the industry, ownership, and type of financial intermediary (eg, bank versus other finance). Heavy industries (eg, chemicals, machinery, metals processing, utilities) benefit more from financial intermediation, particularly bank services, than light industries (eg, food processing, stone/ceramics, textiles, wood products). This makes sense considering firms in heavy sectors require greater financial resources to start up, which formal financial institutions provide.

As for ownership and financing, while financial intermediation of any kind had a positive impact on both listed and unlisted firms, startup activity of listed firms (eg, joint stock) is more strongly associated with non-bank financial institutional growth while unlisted firms gain more from greater numbers of banks. Given that firms listed on public exchanges comprise a majority of startup establishments, this finding suggests that early industrialization may have relied less on bank intermediation than previously thought.[7] Instead, the result supports recent revisionist interpretations of Japanese development that the financial system was less underdeveloped than supposed in the latter part of the Meiji Period.[8]

Other non-financial factors appear to affect industrial development, such as urbanization, natural resources, geography, and trade.[9] Urban prefectures, particularly those of metropolitan Tokyo and Osaka, have faster industrial growth, which may be due to their greater concentration of finance and production inputs as well as market size and commercial access. Endowments of coal, timber, and petroleum, when interacted with urban areas and foreign trade, seem to induce industry establishment, perhaps by providing raw materials and energy inputs. On their own, however, resource constraints do not appear to have either aided or impeded industrial development, perhaps because domestic endowments were relatively meager. Higher temperatures (ie, climate) and surface water (ie, irrigation) are positively associated with light industrial startup, suggesting the importance of agricultural inputs for manufactures of textiles and processed foods.

Taken together, these findings suggest that while support remains for finance-led growth in Japan, aggregate financial figures may insufficiently characterize the effect of financial intermediation on industrial and economic development. Clearly, financial intermediation played a significant role in industrialization, despite it being oriented at first toward light sectors. This study also qualifies earlier discussion of what contributed to Japanese development by demonstrating the importance of industrial agglomeration in large cities[10] and the relative insignificance of foreign commerce.[11]

The remainder of the paper continues with Section 2, which describes the historical context in which the Japanese financial system emerged. It also surveys the literature on the relationship between finance and economic development. I then describe the data and methodology in Section 3, with results presented in Section 4. Section 5 presents some sensitivity analyses, while Section 6 discusses the implications of the paper as well as some extensions. The paper concludes with Section 7.

2 History and Literature Review

Even as the government experimented with model factories and industrial policies, it overhauled the existing financial system and laid a legal framework around which modern institutions could develop.[12] Immediate objectives included redeeming previously issued notes of credit by feudal lords, establishing a credible currency, and creating a national banking system.[13] Impressed by the modernity of both the United States and Great Britain as well as recognizing the importance of financial intermediation, government leaders immediately began a series of reforms culminating in the National Bank Act of 1872.

This act established a decentralized national banking system similar to that in America.[14] As shown in Table 1, government leaders alternated from restricting banking activity to liberalizing it until the early 1890s, with the adoption of the gold standard and enactment of comprehensive commercial and banking codes marking the maturity of the financial system.

[Table 1 here]

To Meiji leaders, the association between financial development and economic growth was unquestioned; nevertheless, the significance of financial intermediaries like banks as well as the direction of causality remain controversial. Joseph Schumpeter argued that financial institutions were fundamental to economic growth because they not only amass investment finance from diverse sources, but also ensure that the funds are used effectively.[15] Among the numerous supporters of the finance-led growth hypothesis is Alexander Gerschenkron, who gives financial institutions pride of place in his theory of late development.[16] Gerschenkron argues that countries can overcome economic backwardness by acquiring modern technology and industries, with the main caveat being the substantial capital investment they require. It is through financial intermediaries, be they in the form of long-term investment banks (Germany) or government enterprises (Russia), that capital is channeled to the appropriate sectors.

Subsequent studies appear to confirm that financial sector development contributes to industrialization and more generally to economic growth. Robert King and Ross Levine compared data from eighty countries between 1960 and 1989, and find that measures of financial development (ie, liquid liabilities, bank deposits) are positively associated with contemporaneous and future economic growth.[17] Peter Rousseau and Paul Wachtel also find for a smaller group of countries that financial intermediaries make a critical contribution to economies at earlier stages of development.[18]

An outstanding example of successful late development is nineteenth century Germany, whose universal banking system is frequently invoked to support the theory of finance-led industrialization. Notable exponents of the German example include Gerschenkron and Charles Kindleberger, who asserted that large universal banks "were found at the critical margin affecting [economic] growth."[19] Nevertheless, this example has been challenged as anachronistic and empirically suspect. Some concerns include the apparent emergence of the universal banking system after the initial stage of industrialization; its geographic and sectoral heterogeneity; and its exercise of market power in lending to the detriment of national development.[20] Separately, Jeremy Edwards and Sheilagh Ogilivie impugn the importance of German credit banks by suggesting that instead of excessive influence, German credit banks were too small to make an impact on the German economy.[21] An important limitation of many of these studies is the lack of data from the early and mid 1800s to quantify the effects, if any, of banks on industry.[22]

Nineteenth century Japan may provide an illustrative example to examine of finance-led industrialization. Regularly cited as another example of successful late development, Japan is notable for developing both its industrial and financial sectors based on foreign institutions and technologies.[23] In particular, its financial institutions possessed characteristics similar to those in other late developing countries, like

diversified portfolio investments, close relationships with their clients, and vigilant screening of loan applications.[24] This may help to explain the country's rapid build-up of physical capital, with gross domestic capital formation averaging 12 percent from 1887 to 1916.[25] Furthermore, the decomposition of capital investment into traditional and modern sectors indicates the brisk transition toward the latter, as shown in Table 2. Given both its isolation from international goods and financial exchange until the mid 1800s and its accelerated industrialization in the half century thereafter, Japan can be considered a "blank slate" from which one can view the origins and development of modern industries and finance as well as determine causal influence (if any) one may have had on the other.

[Table 2 here]

Previous research on early modern Japan has generally supported the theory of finance-led growth, with better financial intermediation driving increases in banking assets and publicly traded securities, both of which contributed to economic development.[26] Banking activity was particularly important for industrial investment when compared to funding raised on equity markets. Table 3 compares outstanding loans to the capital of firms listed on the Tokyo Stock Exchange during this period of time.[27] Nevertheless, because they rely on national data and lack sector-specific figures, these studies have difficulty specifying the channels through which financial intermediation effect economic growth, nor can they distinguish the impact of financial institutions on different industries or different regions of the country. While some scholars attempt to overcome the issue of data scarcity using parsimonious approaches like vector autoregression (VAR) analyses, these models are criticized for being difficult to interpret, having aggregation bias, and lacking economic rigor. This study addresses these issues by using a new panel dataset collected from firm genealogies and instrumental variables (IV) regression analysis.

[Table 3 here]

3 Research Design

3.1 Data

The research in this study is based on an original dataset of firm establishments in the Meiji Period. The lack of detailed records from the nineteenth century means most research from Japan's early industrialization relies on national aggregates. However, an alternative can be found in corporate genealogies, such as those in the *Shuyo Kigyo no Keifuzu* collection, which trace a firm's lineage back to its origins and provide basic information like a date of establishment, ownership, industry classification, and geographic location. Previously used to study the leadership of financial conglomerates known as *zaibatsu*,[28] the *Shuyo* compilation includes genealogies for 1,089 firms and cumulatively contain over 14,000 unique establishments dating back to the early nineteenth century or earlier.[29] Arguably, they represent the oldest reliable documentation of firm activity across the entire Japanese economy.[30] Figure 1 shows a

typical genealogy from the collection and illustrates the type of information available,[31] and Figure 2 plots the annual increase in startup establishments over the Meiji Period.

[Figures 1 and 2 here]

To compare financial and industrial development, I group firm establishment data by major industry based on firms' respective industrial classification code, assigned from the 1984 edition of the *Standard Industrial Classification of Japan* (JSIC).[32] These major sectors include agriculture, mining, food processing, textiles, wood and paper manufactures, chemicals, stone/ceramic/glass manufactures, metal processing, machinery, miscellaneous manufacturing, utilities, transportation/communication, retailing, banking, other financial services, construction, and miscellaneous services. From these seventeen groups, I construct three industrial series: modern, light, and heavy.[33] For finance, I construct two series: one that includes all types of financial intermediaries[34] and another that contains only banks. Figures 3 and 4 break down firm establishment by major sector and capital intensity, respectively. Table 4 provides some descriptive statistics about the dataset, and will be further discussed in the section on results.

[Figures 3 and 4 here]

[Table 4 here]

As shown in Figure 2, total firm establishments over the period appear to have two intense periods of growth, in the late 1870s and in the late 1890s. This pattern is especially pronounced for new financial institutions in Figure 3. The first wave of financial startup is due to the disbursement of government bonds to ex-samurai in exchange for giving up their hereditary pensions, many of whom used these bonds to capitalize banks.[35] The second wave owed to new banking laws promulgated between 1890 and 1895 that liberalized business practices and clarified fiduciary responsibilities of debtors and lenders.[36]

The co-movement after 1900 between the modern industrial and financial series may indicate economic maturation (eg, emergence of a modern business cycle). This is corroborated by the dramatic increase in heavy industrial startup, which presumably required greater financial intermediation than the light industries that dominated earlier in the period. Prior to the turn of the century, however, the industrial and financial series do not appear to share a trend, which raises the question of whether a predictable (causal) relationship exists between them.

Other variables include those for ownership, natural resources, geographic features, and year fixed effects. The variable for firm ownership type takes the value of one for publicly-listed (joint stock) firms or zero for privately-held firms.[37] In an economy with an immature financial system, there may be greater advantages to internal or debt-based financing compared to joint stock (equity-based) funding. Anecdotal evidence suggests that equity-financed firms were constrained by their need to pay dividends, resulting in firms that remained small and undercapitalized.[38] Furthermore, privately-held ownership may allow a firm to make capital-intensive, longer-term investments since financing was neither subject to

business cycle volatility nor reliant on investors unwilling to tolerate long gestations until the enterprise makes a profit.

Ownership also addresses the issue of corporate monitoring, prominent in discussions of postwar Japanese conglomerates (although important in the prewar era as well). Prior to the adoption of the 1893 Commercial Code, which standardized incorporation procedures and defined fiduciary responsibilities, the limited ability of outside investors to monitor management and dominant owners may have hindered the public listing of firms (and thus created a market failure for investment).[39] This is because while incorporation occurred as early as 1872, with the passage of the National Banking Act, there were few institutions governing business practice or protection of property rights until the 1890s.[40] Together these observations suggest a positive correlation between private ownership and first entry.

The dataset also includes natural resources at the prefecture level. I use four dummy variables to control for endowments of timber, coal, petroleum, and metal ores, with prefectures coded with a one for possessing a resource or a zero otherwise. Figure 5 presents a map of the 47 Japanese prefectures, while Figure 6 indicates areas with resource deposits.[41] The resource data, from a geographic survey of Japan taken in the early 1900s, may indicate whether industrial development occurred for reasons aside from finance availability, such as suitability for extractive instead of manufacturing sectors.

