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Technological Leadership and Late Development: Evidence from Meiji Japan, 1868-1912

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Abstract

Large family-owned conglomerates known as zaibatsu have long been credited with leading Japanese industrialization during the Meiji Period (1868-1912), despite a lack of empirical analysis. I develop a new dataset collected from corporate genealogies and estimate the likelihood of a firm being an industry pioneer with discrete choice econometric methods. I find that certain characteristics associated with zaibatsu increase the likelihood of leading entry into new industries. In particular, first entry probabilities increase with industry diversification and private ownership, which may provide internal financing and risk-sharing. Nevertheless, the costs of excessive diversification may deter additional pioneering, which may account for the loss of zaibatsu technological leadership by the turn of the century.

JEL classifications: L25, N85, O14, O33
Keywords: diversification, industrialization, Japan, late development, technology adoption

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I

Japan's rapid industrialization at the end of the nineteenth century is commonly attributed to the leadership of large, family-owned conglomerates known as zaibatsu. These firms had the advantages of size, which gave them sufficient scale to adopt capital-intensive technology; family ownership, which conferred autonomy from shareholders seeking short-term profit; diversified holdings, which spread risk and allowed for internal financing of investments; employment of well-educated salaried managers; and access to natural resources like metals and coal.[2] The benefits of these features were especially magnified in Japan during the Meiji Period (1868-1912), which shared with other late developing economies weak institutions, poor infrastructure, and immature capital markets.[3] Consequently, it has been argued that these business groups ``[provided] the impetus to the country's modern economic development,'' without which Japanese success would not have been nearly as rapid or assured.[4]

Belying these apparent advantages, however, are a number of uncomfortable observations. First, Japanese industries were primarily labor-intensive during this period, with the economy transitioning to heavier sectors starting in the 1900s. This suggests that zaibatsu had few opportunities to exploit scale economies, especially given that many of their holdings were commercial (for example, shipping, merchandising). While commerce did allow for economies of scope, the attributes of size and wealth are less meaningful. Scope economies differ from scale economies in their reliance on the savings from fixed costs (for example, shared facilities, distribution channels) rather than variable costs (for example, shared inputs, learning curves). Another way of distinguishing the two is that scope economies typically involve production of multiple, unrelated goods while scale economies are usually from increased production of the same (or similar) goods.} Second, despite their substantial wealth, zaibatsu did not lead development of two important early sectors, cotton spinning and railways, which due to their scale required funding from

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[2] Morikawa, *Zaibatsu*, pp. 12-14; Fruin, *Japanese Enterprise*, pp. 3-5.
[3] Gerschenkron, *Economic Backwardness*.
[4] Morikawa, *Zaibatsu*, p. xvii. While the direct translation of zaibatsu is ``financial clique,'' they are more commonly known as ``business groups'' in existing literature; see Morck and Nakamura, ``Business groups.''

issued stock.[5] Evidence of zaibatsu leadership in developing new industries is also underwhelming: new data indicate that of the 109 privately started industries in the Meiji Period, only 12 were pioneered by zaibatsu. Other scholars claim that these conglomerates owed their pathbreaking efforts to government patronage, not to their own merits or intrinsic qualities.[6] More recent work suggests zaibatsu employed few university graduates during the Meiji Period and lagged their competitors in using new technology thereafter.[7]

Notwithstanding these concerns, the visibility of zaibatsu has generated a substantial body of research. Common to countries at an early stage of development, ``[Japan] lacked the basic commercial and financial infrastructure and the technical and managerial skills essential to introduce and operate Western industrial technology."[8] Consequently, numerous studies have asserted that zaibatsu led the introduction and use of foreign technology in Japan's early period of industrialization, although these claims are supported mainly by anecdote, case studies, or cross-country comparisons. The few papers that use quantitative data to compare zaibatsu behavior to other firms are limited to financial records dating primarily from the Taisho Period (1912-1926), leaving what occurred in prior years unclear.