[Figures 5 and 6 here]

The geographic features are continuous variables (but not time series) and include average yearly temperature, rainfall, latitude and longitude coordinates, length of coastline, and the area covered by water for each prefecture. These data are from modern references[42] (temperature, rainfall, coordinates) and official statistics[43] (coastline, surface water area). Temperature, rain, and physical location may serve as proxies for agricultural production suitability (ie, climate), which may compete with manufacturing industries for labor and capital. Both coastline and surface water are thought to ease communication and lower transportation costs, while surface water may additionally measure access to hydropower, which was commonly used for millwork and paper production.[44]

3.2 Methodology

The absence of a modern financial system in early nineteenth century Japan means that the establishment of banks and other financial services firms directly measures financial sector development in the economy.[45] It may be argued that the number of financial institutions proxies for extensive growth of the financial sector, not intensive growth, and that the latter may be better measured by the assets of individual banks. However, no such financial documentation is available for Japan in this period, only aggregate values of all bank deposits without institution-specific identification.[46] Furthermore, changes at both the extensive and intensive margins are important characterizations of sector development, and this research complements existing studies measuring the latter.[47]

Similarly, most manufacturing industries were new to the Japanese market, based on technology and physical capital acquired from abroad.[48] Important examples include textiles, with equipment imported from western Europe and the US; metals processing; steamships and railcars; and heavy machinery.[49] Given the absence of most of these industries at the beginning of the period and the high cost of capital, entry of startup firms in manufacturing sectors is likely to directly correspond with the emergence of modern industries in the economy.

These characteristics of the early modern Japanese economy motivate the central hypothesis of this study, which is that prior financial sector development predicts later industrial development. There may also be differences between listed and unlisted establishments based on their sources of funding (ie, equity versus internal financing/debt). I hypothesize that listed firms benefit more from the overall expansion of financial intermediaries (eg, brokerages, securities firms) compared to unlisted ones, and the opposite when looking only at banking growth.

The prefecture-level dataset and inclusion of control variables for resources and geography allow me to look at other influences on industrialization. In other words, I can test whether the impact of financial sector development varies by region, with temperate areas and those with more abundant natural resources benefiting less from the development of financial markets because primary and extractive industries crowd out industrial entrepreneurship. Similarly, regions with better access to commercial markets, as proxied through coastline length and surface water area (eg, rivers, lakes), may need less local intermediation for industrial development. Financial sector growth may also be less important for more densely populated areas given their better infrastructure, availability of capital, and alternative sources for investment. I explore these questions with a variety of estimation methodologies, which are explained below.

3.3 VAR Model

A common way to assert causality between two series is to assess the predictive power of one series on the other over time. This statistical relationship, known as Granger causality in VAR analysis, can be further refined with the addition of exogenous variables as well as parameter constraints. Arguably, including lagged values of both independent and dependent variables in a regression model (ie, timing) accounts for feedback effects and identifies the influence of explanatory variables in the model. The parsimony of VAR models also allows analysis of macroeconomic questions that can be supported by modest data availability.[50]

There are a number of criticisms regarding the VAR approach toward identifying causality. One is that the attribution of causality is dubious if both series are slowly increasing over time (ie, non-stationary).[51] Another is that because VAR models are highly sensitive to the number of lags included in the system, especially if the results are used for forecasting, there is a degree of arbitrariness. VAR models commonly use orthogonalized shocks of one series to assess its impact on the other. This is

controversial given that these models assume endogeneity between series, which precludes the ability to makes an independent change in one series without affecting the other.[52] A more general objection is that the approach, by lacking parameter constraints informed by economic theory, makes economic interpretation of its results difficult.[53]

3.4 GMM Model

An alternative approach is to use panel data estimation, which not only provides cross-section variation but also accounts for changes over time. Its greater variation produces more efficient estimates, there is less collinearity in the data, and one can control for data heteroskedasticity.[54] The drawback is that panel data require more information than is typically available for historical macroeconomic studies. Fortunately, the current dataset spans the period 1868 to 1912 and has a panel of 46 Japanese prefectures, shown in Figure 5.[55] This panel data allows one to test the central hypothesis that financial sector development has a positive impact on modern industrial development, and by extension economic growth.

The basic model setup regresses the annual number of modern industrial startups $y_{i,t}$ on the annual number of financial firm startups $x_{i,t}$, where i indexes prefectures and t indexes time in years. To account for possible endogeneity between these series, I instrument the financial sector startups series with all of its lagged differences, $\Delta x_{i,s} = x_{i,s} - x_{i,s-1}$ for $s \in [0, t]$. This estimation method, first proposed by Mañuel Arellano and Olympia Bover and further elaborated by Richard Blundell and Stephen Bond, is also known as system generalized method of moments (GMM) estimation.[56] This arguably is an improvement to VAR analysis because the inclusion of all lagged values removes some arbitrariness due to lag selection.

In addition, GMM estimators have a number of advantages over other panel data estimation methods: they are consistent (unlike ordinary least squares (OLS) and fixed effects/within-group estimators)[57] and asymptotically efficient (compared to two-stage least squares (2SLS)). Even for most finite samples of panel data, GMM estimators perform better to these alternative methods and are computationally straightforward.[58] By having more instruments than regressors, one uses the maximum amount of information available, which may potentially increase estimation efficiency.[59] The downside to system GMM estimation is that it requires all series to be stationary and no serial correlation between error terms.[60] Fortunately, both these assumptions can be verified, the former with unit root tests and the latter with tests for autocorrelation (eg, Arellano-Bond test).

I specify both heavy and light industries in addition to modern industries as dependent variables in the model. For all three industrial specifications, I use two financial series, one with all financial intermediaries and the other with only banks. One reason for breaking down the industrial series is that firms in more capital-intensive industries (ie, heavy) may require greater investment capital, and thus depend more heavily on financial sector development. Also, separating out banks from all financial intermediaries may improve identification by removing noise introduced by financial services heterogeneity

(eg, pawnshops, insurance companies). Another advantage to using this narrower measure of financial intermediation is the availability of official estimates of the aggregate number of banks for comparison. As shown in Figure 7, which plots the series for the cumulative number of bank startups against the annual stock of banks, the current dataset trends closely with historical figures.[61]

[Figure 7 here]

Besides financial sector development, I include the current value of annual foreign exports as another possible endogenous variable.[62] Considering the historically important role of exports in financing Japanese modernization, it is reasonable to assume foreign demand for export products may have spurred the development of certain industries (eg, textiles) without needing an existing domestic financial system or sources of funding.[63] These industries in turn may have expanded in response to foreign demand and led to greater trade volume, although this is subject to debate.[64] I hypothesize that exports would decrease the effect of domestic financial intermediation on industrial development.

I include a dummy variable for the type of firm ownership to account for differences in financial access, investment preferences, and management. While the current dataset does not provide information with regard to firm size or asset holdings (and assumes comparable firm-level characteristics across time and space), anecdotal evidence suggests that publicly-listed firms (especially railways) were larger than privately held ones, requiring greater financing.[65] This is consistent with estimates that the average joint stock company was capitalized at three times that of a private unlimited partnership in the year 1925.[66] Moreover, making this distinction is important for prewar Japan since many new industrial ventures were financed by parent holding firms (eg, *zaibatsu* conglomerates), which could rely on internal funds for investment instead of through the operation of the nascent financial system.[67].

Other control variables, also defined earlier, are for natural resources, geographic features, and urbanization (based on population density). In some specifications, I include interaction terms between these controls and exports. This is to account for the influence of natural resources on the production of exports; coastline and surface water area lowering transaction costs for foreign commerce; and cities having foreign nationals.[68] Year dummy variables are included to take into account temporal fixed effects, which decreases the chance that idiosyncratic disturbances are correlated across prefectures.[69]

4 Results

4.1 First Look at the Data

The breakdowns by industry, shown in Table 4, indicate that industrial and financial establishments each comprise about half of the sample. In addition, firm establishments listed on a stock exchange form the majority in all industrial and financial series, although proportionally more so for heavy industries than any others. This is reasonable considering the larger amounts of startup funding needed for capital-

intensive investments. High startup costs may also explain the lower representation of heavy industries throughout the prefectures, in 30 out of the 47, compared to other industrial or financial sectors.

For the correlation analysis, I make two comparisons: results using national figures to those from prefectures, and publicly-listed to privately-held establishments. As indicated in the Table 5, results vary substantially depending on the level of aggregation. At the national level, banks do not appear to be positively correlated at a statistically significant level with any of the three industrial series (and is negative for heavy industries). Light industry startups are also much more strongly correlated with all types of financial intermediaries compared to those in modern or heavy industries, the latter result being surprising when one assumes that the former would require greater financing (and thus financial intermediation).[70] In contrast, at the prefecture level, both all financial intermediaries and banks have a statistically significant positive correlation with all industries series. Furthermore, unlike the national-level results, the three industrial series for prefectures have correlations of similar magnitudes, with banks more strongly correlated with heavy industry startups than with light ones.

[Table 5 here]

Both publicly-listed and privately-held industrial startups are positively correlated with the two financial series, although listed startups in heavy industries have a relatively weaker relationship with financial intermediation than do unlisted ones. This is consistent with listed firms (especially capital-intensive ones) relying less on private sources of funding (ie, internal financing among *zaibatsu*). These findings suggest significant variation between prefectures and possible biases due to aggregation.

4.2 VAR Analysis

Model Selection

While VAR analysis may not provide results as robust as those from a GMM model, it may be informative to compare the results between the two models. Prior to setting up a VAR model, one must first determine whether the individual series are stationary and if multiple series share long-run characteristics. This is done with unit root tests and cointegration tests, respectively, the results of which are presented in Table 6. Each series aggregates firm establishment at the national level.

[Table 6 here]

I use two different unit root tests, the augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test. Rejection of the null hypothesis, that a unit root exists, indicates that the given series is a stationary process. This is important because for non-stationary processes, measures like R-squared and t-statistics do not have their standard econometric interpretations and may give rise to spurious results.[71] The ADF test includes lags of the variable in question as well as lags of its first difference; as a further refinement, the PP test uses Newey-West standard errors to control for heteroskedasticity and serial

correlation. Besides lagged variables, the tests include a constant term if the series have non-zero means (which they do) and allow for the constant to trend (aka, "random walk"). Based on visual inspection of the data (Figures 3 and 4), constant terms with trends appear appropriate for all the industrial series. Minimization of the Schwartz information criterion suggests including one lag for both the ADF and PP tests.[72]

The ADF test fails to reject the null hypothesis for all series except light industries and banks, while the PP test rejects the null for all industrial and financial series at the five percent level. Given the sensitivity of the ADF to the number of lags included as well as not being robust, I use the results from the PP test to conclude that all the series are stationary.[73] The lack of integration of each of the series implies that testing for series cointegration is unnecessary.

Model Estimation

The stationarity of each series suggests that VAR analysis in levels is appropriate, with the functional form of the model as follows:

$$x_{i,t} = a_{i,0} + \sum_{n=1}^{k} a_{i,n} x_{i,t-n} + \sum_{n=1}^{k} b_{i,n} x_{j,t-n} + u_{i,t} \tag{1}$$

$$x_{j,t} = a_{j,0} + \sum_{n=1}^{k} a_{j,n} x_{i,t-n} + \sum_{n=1}^{k} b_{j,n} x_{j,t-n} + u_{j,t} \tag{2}$$

where i indexes one of the three industrial series (modern, light, heavy), j indexes one of the two financial series (all finance, banks), and k is the number of time lags selected by likelihood ratio tests.[74]

I report the results for the VARs in Table 7, with the top panel summarizing results for all financial services firms and the bottom panel those for banks. The sum of lagged coefficients and its F-statistic are bolded to indicate the direction of causality. The F-statistic tests the joint significance of the lagged values and is commonly known as a Granger causality test, with the null hypothesis that the coefficients of each variable's lagged coefficients are jointly equal to zero. A significant F-statistic would indicate that lagged values of one series predict (ie, Granger-cause) current values of the other series.