This paper attempts to fill in some of these gaps, particularly on the issues of industrial and technological leadership. I test whether characteristics typical of zaibatsu increase the likelihood of being an industry pioneer, and thus gauge how important these business groups were to technological adoption in Meiji Japan. These features include industry diversification and concentrated private ownership, and I further control for industry type and technological innovation.[9] My main finding is that both diversification and private ownership significantly affect a firm's probability of introducing new production technology. This is consistent with

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[5] Morikawa, *Zaibatsu*, p. 27.
[6] Morikawa, *Zaibatsu*, p. 23; Nakagawa, ``Business strategy," pp. 2-12.
[7] Frankl, ``Analysis," p. 1001.
[8] Morikawa, *Zaibatsu*, p. x.
[9] A third common feature among zaibatsu is the substantial wealth held by their founding families, but this information is not publicly available and thus omitted from the analysis. Nevertheless, some specifications include an indicator for zaibatsu affiliation in addition to private ownership and diversification to proxy for this characteristic.

studies averring that diversification allows firms to take greater risks in their investments and subsidizes costs using revenues from existing operations and retained earnings. Private ownership also provides flexibility in financial choices and a potentially longer investment horizon. In the absence of developed financial markets, these features may have given zaibatsu the edge over smaller independent firms in leading technology adoption.[10]

Ironically, I also find that there is an optimal level of diversification, beyond which the probability of pioneering an industry decreases relative to less diversified firms. One explanation is that the administrative costs and managerial difficulties of entering, much less pioneering, new sectors begin to outweigh the benefits of risk sharing. Specifically, I find that highly diversified firms are less likely to pioneer additional industries as early as the 1880s, even in innovative sectors where their advantages are more pronounced. This behavioral change corroborates other research that shows Meiji-era zaibatsu lagging behind technologically independent firms and newer conglomerates in the Taisho and early Showa (1926-1989) Periods.[11]

At the heart of the analysis is the assumption that the timing of an industry's initial appearance approximates when its production technology was introduced to Japan. As a latecomer to industrialization, Japan could borrow existing technologies without needing to develop them itself. Thus, it seems reasonable to consider the first Japanese firm in a new sector as the first adopter of the technology, with all the associated costs and risks. By extension, determining whether zaibatsu characteristics correspond to those of industry pioneers provides a way to evaluate claims of their purported leadership and to assess what specifically may have contributed to their early leadership in Japanese development.

A consequence of the ``first appearance, first adoption'' assumption is that my analysis eschews the need for financial records, few of which existed before the twentieth century. Instead, I develop a new establishment-level dataset from the Meiji Period, which I gathered from corporate genealogies. These genealogies arguably comprise the oldest source of firm information across industries for Japan.

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[10] Morikawa, *Zaibatsu*, pp. 93-94.
[11] Frankl, ``Analysis,'' p. 1001.

By focusing on the Meiji Period, when Japan began to industrialize, I avoid drawing anachronistic conclusions that use more detailed documentation from later years. Furthermore, I circumvent the distortions associated with the global depression in the 1920s and militarization in the 1930s.

Other departures from existing research include looking at specific features of Meiji-era zaibatsu, as opposed to individual zaibatsu, and using a cross-section of industries in the economy. Given that discussions of Japanese industrial development refer to zaibatsu collectively, it makes sense to weigh the importance of their shared features like family ownership and diversification. Similarly, considering a wide range of industries allows one to compare differences in factor intensity and corresponds with late development theory's emphasis on multi-sector coordination.[12]

II

As a late developing economy with immature financial and legal institutions, Meiji Japan seems to provide an ideal context for zaibatsu-led industrialization. In particular, given the need for capital mobilization and broad-based development, zaibatsu attributes like diversified holdings, internal financing, family wealth and ownership, and access to natural resources and skilled labor would be highly advantageous. Before World War II, these features allowed zaibatsu to import physical capital and technology from abroad; employ skilled foreigners and graduates from newly established Japanese universities; and expand into new markets.[13] Independent firms, on the other hand, were typically under-capitalized due a wealthy merchant class reluctant to invest in unfamiliar technology; high dividend payments that left little retained earnings for expansion; and weak capital markets plagued with ill-defined property rights and high barriers to equity finance.[14]

Nevertheless, some scholarship disputes these factors as motivating zaibatsu leadership and suggests these conglomerates emerged only through government

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[12] See Morck and Nakamura, ``Business groups."
[13] Morikawa, *Zaibatsu*, pp. xvii-xxiv; Fruin, *Japanese Enterprise*, pp. 3-5.
[14] Morikawa, *Zaibatsu*, pp. 4, 57, 93-94.

assistance.[15] Throughout this period, the government sponsored study trips and foreign employment; invested in roads, telegraphs, utilities and transport facilities; and subsidized strategic sectors like shipping, construction, armaments, and mining, all which tended to benefit zaibatsu given their fields of operation and international exposure. More controversial were the personal relationships between zaibatsu families and government officials, with zaibatsu allegedly receiving preferential treatment in contracts and the privatization of public enterprises during the 1880s.