[Table 7 here]

The Granger causality tests indicate that none of the industrial series has predictive power for either financial series; similarly, neither financial series has predictive power for any industrial series. These results imply that earlier financial sector development (measured with either all financial intermediaries or just banks) does not predict current industrial development (modern, heavy, or light), which was suggested by visual representation of the two major sector series (Figure 3).

On the other hand, lagged values for all of the series consistently predict their own development at statistically significant levels. With modern industries, every ten startups in the previous period are associated with five more modern startups in the current period (Rows 1 and 7), regardless of the

financial series used. For light industries, ten startups in the previous period predict three additional light startups (Rows 3 and 9), while heavy industries see seven new startups for every ten in the previous period (Rows 5 and 11). For all financial services establishments, ten startups in the past period are correlated with six new startups in the current one (Rows 2, 4, and 6); for banks, the current increase is approximately four (Rows 8, 10, and 12).

These values suggest own-sector path dependence, but little interaction between industrial and financial sectors using earlier values. Some explanations for this finding may be that either the data do not provide sufficient detail to demonstrate causality or the estimation method is inappropriate. This may justify using disaggregated data or alternative estimators. In particular, as discussed in a robustness check later in the paper, there may be differences between urban and rural prefectures that a VAR using national data cannot pick up. Another explanation may be that since both sectors developed contemporaneously, previous values are not good predictors of current activity. This raises the possibility that alternative factors (eg, trade, natural resources) may have contributed to the development of both industry and finance. Using panel data in a GMM estimation framework allows me to address all these concerns.

4.3 Alternative Estimation Methods

While there are clear advantages to using GMM estimation compared to either OLS or VAR models, less obvious are alternative methods that are computationally simpler and can take advantage of the prefecture variation. These include a least squares dummy variable (LSDV) model or a two-stage least squares (2SLS)[75] model that uses lagged values as instruments.

A LSDV model has dummy variables for each prefecture, thereby capturing possible fixed effects and reducing bias due to correlation among observations for each prefecture.[76] Such a model differs from one using lagged values as instruments in that the latter suggests a causal relationship.[77] A 2SLS model is similar to a GMM model except that instead of using all lagged values as instruments, one chooses the number of instruments.[78] However, one does not include lagged values of the dependent variable in a 2SLS model, which removes the own-dynamic component from the specification.[79] Table 8 compares the results of the estimates using LSDV, 2SLS, and GMM. OLS estimates with lagged dependent values are also given to provide a reference to the other three.

[Table 8 here]

As shown in the table, all four estimation methods indicate a significant and positive relationship between financial sector development and the establishment of modern industries. That is, the coefficients for lagged values of the financial series (Row 3) are all positive, varying from 0.136 (LSDV) to 1.186 (2SLS). I interpret a positive coefficient on a right-hand side variable (ie, lagged values of industry and finance, ownership, geography) as promoting growth in the left-hand side variable (ie, current values of

industry). The GMM model (Column 4) estimates a coefficient of 0.561 for lagged values of financial development, which falls between those using LSDV and 2SLS models. This result is consistent with other studies that claim the GMM model provides more realistic and unbiased estimates.[80]

There are also substantial differences in the statistical significance of some control variables (not shown in table), depending on the specification. For example, LSDV estimates suggest timber, coastline, and latitude positively affect industrial development while deposits of coal, petroleum, and metal ores and urbanization have a negative effect. On the other hand, 2SLS indicates a negative association with timber and a positive one with average temperature. Estimates from GMM, covered in more detail in the next section, show influence only from coal deposits (negative) and average temperature (positive) alongside financial sector development.[81]

Finally, estimates from OLS, LSDV, and 2SLS indicate second order autocorrelation in the first-differenced residuals, shown by the rejection of the Arellano-Bond AR(2) test.[82] This suggests endogeneity in these methods, unlike in GMM. Based on the favorable comparison to alternative methods, I will use GMM for the remainder of this study.

4.4 GMM Analysis

The results from GMM panel data regression fail to reject the hypothesis that financial sector development predicts industrialization. As shown in Tables 9 to 11, lagged values of financial sector growth, in the second row of each column in the tables, are positively associated with increases in current industrial startups. For instance, in Column A of Table 9, I interpret the coefficient 0.590 as suggesting that ten previously established financial institutions correspond to nearly six current modern industrial startups. This result is robust even after controlling for foreign exports (Column B) and other control variables (Column C).[83] Similar results obtain for banking development (Column D). The significant findings for both broad and narrow financial series are consistent with earlier studies on finance-led growth. Finally, the negative coefficients for coal deposits and average annual temperature also confirm the hypothesis that prefectures suited for extractive or agricultural activities may have crowded out manufacturing development.[84]

[Table 9 here]

Tables 10 and 11 also show a positive relationship between financial sector growth and industrial development based on capital intensity and ownership type, respectively. In Table 3.10, both broad and narrow measures of financial intermediation are more important for heavy industry startups than for light industries. This is suggested by the theory of finance-led development given the greater financing needs to start a heavy sector establishment. Between all financial intermediaries and banks, the latter's greater effect on heavy industries may owe partly to the inability of some non-bank institutions to provide significant capital and to monitor more sophisticated sectors like chemicals and metals processing, as

argued by Schumpeter. Lighter sectors also gain from easier market access, indicated by the positive coefficients on surface water area and the interactions of exports with petroleum and annual rainfall. This is also expected because of the dramatic growth of textile exports during this period of time.

[Tables 10 and 11 here]

Financial intermediation as a whole had a greater impact on publicly-listed startups (Table 11, Column 1) compared to unlisted ones (Column 3). In contrast, banks are more strongly associated with unlisted establishments (Column 4) than with listed ones (Column 1). As mentioned earlier, these results may obtain because listed startups by definition use non-banking intermediaries while unlisted ones raise capital either internally or through debt. Another possibility is that the greater scale of listed establishments (eg, railroads) required funding beyond the capacity of banks. Unlisted establishments may have been more likely to be affiliated with *zaibatsu* conglomerates, which had affiliated banks that could provide finance preferentially.

Finally, given financial intermediation, variables controlling for exports, natural resources, geography, and urbanization seem in general to have minimal or no effect on industrial startup. Export values drop from the regression due to collinearity with some of its interactions with other variables. Mean annual temperature has a small positive association with industrial startup activity (Tables 9 to 11), possibly due to its impact on textile output (with the raw materials coming from agricultural areas). I check these results in the following sensitivity analyses as well as offer explanations in the discussion section.

5 Sensitivity Checks

5.1 Metropolitan Bias

An advantage of prefecture-level analysis is that individual regions may be more closely scrutinized and compared with others, unlike the assumption of an equitable distribution of economic activity across the country. In particular, considering that many developing countries confront the problem of uneven development between center cities and peripheral areas, it may be important to assess the role played by Japan's two main population centers, Tokyo and Osaka.[85] These two metropolitan areas were known to have a disproportionately large impact on overall growth and comprise two thirds of startup activity in the dataset.[86] Thus, it may be that the earlier results are driven by these two cities as opposed to prefectures in general, which may explain the insignificance of many control variables. This is because the inclusion of other urban areas alongside these two cities may add noise to the estimation. To address these issues, I divide the dataset into two groups, one for metropolitan Osaka and Tokyo and the other with the remaining prefectures. These results are presented in Tables 12 and 13.

[Tables 12 and 13 here]

An immediate difference between the two groups (and the previous findings as well) is that financial sector development has a substantially greater impact on all industries in the two major cities. This is especially true for banking growth (Table 12, Column 2). In contrast, other prefectures receive a much smaller boost from financial services in general (Column 3) and no significant effect from banks (Column 4).

Separating light and heavy industrial startups indicates that metropolitan startups benefit from financial intermediation (Table 13). That urbanization contributes to industrial development is shown with the positive coefficients on the interactions between urban and other control variables. This suggests that certain non-financial characteristics of cities (eg, politics, infrastructure, networks) facilitate industrialization.

5.2 Intertemporal Comparison

One implication of the theory of finance-led growth is that financial intermediation on its own may be irrelevant without other institutions governing the broader economy. That is, without protection of property rights and a stable political system, no amount of investment will induce industrialization. To see if this is the case with Meiji-era Japan, I separate the data into two periods, before and after 1893. The year 1893 is notable for the promulgation of a new commercial code that legitimized incorporation of firms and made explicit fiduciary responsibilities of shareholders and investors.[87] It also followed shortly after the promulgation of a new national banking act, which increased transparency of bank transactions and regulatory oversight by the government.[88] These results are given in Table 14.

[Table 14 here]

As expected, the results for the earlier period indicate no significant relationship between finance and modern industry, while those for the later period do. In the post-1893 sample, two previously established financial institutions correspond to an additional modern industrial startup (Column 3). Even more striking is the effect of banking growth: three bank startups correspond to two modern industrial startups (Column 4). The remaining control variables, like those from the earlier section, are relatively less important to industrial growth. In contrast, during the pre-1893 period the interaction of exports with surface water (eg, irrigation, inland transport) is positive and significant with new modern startups.

These findings corroborate the claim of institutionalists that political uncertainty, ill-defined legal provisions, and immature product and capital markets affect industrial growth. In Japan's history, this appears to be the case: it was only after the 1880s, with political consolation[89] and public confidence in the financial system,[90] that the conditions for industrialization were met.[91]

5.3 Alternative Export Series

The small impact of foreign exports on industrialization (compared to financial intermediation) in earlier results goes counter to a number of claims that assert Japan's modernization derived from its trading prowess.[92] To test whether the results are sensitive to particular data series, I rerun the GMM regressions with an alternative export series constructed using expenditure data.[93] This series, with national figures between the years 1885 and 1912, takes place after the early years of political consolidation, national deflationary policies, and the privatization of government industrial enterprises, which should allow for more precise identification of market-oriented industrial growth. The results, in Table 15, show that the alternative export series produces similar estimates as the original series, with the coefficient on financial intermediation remaining significant and positive for both the modern (Columns 1 and 2) and light (Column 4) industry series.

[Table 16 here]

6 Discussion and Conclusion

The main finding of this study is that for early modern Japan, financial sector development had a significant and positive impact on industrial development. This result applies to both listed and unlisted firms as well as industries varying in capital-intensity levels. Furthermore, this paper demonstrates the relevance of having disaggregated data sufficient to control for regional and environmental differences, which many existing studies of finance-led industrialization neglect.

That said, the benefits of financial intermediation may have owed more to the larger institutional framework and infrastructural improvements rather than to the banks themselves. Understanding the influence of these and global factors would make the findings from this study more useful to modern day economies that face different financial and technological obstacles. Local factors such as the externalities from urbanization and information asymmetries among banks could also play important roles in expanding industrial activity.

Indeed, one may question how well Gerschenkron's schema for technological convergence applies to post-industrial economies and temporal constraints on human capital acquisition. But despite differences in space, time, and technology, some of the critical conditions surrounding Meiji Japanese industrialization exist at present, such as the emphasis on free trade[94] and the globalization of financial capital.[95] Thus, it may be a useful exercise to revisit other historical late development episodes like Germany or Russia in the nineteenth century Germany or Korea and Taiwan in the twentieth, and observe patterns in industrial finance, market access, and technology transfer.