Proponents of this perspective, however, also find it difficult to substantiate their claims, such as identifying the direction of causality or demonstrating that zaibatsu received benefits disproportionate to the risks involved. For example, Mitsui claims it invested in industries like coal mining, textiles, and machinery because of their anticipated importance to economic growth and potential profitability.[16] Whether government-zaibatsu relationships on balance benefited the latter is questionable, considering that some came close to bankruptcy due to changes in political administration or public pressure for competition.[17] Many zaibatsu also emerged with no official patronage, having been established well before the Meiji Period or operating in trades that received little public investment, and their purchase of state assets below book value may have had less to do with favoritism and more with government haste to staunch continued losses. More generally, public goods like education and infrastructure are non-excludable and thus were available to both zaibatsu and independent entrepreneurs. Finally, others note that Japan's takeoff occurred toward the end of the century, post-dating most of the government's industrial activities.[18]

Similarly, research comparing the performance of zaibatsu to other private firms finds mixed evidence supporting zaibatsu technological leadership. Jennifer Frankl, using financial records for 130 firms between 1915 and 1937, analyzes the effect of zaibatsu affiliation on equity returns and risk profiles. She finds that Meiji-era zaibatsu had more volatile returns on equity than its competitors.[19] In

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[15] Nakagawa, ``Business strategy,'' pp. 3-12.
[16] Morikawa, *Zaibatsu*, p. 66.
[17] Morikawa, *Zaibatsu*, pp. 20-26.
[18] Ohkawa and Rosovsky, *Japanese Economic Growth*, p. 20.
[19] Frankl, ``Analysis,'' p. 1012.

addition, these zaibatsu were slow to adopt new technology and to expand into new industries and markets. Two other studies, in contrast, find the average zaibatsu outperforming independent firms and having less volatile returns, which the authors attribute to concentrated ownership and the holding company structure.[20]

The discrepancy in findings partly depends on whether a study distinguishes Meiji-era zaibatsu from newer ones, something Frankl does and the others do not. Yet it may be the case that none of these studies apply to an earlier period with different institutional and market conditions, and that the designation of zaibatsu is itself endogenously determined based on their continued success and non-market considerations. Another concern recognized by the authors is that using records from a modest sample of large firms introduces bias to the results and overlooks contributions from smaller or non-traded firms.[21] Since the latter may not have been required to document their finances, results excluding them may not generalize for the whole of the economy. Thus, a more representative firm-level dataset across the industrial spectrum from the Meiji Period would help to clarify the role of zaibatsu in industry formation and innovation.

III

A problem common to historical studies of economic development is the lack of data. Few developing countries have the capacity to create and maintain detailed information on industries and firms, and Japan in the nineteenth century was no exception. Even historic data in the *Long Term Economic Statistics of Japan* document industrial development beginning in 1887 and only available at the national level.[22] Nevertheless, potentially valuable information may be found in an overlooked resource: corporate genealogies, which track firms from their origins to modern times. In particular, genealogies provide dates of establishment, ownership and source of setup finance, industry classification, and geographic location. Despite being less quantitative than financial reports, these data can be used to assess relationships between firms and sectors while controlling for the abovementioned characteristics. More importantly, they often represent the oldest reliable evidence

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[20] Miyajima et al, ``Corporate governance''; Okazaki, ``Role.''
[21] Frankl, ``Analysis,'' p. 1003.
[22] Ohkawa, *Nihon*.

of firm activity across the industrial spectrum. I use as my primary data source for this study the *Shuyo Kigyo no Keifuzu*, a compilation of corporate genealogies edited by the business historians Shintaro Yagura and Yoshiro Ikushima. Additional data include firm financial reports from the *Eigyo Hokokusho Shusei* collection and various Japanese industry indices and firm case studies.[23]

The *Shuyo* compilation includes genealogies for 1,089 firms that were listed on the Tokyo Stock Exchange as of September 1984, contain over 14,000 unique establishment observations, and date back to the early nineteenth century or earlier. One concern to using genealogies is that they do not represent a random sample of business activity because of firm survivor bias, meaning that they contain only establishments that survived long enough to be recorded. This bias is partly mitigated in the *Shuyo* because the genealogies explicitly identify asset transfers from bankrupt or merged establishments to successful ones. Thus, despite firm failure or reorganization, both surviving and deceased firms remain on record. The authors also cross-reference establishments that appear in multiple genealogies and track the ancestry of failed establishments, providing a way to verify a firm's startup status. The inclusion of failed establishments is particularly relevant in manufacturing sectors since they typically leave behind transferable assets, unlike firms in some service industries that require little capital investment or equipment. Figure 1 shows the number of startup establishments over the Meiji Period.

[Figure 1 here]

Industries can be identified through the company name or editorial annotation, and I retroactively apply industry codes to each observation using the 1984 edition of the *Standard Industrial Classification for Japan* (JSIC) produced by the Statistics Bureau of Japan. The Japanese SIC system resembles the United States SIC system (replaced in 1997 with the North American Industry Classification System), but is not a one-to-one mapping. Like its American counterparts, the Japanese system classifies industries hierarchically, from broader

[23] See Yushodo, *Eigyo*; Asia Research, *Outline*; Dodwell, *Industrial Groupings*; Mitsubishi Public Affairs Committee, *Brief History*; Ohsono, *Charting*; and Russell, *House of Mitsui*.

industry groups (two-digits) to narrow ones (four-digits). For example, a two-digit code of 05 refers to Metal Mining; a three-digit code of 053 refers to Iron Ore Mining; and a four-digit code of 0534 refers to Chromium (a type of iron ore) Mining.

Typically, company names in Japan have three parts: personal/geographic name + industrial activity + industrial operation/facility (for example, Ishitsuka + Bottle Manufacturing + Factory), although there are many that use a combination of only the first two identifiers. There are also some exceptions to the single-industry-per-establishment identification, excluding conglomerates. For example, Kotahara Coach and Rail is classified in both the Local Railway (JSIC four-digit code 4021) and Light Passenger Vehicle Transport (JSIC4 4141) industries. For establishments without any industry indicator in the genealogies, which represent less than ten percent of the sample, I search for Japanese firm names in electronic databases as well as industry reports.

IV

For my analysis, I use a maximum likelihood probit model to estimate relative likelihoods of first entry. That is, I set the entry outcome (first entry or not) as my dichotomous dependent variable. My main independent variables include a continuous measure of how diversified a firm is (eg, the number of industries a firm operates in at the time of entry) and an indicator for ownership type (ie, publicly traded or private-held), both considered essential differences between zaibatsu and independent firms. Other differences like family wealth, employment of highly skilled labor, access to natural resources, and relationships with the central government are not identifiable with existing data. However, to address this possible omitted variable bias, I use both a specification test and variable decomposition as described in the next section. To capture the decreasing marginal benefit of diversification, I include the square of the firm's number of industries. I also use an indicator for technological innovation, which considers whether an industry uses technology that is new to the domestic market or is similar to an existing industry. In addition to interaction terms between each of these variables, I account for factors like regulatory change, market demand, and industry preferences with time and industry group dummy variables. The estimated equation takes the following form:

$$\Pr(Y=1) = \Phi (X_i \beta_i + X_j \beta_j + X_k \beta_k + X_t \beta_t), \text{ where}$$

Y = JSIC four-digit industry pioneer

Φ is the cumulative normal distribution function

X_i = firm-level variables (diversification, ownership)

X_j = industry-level variables (innovativeness, JSIC2 indicators)

X_k = interaction terms among X_i and X_j

X_t = five-year indicator variables

Industry diversification, measured in the number of industries a firm is already in at the time of establishment in a new industry, appears twice in the estimation. By definition, a conglomerate is a multi-sector firm; however, independent firms that simultaneously enter multiple industries at the time of establishment can be considered diversified as well. This variable increases in magnitude for each zaibatsu over the Meiji Period. Since diversifying across industries reduces volatility in revenues and spreads industry-specific risk, it is reasonable to expect diversified firms being more likely to lead entry in new sectors.

On the other hand, having many different industry holdings, especially in technologically advanced and capital-intensive sectors, poses organizational and strategic challenges and may deter further diversification. This was the case in the nineteenth and early twentieth centuries, before multi-divisional enterprises and professional management became the norm.[24] In other words, synergies may exist between certain firms and industries but not for others, and there may be an optimal number of industries for a single firm to operate in, beyond which the costs of multiple holdings exceed the benefits. Some examples include disputes between the directors of the Mitsui trading company and Mitsui bank over investment strategy and irrational investment choices by the founder of the Furukawa zaibatsu.[25] I account for this decreasing marginal benefit by separately including the square of the diversification variable.