Notes

[1]See Lockwood (1954), Goldsmith (1983).

[2]In particular, Suto and James (1999) attribute the increase in saving and investment rates in Meiji Japan (1868-1912) to improved financial sector intermediation. Rousseau (1999) claims that financial sector reform and institutionalization at the turn of the century led to expanded national output and investment.

[3]Other countries include Austria, Belgium, England, France, Germany, Italy, Russia, Scotland, Serbia, Spain, and the United States; see Cameron (1967, 1972).

[4]Schumpeter (1934), Gerschenkron (1962).

[5]Robinson (1952), Lucas (1988).

[6]Surveys of earlier research include Levine (1997) and Eschenbach (2004).

[7]For example, see Ishii (1997, 1999). Private business groups, aka the *zaibatsu* conglomerates, are credited with leading industrialization and were able to internally finance their investments; see Tang (2007).

[8]Okazaki (1993), Okazaki and Okuno (1993), and Okazaki, Hamao, and Hoshi (2005).

[9]In the interest of coherency and focus, the influence of government policy (and militarization) is not discussed in this study.

[10]See Hoselitz (1955) for a discussion of the relationship between cities and economic development.

[11]Lockwood (1954) and Youngson (1959), for example, assert the primacy of foreign trade to economic growth among late-developing countries.

[12]See Crawcour (1961) for a description of the Japanese credit system in the seventeenth century.

[13]The new government assumed responsibility of feudal-era credit notes in 1871, replacing them with inconvertible notes at current value. Owing to substantial counterfeiting and overprinting, these notes circulated at an increasing discount, a problem not remedied until 1881 with deflationary policies and privatization of public enterprises.

[14]These chartered national banks operated under a fractional reserve system, based on government bond holdings that could be used to redeem government paper notes. As a compromise with proponents of the alternative gold reserve system, national banks could issue also notes that were convertible to gold. However, with the depreciation of government notes, these banks incurred substantial losses and petitioned for paper-convertibility only. After numerous revisions to the first banking law, the last of which ended the national banks' power to issue notes, the government promulgated a second National Banking Act in 1890. The new law imposed lending restrictions and financial reporting on ordinary banks and coincided with a new commercial code for non-banking firms.

[15]Schumpeter (1934).

[16]Gerschenkron (1962).

[17]King and Levine (1993).

[18]Rousseau and Wachtel (1998). The five countries in these studies are Canada, Norway, Sweden, the United States, and the United Kingdom.

[19]Kindleberger (1993).

[20] Fohlin (2007), Neuberger and Stokes (1974).

[21]Edwards and Ogilvie (1996).

[22]Both Fohlin (2007) and Burhop (2006) use German financial intermediation data from the second half of the nineteenth century.

[23]While currency and credit existed prior to the nineteenth century, their use was primarily for small commercial transactions, not long term industrial investment; see Rosovsky (1961).

[24]Burhop (2006).

[25]Rosovsky (1961). It is interesting to note that despite considerable attention given to the government's role in capital investment, both public and private investment were comparable throughout the pre-WWII period. Private sector investment also had much less volatility.

[26]Suto and James (1999), Tomita (2005), Teranishi (2007). Teranishi also provides a number of Japanese-language references.

[27]Japan Statistical Association (1987).

[28]Tang (2007).

[29]These genealogies are of firms listed on the Tokyo Stock Exchange as of September 1984 and were compiled by business historians Shintaro Yagura and Yoshiro Ikushima; see Yagura and Ikushima (1986).

[30]The inclusion of defunct firms whose assets were transferred to a direct ancestor of a firm with a genealogy mitigates the issue of firm survivor bias. Furthermore, unlike non-financial services that may require little capital investment or equipment, manufacturing typically leaves behind assets that may be purchased by other manufacturers, thus increasing the chance that the previous owner will appear in the genealogies.

[31]Not all the observations contain every piece of information, eg, some lack their establishment location. The discrepancies are apparent in the different sample sizes provided in the summary statistics and econometric results.

[32]At the two-digit level; see Statistics Bureau of Japan (1984). Tang (2007) provides a detailed discussion of the construction of the dataset. Government enterprises are excluded due to their access to public sector financing, which precludes the need for private sector financial intermediation.

[33]Modern industries include textiles, chemicals, metal processing, machinery, utilities, and transport and communication industries. Light industries include food and beverage manufacturing, textiles, wood-working and paper products, stoneware and ceramics, and miscellaneous manufacturing. Heavy industries include chemicals, metal processing, utilities, and transport and communication industries. All three series follow breakdowns in Rosovsky (1961).

[34]Including banks, non-bank credit and investment organizations, securities brokers, insurers, and pawnbrokers.

[35]The ex-samurai had little alternative to using their government notes owing to the high discount that prevailed on the open market (capitalization was at par value); see Soyeda (1994) and Lockwood (1954).

[36]Soyeda (1994).

[37]There may be some confusion as to terminology: "privately-held" means firm equity that is not available to the public as shares (ie, unlisted), and differs from "private sector" firms, which are those not owned by the government. As mentioned earlier, all government-owned firms are excluded. While the analysis distinguishes only two types of ownership, these can be further subdivided: private ownership includes individual proprietorship or partnership (unlimited and limited liability) as well as mutual associations, and public firms came in both limited and unlimited liability flavors; see Yagura and Ikushima (1986).

[38]Morikawa (1992); Teranishi (1999). For example, many publicly-listed firms were run for short-term profit and were incorporated for a predetermined time period, between three to ten years (Fruin 1992).

[39]Loenholm (1906). There is an interesting literature on the effect of owner-managed firms on performance; see Denis, Denis, and Sarin (1999).

[40]Rosovsky (1961).

[41]Trewartha (1945). Note that these prefectural borders were established in 1888, following consolidation of 209 smaller jurisdictions from the feudal period, and continue to the present.

[42]Weather Channel (2007).

[43]Japan Statistical Association (1987).

[44]Although Japanese rivers were not conducive to navigation, being short, shallow, and swift; see Trewartha (1945).

[45]This assumes that establishment itself is an adequate measure of increased access to financing, and discounts the role of "fly-by-night" banks that fail as rapidly as they start. Nevertheless, banking regulations such as a minimum capitalization requirement of 10,000 yen, to be paid up within the year of establishment, and the government's assumption of liabilities upon bank default suggest that the act of establishment is a credible signal of firm activity; see Soyeda (1994).

[46]Japan Statistical Association (1987).

[47]The current dataset also better accounts for access to funding (through geographic proximity of industrial firms to banks) than other studies.

[48]Lockwood (1954), Rosovsky (1961). Interestingly, unlike technology, not much foreign financial capital was involved in industrial development during the Meiji Period. This was due to government reluctance to allow foreign ownership of Japanese industries as well as issuing too much debt on international markets.

[49]Pre-existing manufacturing was also improved with western methods, such as in soy sauce brewing and papermaking.

[50]Rousseau (1999) is an example of this methodology for finance-led industrialization in Japan.

[51]Moreover, tests of stationarity suffer from low power and small-sample bias; see Harvey (1997).

[52]See Cooley and LeRoy (1985) for a more detailed critique of this and other aspects of VAR analysis.

[53]The development of vector error correction models, which impose constraints on parameters, in part is a response to this criticism.

[54]Bond (2002), Baltagi (1995).

[55]Of the 47 prefectures in Japan, there are 46 with startups during this period (Miyazaki is not represented).

[56]Arellano and Bover (1995); Blundell and Bond (1998). System GMM estimation is similar to Arellano-Bond estimation (aka, difference GMM), except that system GMM uses lagged differences to instrument for levels while difference GMM uses lagged levels to instrument for differences. Consequently, system GMM allows for time-invariant regressors while difference GMM does not, which is the main justification in choosing system GMM; see Arellano and Bond (1991) and Roodman (2006). Unless noted, GMM will hereafter refer to system GMM.

[57]OLS estimates may be inconsistent if there is high correlation between the disturbances in the regression. To show that instrumental variable (IV) estimation, which is a special case of GMM, is indeed consistent and asymptotically unbiased compared to OLS estimation, I perform Hausman specification tests on the coefficients resulting from the two estimation methods. Under the null hypothesis that there is no systematic difference between the two sets of coefficients, I reject the null for the modern and light industry series using both financial series, and for heavy industries using the bank series. These results indicate the appropriateness of using IV estimation over OLS. For the two instances in which the null fails to be rejected, their estimates are sufficiently similar to those for OLS that I report IV estimates for all series specifications in the section on results.

[58]Judson and Owen (1999).

[59]The value of extra instruments can be checked using tests of overidentification (eg, Sargan and Hansen tests). I compare various estimation methods in the next section.

[60]The latter assumption also applies to difference GMM.

[61]The discrepancy between the two series in Figure 3.4 may be due to the inclusion of all banks (startup or otherwise) in the official statistics. The official series may also overestimate the actual number of banks as it includes "quasi-banks" that in reality were non-bank financial service firms or speculators; see Soyeda (1994).

[62]It may be argued that export demand is an exogenous variable given the small size of Japanese production at the beginning of the period. However, the transition from minor to major player on world markets is not well-identified, and I use a more conservative specification.

[63]Export values were reported by the port authorities in Hakodate, Kobe, Nagasaki, Niigata, Osaka, and Yokohama; see Japan Statistical Association (1987). As mentioned earlier, in contrast to technology imports and international trade, foreign direct investment into Japan was negligible.

[64]Nghiep and Hayami (1979) argue that native technological developments in silk production catalyzed foreign exports, while Tang (2004) suggests that foreign demand provided greater impetus.

[65]Morikawa (1992). Note that "privately financed" firms differ from "private sector" firms. The former includes firms that did not use equity listings to raise initial capital, while the latter includes all firms not owned by the government.

[66]Teranishi (2007).

[67]Tang (2007).

[68]Japan's international treaties in the 19th century allowed foreigners access to a number of ports, which were usually in or around major urban centers; see Lockwood (1954).

[69]Roodman (2006).

[70] Although early Japanese industrialization was oriented around light industries.

[71] Harvey (1997).

[72] The Schwartz information criterion minimizes $ln(\frac{SSE}{T}) + \frac{KlnT}{T}$, where T is the sample size and K is the number of regressors; see Harvey (1997).

[73] Stationarity also means that one of the two requirements to use system GMM is met.

[74] Under the null hypothesis that all the coefficients on the kth lag of the endogenous variable is zero, the likelihood ratio test compares a model with k lags to one with $k-1$ lags. Starting with k_{max} (ie, four lags), the first test to reject the null uses that k for the VAR lag order. See Lütkepohl (1993).

[75] Also popularly known as an instrumental variable (IV) model.

[76] Judson and Owen (1999).

[77] This is because by construction the independent variables are (weakly) exogenous to the dependent variable; see Anderson and Hsiao (1982).

[78] For example, y_{t-1} for y_t in just-identified specifications; additional lags are used in over-identified specifications.

[79] *Ibid.* Distortions may be present if the observations are not independent and identically-distributed (iid); see Roodman (2006).

[80] *Ibid.*, Judson and Owen (1999).

[81] When using banks only, the interaction between exports and petroleum deposits show a negative relationship with industrialization.