The variable for firm ownership type takes the value of one for publicly-traded, joint-stock firms or zero for privately-held, non-traded firms. Since one

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[24] Morikawa, *Zaibatsu*, pp. 23, 113.
[25] Morikawa, *Zaibatsu*, pp. 66, 74.

prominent characteristic of zaibatsu is their family ownership, this variable may indicate their desire for investment autonomy and to avoid public disclosure of their finances.[26] That said, many zaibatsu held controlling interests in publicly-traded firms and there were independent non-traded firms, so this variable only partly captures the difference between zaibatsu and non-zaibatsu firms. Anecdotal evidence suggests that equity-financed firms, unlike those with internal or debt-based financing, were small and undercapitalized by their need to pay dividends. Moreover, many listed firms were run for short-term profit and were incorporated for a predetermined time period, between three to ten years.[27] I hypothesize that non-traded, private ownership allows a firm to make riskier, long-term investments such as leading entry into new industries since financing was less subject to business cycle volatility and investor impatience.

This ownership variable also addresses the issue of corporate monitoring through holding companies, which was important in both the pre- and postwar eras. 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. Although incorporation existed since the 1860s, the lack of institutions governing business practice or protecting property rights remained until the 1890s. Thus, these two factors also suggest a positive correlation between non-traded ownership and first entry.

The rationale for focusing on industry innovativeness is that pioneering sectors that use technologies similar to those already in the market incurs less entry risk and demonstrates less leadership. This is because another firm had already borne the cost of foreign adoption, which presumably is more than adapting technology from a domestic source. Firms using derivative technology are also aware of how the original has been received by the market and some of its operational difficulties. I differentiate between these two types of industry pioneering with an indicator variable for technology innovativeness. It takes a value of one for an industry that is the first to be established out of its broader industry

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[26] Morikawa, *Zaibatsu*, p. 43.
[27] Fruin, *Japanese Enterprise*.

grouping, and zero for industries that are not. An example of this is the three-digit industry grouping ``251: Glass Manufacturing,'' which includes the related four-digit industries of ``2511: Plate Glass,'' ``2514: Glass Container,'' and ``2515: Scientific Glassware.'' If there were no glass manufacturing industries prior to 1871, when the Ishitsuka Bottle Manufacturing Factory was founded, then only the four-digit industry ``2514'' would be coded as innovative. Based on zaibatsu advantages and the claim that, ceteris paribus, Japanese entrepreneurs were ``reluctant to invest in modern industries in which they lacked experience,'' I expect the interaction between zaibatsu and innovativeness to be positive.[28]

The weakness of private capital and lack of robust financial intermediaries suggest problems mobilizing investment funding for capital-intensive industries, and play to the advantages of zaibatsu affiliation. However, since no data exist to quantitatively measure the capital intensity of Japanese industries during this period, I use major industry dummies to account for inter-industry differences and cluster standard errors by four-digit industry to control for random industry shocks. To identify shared influences, I interact pairs of the following independent variables: zaibatsu affiliation, diversification, diversification^2, ownership, and industry innovativeness. I also include five-year period indicator variables to capture short- to medium-term temporal shocks to institutions and market conditions.

As for exclusions, I remove government firms from the sample on the grounds that the behavior of such firms is not obviously driven by market factors. I also remove all sectors that were established prior to the Meiji Period since they are less well-documented and unlikely to use technology borrowed from abroad; these include primary sector activities, traditional apparel/food manufacture, retailing, and other miscellaneous services. For duplicate appearances in the dataset due to changes in name or ownership, only the first appearance is included in the analysis. Establishments in foreign countries are omitted as well. These exclusions reduce the number of zaibatsu affiliates from 89 to 32 in the dataset, and I omit the 173 establishments that could not be identified by industry.

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[28] Morikawa, *Zaibatsu*, p. 4.

V

Between 1868 and 1912, 1,958 entrants could be identified by a four-digit JSIC code. Entrants include both individual firms as well as industry divisions within multi-industry companies (for example, conglomerates). With the restrictions mentioned above, the dataset reduces to 1,478 entrants, of which 1,446 were independent firms and 32 were affiliated with zaibatsu. Of the 109 new industries started with private funding, 12 were pioneered by zaibatsu and 97 by independent entrepreneurs. Additional summary statistics are in Table 1, which shows breakdowns by firm affiliation for various firm- and industry-level characteristics and the numbers of industry pioneers in parentheses.

[Tables 1 and 2 here]

The large disparity between the absolute number of independent and zaibatsu establishments belies substantial behavioral and organizational differences at the industry level. For example, zaibatsu are disproportionately represented in innovative industries (75 percent of establishments) compared to independent firms (23 percent). As expected, zaibatsu are nearly ten times as diversified as independent firms and more likely to have closed, privately-held ownership. Pair-wise correlations in Table 2 are largely consistent with the summary statistics. As hypothesized, first entry is positively correlated with diversification, private ownership, and zaibatsu affiliation in general. Zaibatsu are positively correlated with diversification, closed ownership, and both innovative and heavy industries.[29]

[Table 3 here]

However, as mentioned earlier, it may be more interesting to know why zaibatsu were able to lead the adoption of new technology than simply whether they were more likely to do so. To account for multiple shared features, I use a probit

[29] Heavy industries include chemicals, machinery, metal processing, and utilities, while light sectors include food processing, ceramics and glass, paper and wood products, textiles, and miscellaneous manufactures. The remainder are grouped together as non-manufacturing sectors. See Rosovsky, *Capital Formation*, p. 29.

model to identify contributions from individual characteristics. Results from the regressions are given in Table 3, and suggest that features associated with zaibatsu increase the likelihood of industry first entry as hypothesized. To ease interpretation, coefficients are reported as marginal effects, which measure the change in probability for an infinitesimal change in continuous variables and a discrete change in categorical variables. Thus, the specification in column 1 shows that a firm with operations in another industry (row 1) increases the probability of industry first entry by 3 percent and that a privately-held firm is 18 percent more likely to pioneer an industry compared to a publicly-traded one. I control for data heteroskedasticity by estimating and reporting Eicker-White standard errors, which are clustered by four-digit industry to account for industry-specific shocks.

Column 2 includes the interactions between the firm-level variables in column 1, and column 3 adds industry innovativeness and its interactions. Doing so shows that a firm's degree of diversification conveys an advantage to leading entry only in non-innovative industries, with single and multi-sector firms having comparable probabilities of pioneering an innovative industry. Columns 4 and 5 add indicator variables for major industry groups and five-year intervals, respectively. These help to reduce biases owing to differences between types of industries and changes in economic environment. The coefficients in these columns are qualitatively similar to the earlier ones, suggesting that the net effect of diversification to the likelihood of industry first entry up is positive and that the effect is stronger in non-innovative sectors. For all the specifications, being a private, non-traded firm increases the chances of industry pioneering by a smaller (but statistically significant) amount.

To consider the cumulative effect of all control variables, I calculate probabilities based on the features of a representative Meiji-era zaibatsu (privately-held, ten industries) and a contemporaneous unaffiliated firm (joint-stock, single sector). Accounting for all statistically significant variables in column 4, a typical zaibatsu is 70 percent more likely to lead entry into an innovative sector compared to its independent rival and 51 percent more likely to pioneer a non-innovative industry. These percentages obtain from taking the difference in first entry probabilities for the reference zaibatsu and independent firm, with a positive number indicating a higher relative likelihood for zaibatsu.

With time dummies (column 5), the findings reveal subtle, but substantive differences. While diversification continues to aid expansion into non-innovative sectors, it has the opposite effect for entry into innovative ones. Furthermore, being both highly diversified and privately-held reduce the likelihood of pioneering an industry. The difference between first entry probabilities for a typical zaibatsu and independent firm in an innovative industry is –15 percent (independent advantage); for a non-innovative industry, the difference is 40 percent (zaibatsu advantage).

[Figure 2 here]

These oppositely-sign likelihoods, with zaibatsu favoring non-innovative sectors and independent firms innovative ones, are graphically shown in Figure 2, where I substitute actual zaibatsu diversification over time in calculated probabilities. The relative likelihood of zaibatsu in pioneering a non-innovative industry remains comfortably positive and increases through the turn of the century. This is in contrast to its entry advantage in innovative sectors, which is negligible even early in the period and falls below that for an independent firm in 1876, when average zaibatsu diversification was around six industries. While it would be heroic to rely on this year estimate, the trends suggest that zaibatsu may have lost their technological leadership with regard to industry entry earlier than previously suspected.[30]

To check whether the model is correctly specified, I use a Wald test of significance to see if the coefficients are jointly different from zero. All specifications pass at the one percent level of significance. I also 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, squares them, and reinserts them into the model as an additional variable. The modified model is estimated 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 (since they would not show a pattern that could be explained with additional control variables). A significance level above five percent is generally

[30] Frankl, ``Analysis,'' p. 1001.

interpreted as failure to reject the hypothesis (in other words, model is not incorrectly specified). All specifications are above this threshold, which means that the null hypothesis of no omitted variables cannot be rejected.