[82] Negative first order autocorrelation, which appears in all four specifications, is expected since the present period differenced residual $\Delta\nu_{I,t}$ is related to the previous period's $\Delta\nu_{i,t-1}$ through the shared term $\nu_{i,t-1}$. See Roodman (2006).

[83] The full specification, besides the industrial and financial series, includes the following control variables: exports; natural resources indicators (timber, coal, petroleum, metal ores); prefectural geography (average annual temperature and rainfall, coastline length, latitude and longitude, surface water area); urban indicator; interaction terms (between exports and natural resources/geography, urban and natural resources/geography); year indicators.

[84] That is, prefectures with higher average annual temperatures are likely to engage in agriculture; see Trewartha (1945).

[85] Tokyo and Osaka have been the main cities of Japan since the 1600s, when Tokyo (then known as Edo) became the political center under the feudal shogunate while Osaka remained the commercial capital. During the 18th century, Tokyo's population exceeded one million inhabitants, exceeding that of London during the same period of time; see Trewartha (1945) and Cody (1987).

[86] The metropolitan areas are approximated by the three prefectures of Tokyo, Osaka, and Nara, the latter considered part of Osaka until 1887; see Trewartha (1945).

[87] Loenholm (1906).

[88] Soyeda (1994).

[89] The last domestic uprising, the Seinan Rebellion, was put down in 1878.

[90] The government imposed austerity measures, aka, the Matsukata deflation, to contain inflation.

[91] A separate argument is that until the 1880s, early Meiji industrialization was spearheaded by public investment, which did not rely on formal financial institutions.

[92] See Youngson (1959).

[93] Japan Statistical Association (1987).

[94] Japan did not recover full tariff autonomy until 1911.

[95] The early twentieth century is often acknowledged as the first era of globalization, with the gold standard facilitating international capital flows; see Eichengreen (1998).

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Table 1: Major Banking Laws in the Early Meiji Period, 1868-1897

Year	Name	Description
1872	National Bank Act (NBA)	Regulated businesses performing banking/financial transactions and created system of national banks. Allowed banks to issue gold-convertible notes and to hold 60 percent paid-up capital in government bonds as reserves.
1874	amendment	Provided flexibility in banking safeguards between government and banks.
"	amendment	Regulated dollar certificate issue in commercial banks.
1876	revision	Made legal tender certain yen denominations; allowed paper money convertibility into gold; fixed interest rate at 10 percent; and increased reserve requirements from 60 to 80 percent (but change gold reserve requirement from 40 to 20 percent paper reserve).
1877	amendment	Restricted note issue based on population and taxes.
1878	amendment	Permitted organization of banks to municipal authorities.
1879		*Clearinghouse established in Osaka.*
"		*Yokohama Specie Bank established for foreign transactions.*
1882	amendment	Required local authorities to submit decisions for Treasury approval.
"		*Bank of Japan established as central bank.*
1883	revision	Redeemed outstanding national banks' notes and ended their charter.
1884	Convertible Bank Note Act	Ended issue and circulation of dollar certificates (expiration postponed from 1885 to 1890).
1886	amendment	Limited liability of shareholders of banks with assets exceeding 500,000 yen.
1887		*Clearinghouse established in Tokyo.*
1890	2^{nd} National Bank Act	Incorporated earlier amendments, clarified regulatory supervision, and outlined bank obligations (eg, hours/days of operation, loan and reserve requirements) (effective 1893).
"	Savings-Bank Act (SBA)	Separated businesses in financial instruments (bonds, discounting) from those with investment and commercial interests (effective 1893).
"	Commercial Code	Established corporate liability and regulated firm conduct (effective 1893).
1895	amendment (NBA)	Changed operation hours and abolished loan and reserve requirements.
"	amendment (SBA)	Decreased reserve requirements from 50 to 25 percent paid-up capital (invested in interest-bearing government bonds) and gave preferential claim on assets to depositors.
1897	Currency Law	Adopted the gold standard.

Source: Soyeda (1994).

Table 2: Capital Investment (%)

Year[a]	Traditional[b]	Modern[c]
1890	68	32
1895	50	50
1900	44	56
1905	33	67
1910	32	68
1915	32	68
1920	29	71

Source: Rosovsky (1961).

[a]: Based on five year moving averages.

[b]: Includes residential, commercial, and agricultural construction; roads and bridges; disaster reconstruction; and temples.

[c]: Includes construction of factory, harbor, and utilities; schools; railroads; military spending; and producer durables.

Table 3: Bank Loans vs Listed Firm Capital

Year	Loans[a]	Capital[b]
1890	204	91
1895	387	113
1900	810	342
1905	1048	492
1910	1737	627

Source: Japanese Statistical Association (1987).

[a]: In millions of yen (current). Total is cumulative for all banks. Although formal bank activity begins in 1873 following the National Banking Act, there are missing data between 1876 and 1887.

[b]: In millions of yen (current) at end of year for all firms listed on the Tokyo Stock Exchange.

Table 4: Descriptive Statistics

	Startups	Ownership		Prefectures
		Listed	*Unlisted*	
All Sectors	1046	873	173	46
Modern Industry[a]	392	307	85	39
Light Industry[b]	235	187	48	36
Heavy Industry[c]	197	132	65	30
Financial Services	482	450	6	44
Banks	275	249	26	44

[a]: Includes textiles, chemicals, metals processing, machinery, utilities, and transport.

[b]: Includes food processing, textiles, wood processing and printing, ceramics/glass manufacturing, and miscellaneous manufacturing.

[c]: Includes chemicals, metals processing, machinery, and utilities.

Table 5: Correlations

	Finance	Banks	Finance	Banks
	National		*Prefectural*	
Modern Industry	0.349*	0.095	0.308*	0.186*
Light Industry	0.493*	0.243	0.278*	0.165*
Heavy Industry	0.128	-0.045	0.268*	0.174*
	Listed[a]		*Unlisted*[a]	
Modern Industry	0.265*	0.155*	0.273*	0.176*
Light Industry	0.245*	0.139*	0.176*	0.119*
Heavy Industry	0.183*	0.115*	0.287*	0.192*

Significance level: * 5 percent [a]: prefecture level

Table 6: Unit Root Tests

	ADF	PP	Lags
Modern Industry	-2.429	-5.664**	3
Light Industry	-3.996**	-4.961**	1
Heavy Industry	-1.062	-4.227**	2
Financial Services	-2.787	-3.100*	1
Banks	-3.644**	-3.884**	1

Significance level: * 5 percent, ** 1 percent

Table 7: VAR Results

	Equation	Industry$(t-n)$	Finance$(t-n)$	F-statistic	R^2	Lags (n)
Modern Industry	Eq. 1	0.484***	**-0.025**	**0.073**	0.213	1
	Eq. 2	**0.031**	0.627***	**0.022**	0.406	
Light Industry	Eq. 1	0.303*	**0.033**	**0.228**	0.123	1
	Eq. 2	**0.093**	0.615***	**0.077**	0.407	
Heavy Industry	Eq. 1	0.735***	**-0.023**	**0.303**	0.460	1
	Eq. 2	**-0.269**	0.647***	**0.548**	0.414	

	Equation	Industry$(t-n)$	Banks$(t-n)$	F-statistic	R^2	Lags (n)
Modern Industry	Eq. 1	0.485***	**-0.122**	**0.853**	0.227	1
	Eq. 2	**0.014**	0.482***	**0.009**	0.234	
Light Industry	Eq. 1	0.361**	**-0.049**	**0.277**	0.124	1
	Eq. 2	**0.112**	0.466***	**0.247**	0.239	
Heavy Industry	Eq. 1	0.723***	**-0.047**	**0.589**	0.464	1
	Eq. 2	**-0.211**	0.481***	**0.606**	0.245	

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

Table 8: Comparison of Alternative Estimation Results

Dependent Variable: Modern Industry[a]				
	OLS	LSDV	2SLS	GMM
Financial Services	0.315***	0.136**	1.186***	0.561***
	(0.070)	(0.056)	(0.287)	(0.117)
Prefecture Dummies	No	Yes	Panel	Panel
Observations	2070	2070	2024	2024
Arellano-Bond AR(1) Test[b]	4.75***	1.77*	3.91***	-2.11**
Arellano-Bond AR(2) Test[b]	3.86***	1.87*	3.22***	-0.54
Hansen Over-ID Test[c]		0.00	0.00	0.00

Robust standard errors in parentheses

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

[a]: Included in all specifications are exports, geographic variables, interaction terms, and dummy variables for natural resources. Except for the OLS specification, year dummy variables are included as well. GMM includes lagged values of the dependent variable. All specifications use robust standard errors to account for heteroskedasticity. See text for details.

[b]: Z-statistic values. [c]: χ^2 values.

Table 9: GMM Results

Dependent Variable: Modern Industry				
	Financial Services			*Banks*
	(A)	(B)	(C)	(D)
Modern Industry	0.063	0.063	0.047	0.080
	(0.063)	(0.063)	(0.066)	(0.048)
Financial Series	0.590***	0.590***	0.562***	0.591***
	(0.138)	(0.002)	(0.117)	(0.160)
Exports (mil. yen)		0.462***	dropped[a]	dropped[a]
		(0.157)		
Selected Control Variables[b]				
Coal			-0.131**	-0.155**
			(0.061)	(0.072)
Temperature (°C)			0.030**	0.036**
			(0.013)	(0.018)
Exports · Petroleum			-0.348	-0.414*
			(0.229)	(0.214)
Observations	2024	2024	2024	2024
Arellano-Bond AR(1) Test[c]	-2.05**	-2.05**	-2.11**	-2.02**
Arellano-Bond AR(2) Test[c]	-0.48	-0.48	-0.54	-1.69*
Hansen Over-ID Test[d]	0.17	0.17	0.00	0.00

Robust standard errors in parentheses

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

[a]: Due to collinearity. [b]: Insignificant terms not shown; see text for complete list.

[c]: Z-statistic values. [d]: χ^2 values.

Table 10: GMM Results, by Industry Type

Dependent Variable:	Light Industry		Heavy Industry	
	Finance	*Bank*	*Finance*	*Bank*
Industrial Series	0.154**	0.143***	0.090*	0.111**
	(0.067)	(0.052)	(0.053)	(0.050)
Financial Series	0.285***	0.302	0.338***	0.399**
	(0.087)	(0.172)	(0.100)	(0.160)
Selected Control Variables[b]				
Coal	-0.050	-0.070	-0.068*	-0.083*
	(0.035)	(0.043)	(0.034)	(0.043)
Temperature (°C)	0.015***	0.019**	0.011*	0.0144
	(0.005)	(0.008)	(0.006)	(0.009)
Surface Water (km^2)	0.079**	0.083**	0.013	0.020
	(0.030)	(0.038)	(0.021)	(0.024)
Exports · Petroleum	0.171*	0.136	-0.079	-0.144
	(0.088)	(0.083)	(0.209)	(0.194)
Exports · Rain	0.179**	0.129	-0.081	-0.132
	(0.083)	(0.097)	(0.163)	(0.176)
Urban · Petroleum	-0.133**	-0.127*	-0.060	-0.053
	(0.060)	(0.66)	(0.060)	(0.067)
Observations	2024	2024	2024	2024
Arellano-Bond AR(1) Test[c]	-2.73***	-2.59***	-1.85*	-1.81*
Arellano-Bond AR(2) Test[c]	-0.61	-0.58	0.05	1.04
Hansen Over-ID Test[d]	0.00	0.00	0.00	0.00

Robust standard errors in parentheses

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

[a]: Due to collinearity. [b]: Insignificant terms not shown; see text for complete list.

[c]: Z-statistic values. [d]: χ^2 values.

Table 11: GMM Results, by Ownership

Dependent Variable:	Listed Modern		Unlisted Modern	
	Finance	*Bank*	*Finance*	*Bank*
Modern Industry	0.006	0.020	0.022	0.067
	(0.065)	(0.057)	(0.059)	(0.084)
Financial Series	0.256***	0.173**	0.208***	0.241***
	(0.050)	(0.074)	(0.055)	(0.089)
Selected Control Variables[b]				
Coal	-0.119**	-0.134**	-0.031*	-0.039*
	(0.055)	(0.061)	(0.026)	(0.021)
Temperature (°C)	0.029*	0.033*	0.005**	0.007*
	(0.015)	(0.019)	(0.002)	(0.004)
Exports · Petroleum	-0.277	-0.314*	-0.083	-0.113
	(0.197)	(0.184)	(0.085)	(0.086)
Exports · Rain	-0.067	-0.091	-0.213*	-0.217
	(0.165)	(0.171)	(0.118)	(0.120)
Observations	2024	2024	2024	2024
Arellano-Bond AR(1) Test[c]	-2.29**	-2.24**	-2.22**	-2.13**
Arellano-Bond AR(2) Test[c]	-0.69	0.62	1.10	1.32
Hansen Over-ID Test[d]	0.00	0.00	0.00	0.00

Robust standard errors in parentheses

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

[a]: Due to collinearity. [b]: Insignificant terms not shown; see text for complete list.

[c]: Z-statistic values. [d]: χ^2 values.

Table 12: GMM Metro Results

Dependent Variable: Modern Industry				
	Metro		Other Pref.	
	Finance	*Bank*	*Finance*	*Bank*
Modern Industry	-0.129	-0.120	-0.001	0.007
	(0.112)	(0.106)	(0.049)	(0.049)
Financial Series	0.264**	0.426**	0.175***	0.123
	(0.049)	(0.052)	(0.041)	(0.082)
Selected Control Variables[b]				
Coal	dropped[a]	dropped[a]	-0.099**	-0.102**
			(0.047)	(0.048)
Temperature (°C)	0.570**	0.573***	0.026*	0.028*
	(0.080)	(0.049)	(0.014)	(0.015)
Exports · Timber	-6.226***	-6.847***	0.266	0.283
	(0.557)	(0.537)	(0.213)	(0.217)
Exports · Coal	2.705***	3.117***	-0.006	-0.016
	(0.194)	(0.182)	(0.128)	(0.130)
Exports · Rain	4.600*	3.810**	-0.212	-0.205
	(1.126)	(0.877)	(0.182)	(0.180)
Observations	132	132	1892	1892
Arellano-Bond AR(1) Test[c]	-1.72*	-1.72*	-4.15***	-4.11***
Arellano-Bond AR(2) Test[c]	-0.41	0.29	0.20	0.48
Hansen Over-ID Test[d]	23.49	30.05	0.00	0.00

Robust standard errors in parentheses

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

[a]: Due to collinearity. [b]: Insignificant terms not shown; see text for complete list.

[c]: Z-statistic values. [d]: χ^2 values.

Table 13: GMM Metro Results, by Capital Intensity

Dependent Variable:	Light Industry		Heavy Industry	
	Metro	*Other*	*Metro*	*Other*
Industrial Series	0.196	0.040	-0.155*	0.034
	(0.089)	(0.055)	(0.044)	(0.053)
Financial Services	0.192**	0.059	0.213**	-0.040
	(0.036)	(0.111)	(0.025)	(0.076)
Selected Control Variables[b]				
Temperature (°C)	0.372***	0.014**	0.114**	0.011
	(0.035)	(0.007)	(0.023)	(0.008)
Exports · Timber	-0.517*	0.004	-5.186***	0.068
	(0.122)	(0.053)	(0.178)	(0.167)
Exports · Coal	0.724***	0.035	1.580***	-0.030
	(0.070)	(0.052)	(0.060)	(0.108)
Urban · Timber	dropped[a]	0.163**	dropped[a]	0.126
		(0.080)		(0.084)
Urban · Coal	dropped[a]	0.029	dropped[a]	0.081***
		(0.039)		(0.029)
Observations	132	1892	132	1892
Arellano-Bond AR(1) Test[c]	-1.71*	-3.94***	-1.63	-3.99***
Arellano-Bond AR(2) Test[c]	-0.03	-0.24	-0.92	-0.41
Hansen Over-ID Test[d]	0.00	0.00	135.70	0.00

Robust standard errors in parentheses

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

[a]: Due to collinearity. [b]: Most significant terms shown; see text for complete list.

[c]: Z-statistic values. [d]: χ^2 values.

Table 14: GMM Intertemporal Comparison Results

Dependent Variable: Modern Industry				
	Pre-1893		*Post*-1893	
	Finance	*Bank*	*Finance*	*Bank*
Modern Industry	0.112	0.064	0.069	0.115***
	(0.179)	(0.169)	(0.044)	(0.028)
Financial Series	0.177	-0.168	0.494***	0.704***
	(0.183)	(0.135)	(0.098)	(0.173)
Selected Control Variables[b]				
Temperature (°C)	0.014	0.021	0.055**	0.064**
	(0.011)	(0.014)	(0.026)	(0.031)
Exports · Metal Ores	-3.173**	-3.101**	-0.104	-0.164
	(1.470)	(1.391)	(0.348)	(0.398)
Exports · Coastline	-1.547**	-1.351**	-0.198	-0.155
	(0.751)	(0.661)	(0.156)	(0.145)
Exports · Surface Water	2.844**	2.828**	0.231	0.163
	(1.225)	(1.172)	(0.177)	(0.162)
Exports · Urban	1.914	1.978	0.493**	0.264
	(1.355)	(1.386)	(0.222)	(0.175)
Observations	1104	1104	920	920
Arellano-Bond AR(1) Test[c]	-1.90*	-1.80*	-2.15**	-2.11**
Arellano-Bond AR(2) Test[c]	1.56	1.38	-1.00	-0.21
Hansen Over-ID Test[d]	0.57	0.01	0.54	0.13

Robust standard errors in parentheses

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

[a]: Due to collinearity. [b]: Insignificant terms not shown; see text for complete list.

[c]: Z-statistic values. [d]: χ^2 values.

Table 15: GMM Alternative Exports Results

Dependent Variable:	Modern Industries		Light Industries	
	Finance[b]	*Bank*	*Finance*	*Bank*[a]
Modern Industry	0.058	0.088	0.154*	0.149**
	(0.076)	(0.057)	(0.077)	(0.062)
Financial Series	0.560***	0.743***	0.282	0.417**
	(0.111)	(0.146)	(0.093)	(0.193)
Selected Control Variables				
Coal	-0.206*	-0.244*	-0.083	-0.101*
	(0.109)	(0.124)	(0.053)	(0.059)
Temperature (°C)	0.051**	0.059*	0.024**	0.029**
	(0.024)	(0.030)	(0.009)	(0.012)
Surface Water (km^2)	0.140	0.138	0.125***	0.127**
	(0.093)	(0.095)	(0.046)	(0.051)
Exports · Urban	0.077	0.093	-0.248**	-0.231*
	(0.253)	(0.242)	(0.120)	(0.125)
Urban · Petroleum	-0.227	-0.222	-0.174*	-0.179*
	(0.179)	(0.191)	(0.096)	(0.102)
Observations	1288	1288	1288	1288
Arellano-Bond AR(1) Test[e]	-2.03**	-1.99**	-2.70***	-2.62***
Arellano-Bond AR(2) Test[e]	-0.67	1.75*	-0.77	-0.76
Hansen Over-ID Test[f]	0.00	0.00	0.00	0.00

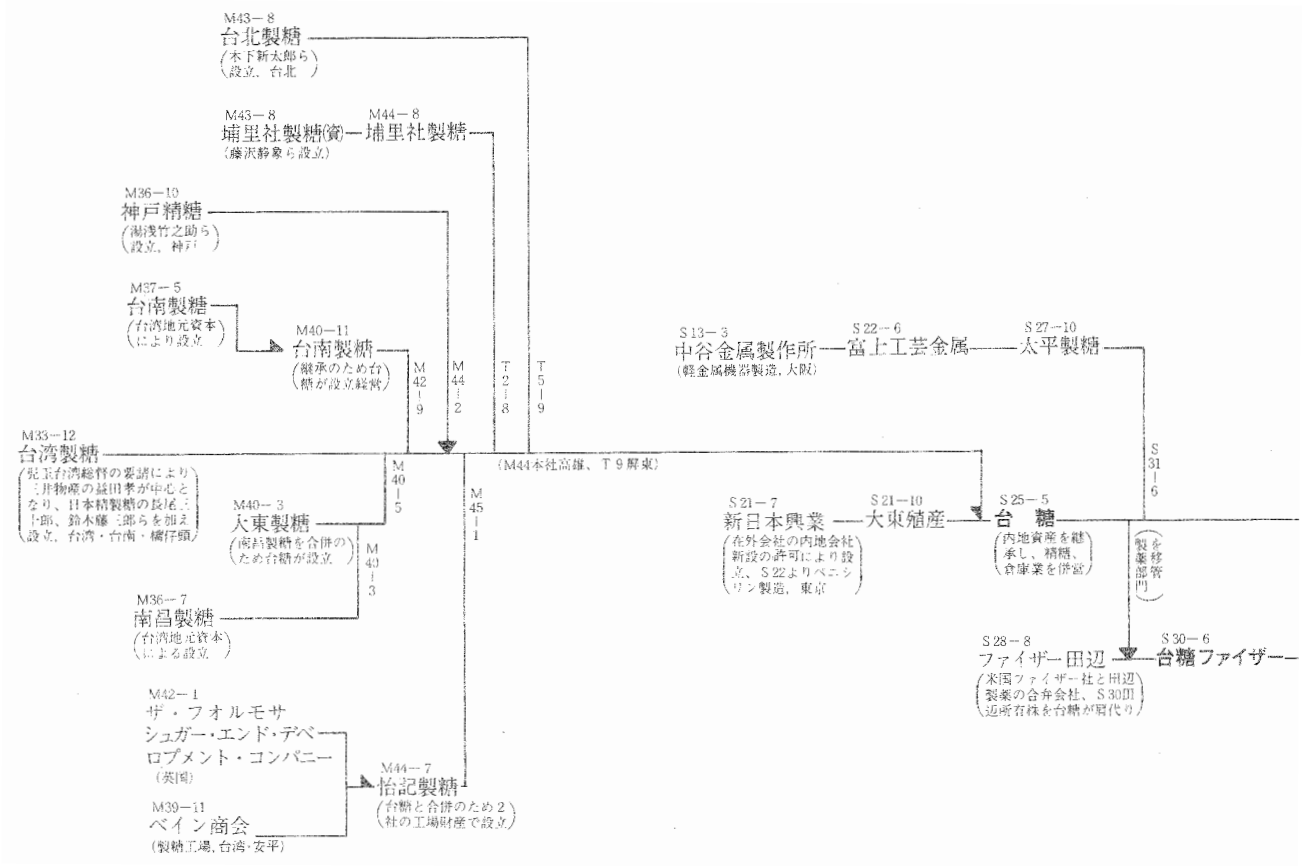
Robust standard errors in parentheses

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

[a]: Due to collinearity. [b]: Insignificant terms not shown; see text for complete list.