[Table 4 here]

How robust are these results, especially considering differences over time and in firm characteristics? To test the prediction that zaibatsu lose their first entry advantage later in the period, I take subsets of the data after various threshold years and rerun the column 5 specification in Table 3. For instance, in column A of Table 4, I use only establishments in new industries dating from 1876, when a representative zaibatsu is expected to retain its first entry advantage for non-innovative industries, but not for innovative ones. This appears to be the case, as the variables for diversification and private ownership continue to increase the probability of industry pioneering, but not when interacted with the variable for industry innovativeness.

By the end of the 1880s, however, zaibatsu appear to have no first entry advantage in any industry over their independent rivals. Column B contains the results for the sample of industries started after 1888, which marks the year by which most state-owned enterprises were privatized.[31] As mentioned earlier, there is some controversy in whether government favoritism to zaibatsu provided the impetus for their industrial leadership. Notwithstanding this paper's exclusion of firms established by the government so as to identify only private sector activity, the privatization program may have affected contemporaneous zaibatsu expansion into other sectors. I find that after the 1880s zaibatsu are statistically indistinguishable from their independent rivals in the probability of pioneering an industry.

Similar results, shown in column C, obtain for the set of new industries started on or after 1893, when the government promulgated a new Commercial Code. Considered a significant milestone for Japanese investors and financial markets, the code provided a legal framework to protect property rights; thus, entrepreneurs may have found it easier to finance investments externally, offsetting

[31] Morck and Nakamura, ``Business groups," Table 1.

the internal financing advantage of zaibatsu. This appears to be the case as none of the features associated with zaibatsu significantly affects the probability of first entry for this sample of industries.

How much of the first entry advantage can be attributed to diversification and ownership as opposed to differences in the distributions of these variables between zaibatsu and independent firms? A common method used to isolate individual contributions between two groups is via Blinder-Oaxaca decomposition, which uses a single set of coefficient estimates in separate regressions for both group subsamples.[32] Taking the difference between the two resulting predictions for each variable allows one to attribute the percentage that can be explained solely by that variable uncontaminated by group distributional dissimilarities. The Fairlie decomposition extends this methodology to nonlinear estimation, which I use to obtain the results in columns D through F.[33]

To calculate variable contribution, I use coefficients estimated from the pooled sample of zaibatsu and independent firms and match pairs of observations from the two groups.[34] Given the smaller number of zaibatsu firms, I take 1,000 random samples of 32 independent firms to match with the zaibatsu observations and report the average from these samples. To ease interpretation and obtain meaningful estimates from each firm group, I do not include interaction terms in the probit regression; otherwise, the specification is the same as that in column 5 from Table 3.

As shown in row 12 of column D, the difference in predicted first entry likelihoods between the two firm groups is 0.306, of which the included control variables explain 0.284 (or 93 percent). In particular, the net effect of diversification explains 0.139 (45 percent) of the total difference while non-traded ownership explains 0.054 (18 percent). Since the individually calculated differences are sensitive to the order of variables in the specification, I randomize all the independent variables to obtain the estimates given in column E, which are

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[32] See Blinder, ``Wage discrimination" and Oaxaca, ``Male-female wage."
[33] See Fairlie, ``The absence."
[34] The choice of which set of coefficients (ie, group A , B, or pooled) is arbitrary. I use coefficients from the pooled sample to maximize sample size; estimates derived from coefficients of the independent firm sample are qualitatively similar.

qualitatively similar to those in the previous column. Finally, instead of assuming a normal distribution for the data, I substitute a logit model for the probit, and obtain comparable results, shown in column F. Altogether, the Fairlie decomposition results are consistent with the hypothesis that zaibatsu possessed characteristics that appear to facilitate first entry into new industries.