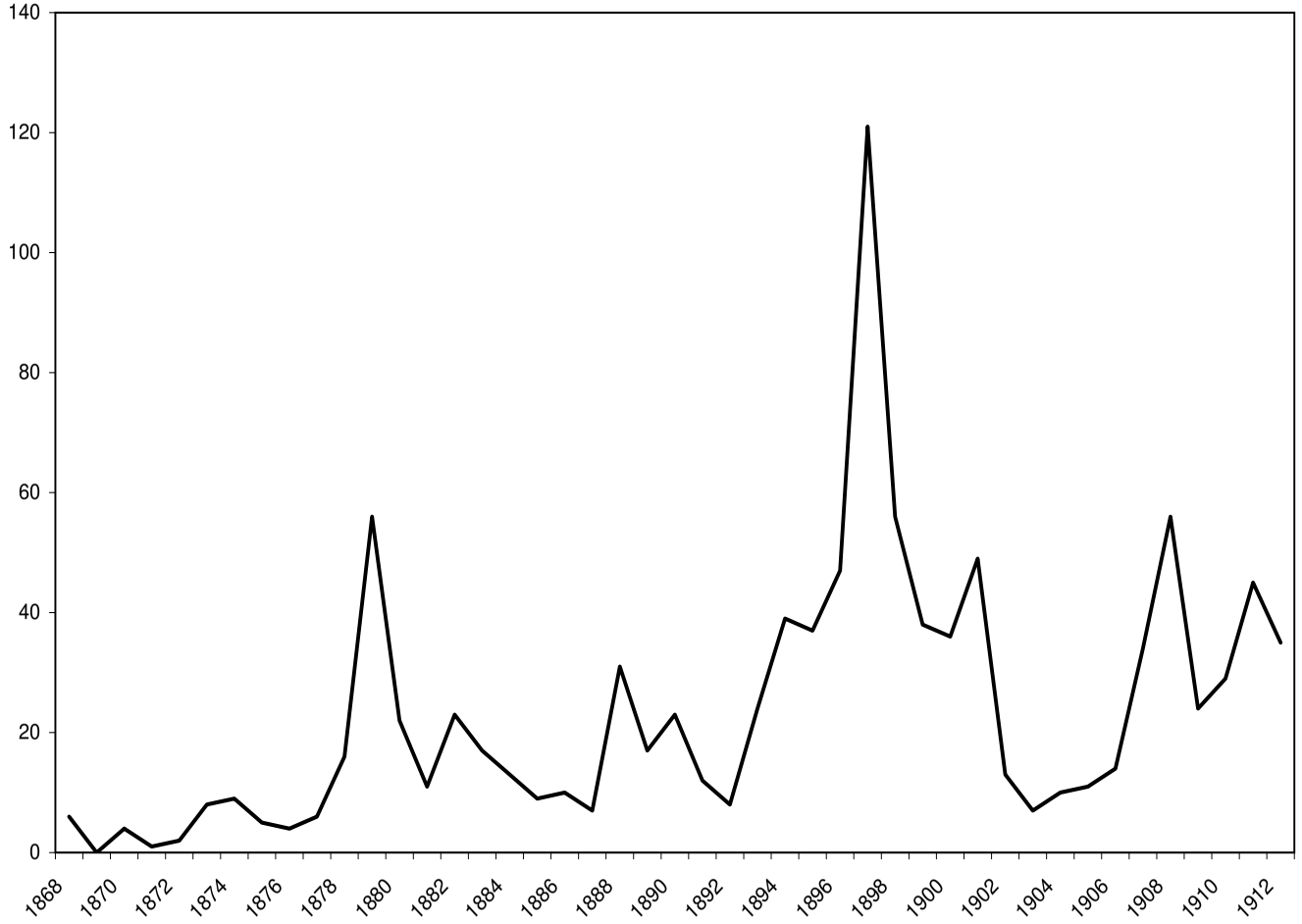
[c]: Z-statistic values. [d]: χ^2 values.

Figure 1: Corporate Genealogy Example



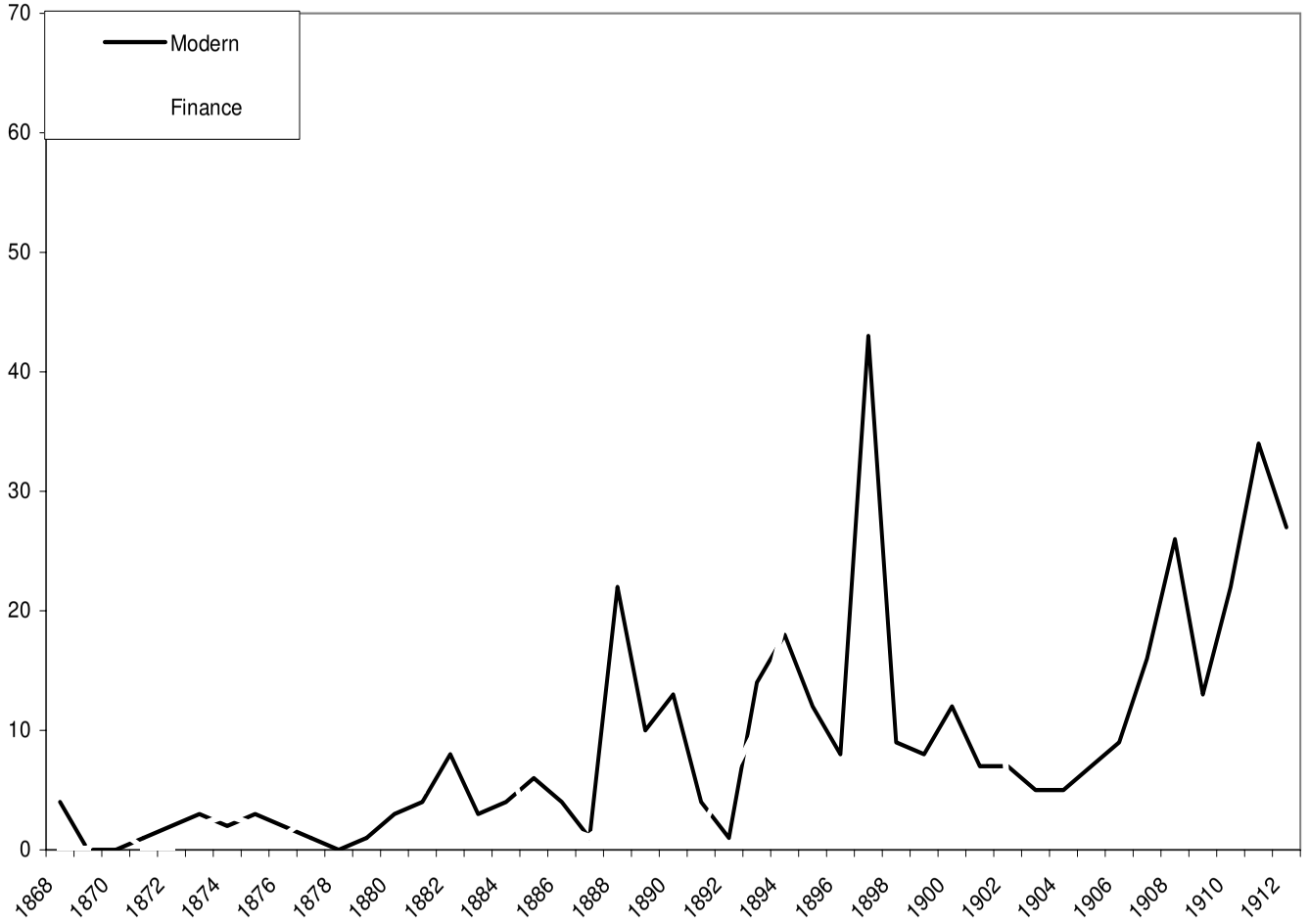
Source: Yagura and Ikushima (1986)

Figure 2: Number of Startup Establishments, 1868-1912



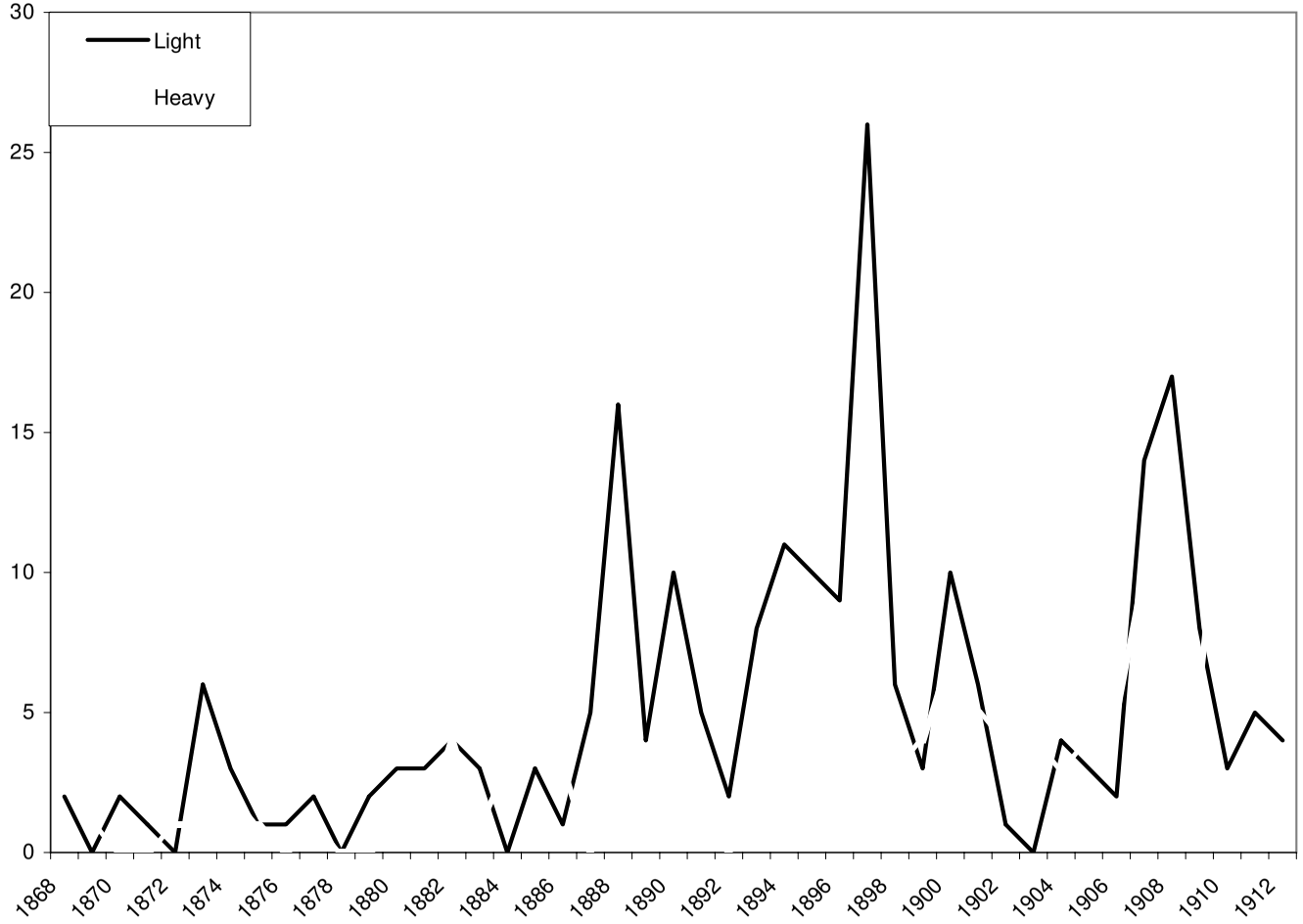
Source: see text

Figure 3: Number of Startup Establishments, by Major Sector



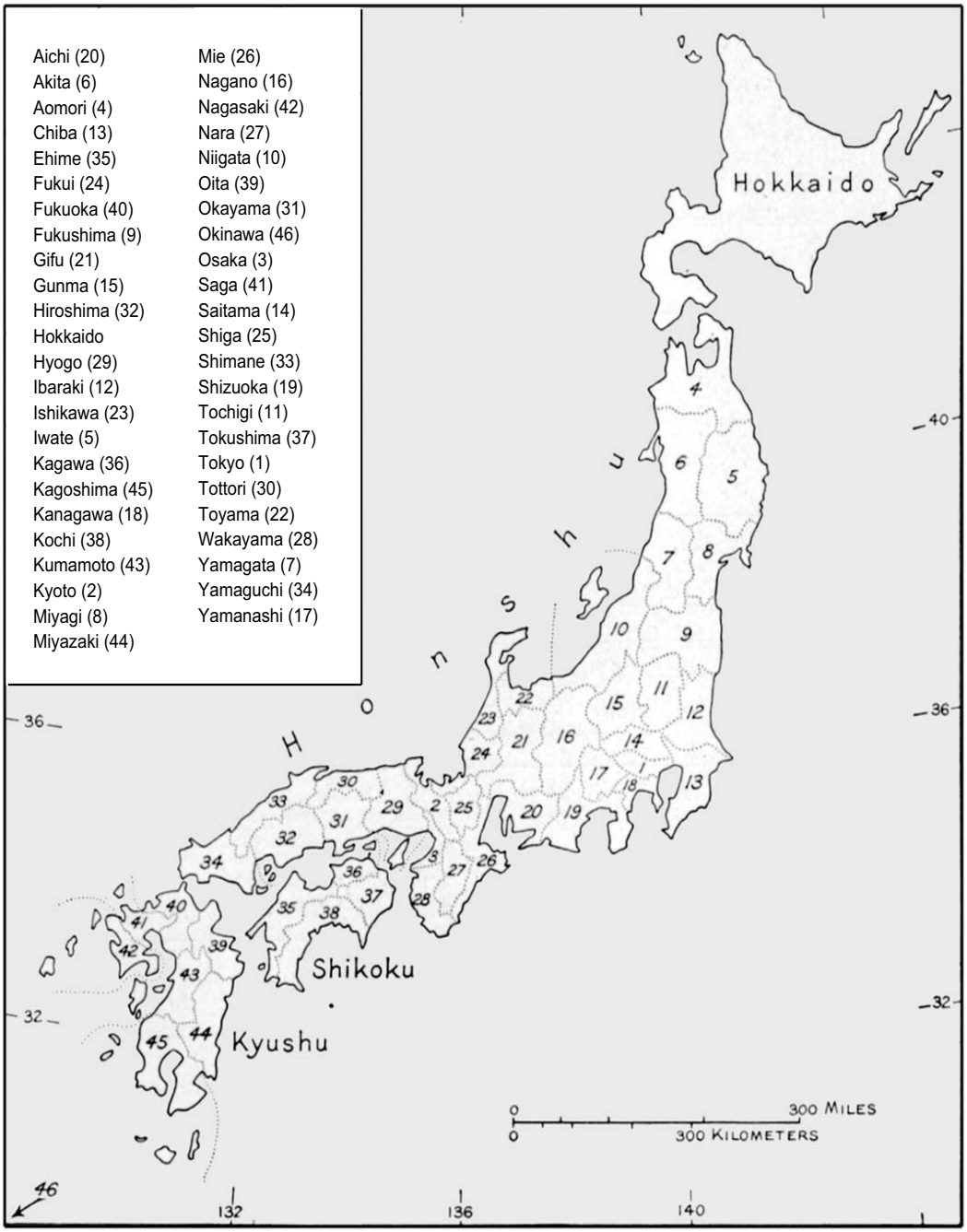
Source: see text

Figure 4: Number of Startup Establishments, by Factor Intensity



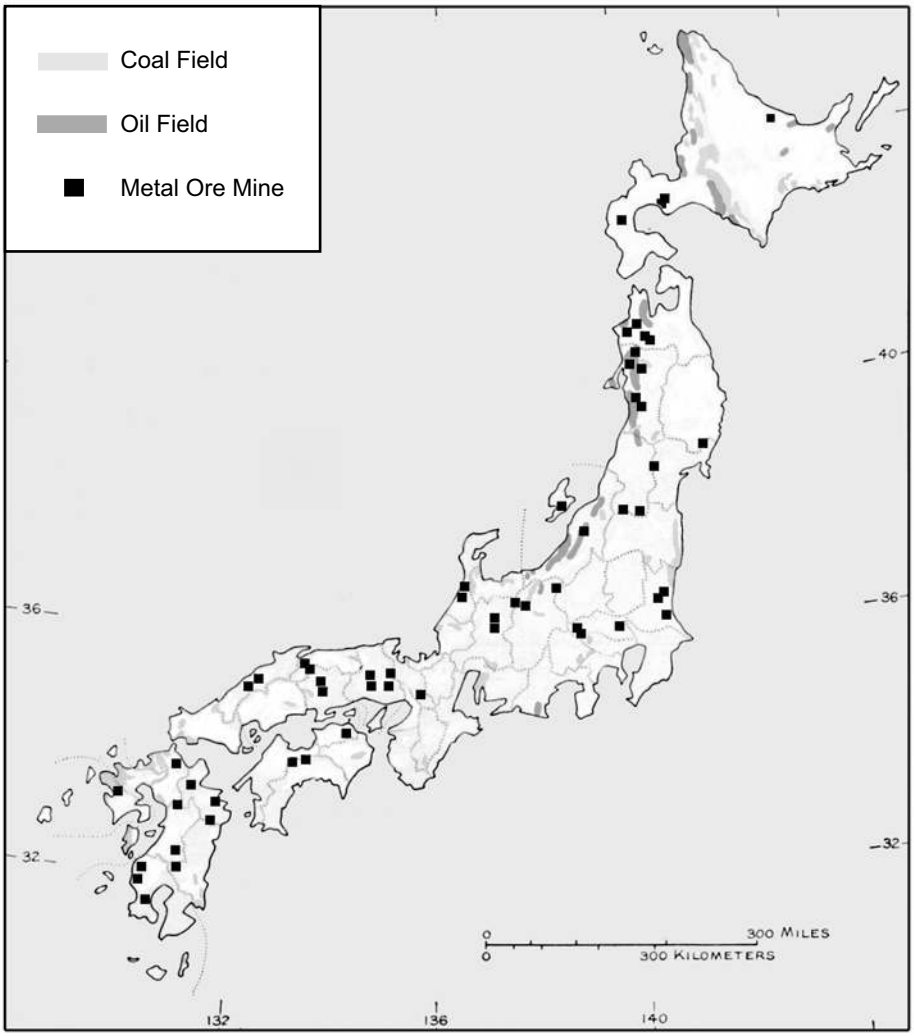
Source: see text

Figure 5: Map of Japanese Prefectures



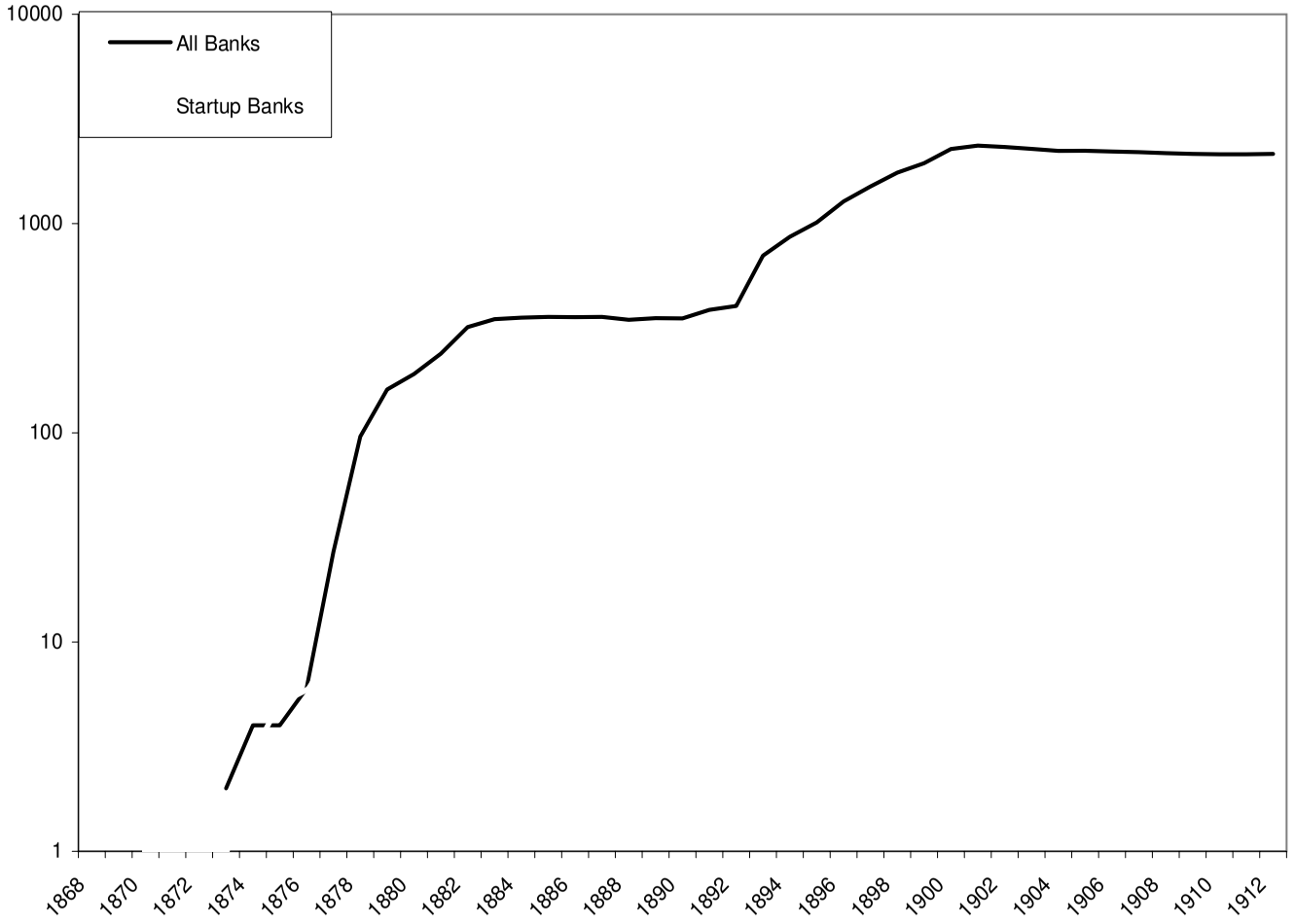
Source: Trewartha (1945)

Figure 6: Distribution of Natural Resources



Source: Trewartha (1945)

Figure 7: Bank Startup Growth vs All Banks



Source: see text