VI

One interpretive concern is that while zaibatsu may have been more likely to lead entry, their absolute number of first entrants is small, bringing into question their overall impact. This observation assumes that zaibatsu and independent firms were similar when in all probability a single zaibatsu affiliate was much larger and more productive. Since this paper employs qualitative measures of industrial activity, it does not directly address this point. Nevertheless, as listed in the appendix, many industries that zaibatsu pioneered were capital-intensive or large scale, and thus out of reach for most independent investors. These industries may also have been important for production in other sectors (for example, metal mining for machine manufacture), providing an alternative means for zaibatsu to lead industrialization even with large establishment numbers or even first entry. That said, given the relatively meager number of firms and industries used in earlier studies for this time period, one of the strengths of the current dataset is its inclusion of independent firms that would otherwise have no record, thus reducing some sample bias. Furthermore, while it may be heroic to use these data for reliable point estimates of variable effects, they nevertheless serve the purpose of comparing firm activity and technology adoption via qualitative measures like entry and industry formation.

Although the main finding of this paper supports the view that zaibatsu assisted the development of industry, it also disputes the notion that they were necessarily vanguards of innovation and suggests a loss of leadership over time. What accounts for these seemingly important omissions in earlier research? Besides data unavailability, an additional explanation may lie in the emphasis on firm characteristics as opposed to industry-level determinants of performance, and inductive reasoning based on case studies. This paper itself leads with stylized facts about zaibatsu's preponderant size and resource access that were deemed critical to

innovation and industrial expansion. These identifying features, however, may be anachronistic and misleading. As mentioned in the introduction, zaibatsu were less able to attain scale economies because their holdings were so diverse. This applied especially to those zaibatsu that began in trading, shipping, and finance. Thus, additional study of inter-industry synergies and their degree of relatedness for firms in the Meiji Period may better identify firm behavior and industry activity by the stage of development.

Similarly, interfirm linkages may have been a way for independent entrepreneurs to combat conglomerate dominance or to overcome capital market deficiencies. This was the case in postwar Japan, where independent firms unable to internalize transaction costs through merger used networks to increase efficiency. This scenario may have applied to prewar Japan as well, and could be explored by expanding the current dataset into panel form. A panel dataset providing dates of ownership change or reorganization may also be useful for studying firm longevity in the Meiji Period, complementing this paper's focus on firm establishment. This would complement the emerging literature on determinants of firm survival (eg, productivity differences, trade) by including the experience of firms in developing economies as well as a historical perspective.

This paper also remains silent on two important influences: government and trade. Among other policies, the government sponsored model factories at the beginning of the Meiji Period to jump-start industrialization. As mentioned above, it later privatized these enterprises (with many purchased by zaibatsu) and indirectly supported industry through subsidies and contracts. A major impediment to assessing the government's contribution is the difficulty in disentangling direct and indirect support. Nevertheless, it may be possible to use this dataset to explore the evolution of sectors started by either the government or the private sector, comparing characteristics like rate of entry or factor intensity. One can then better judge the efficacy of state initiative during early economic development.

Not to be neglected is the international context in which Japan industrialized, considering that its rapid growth relied on technology imports and commodity exports. Using commodity trade flow and Meiji firm establishment data, one may be able to gauge the importance of trade by comparing industry growth rates based on export shares. This relationship may also help to explain the

remarkable resilience of traditional sectors that grew in tandem with the country's increasingly advanced industries.

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Table 1: Summary Statistics

	All Estab.	Zaibatsu (1st entries)	Unaffiliated (1st entries)
New JSIC4 industries	1,478	32 (12)	1,446 (97)
Innovative industries	341	24 (8)	317 (46)
Average diversification per firm		9.8	1.0
Firm ownership			
Joint-stock	1,018	6 (2)	1,012 (48)
Non-traded	166	26 (10)	140 (32)
Establishments by capital intensity			
Light	145	0 (0)	145 (31)
Heavy	103	8 (6)	95 (35)
Non-manufacturing	1,230	24 (6)	1,206 (31)

Source: see text

Table 2: Correlations

	FIRST	DIV.	NONTR.	ZAIB.	INNOV.	HEAVY
First entry	1					
Diversification	0.179*	1				
Non-traded firm	0.264*	0.261*	1			
Zaibatsu affiliation	0.172*	0.829*	0.323*	1		
Innovative JSIC4	0.200*	0.190*	0.161*	0.183*	1	
Heavy sector	0.355*	0.174*	0.190*	0.105*	0.214*	1
Light sector	0.187*	-0.046	0.167*	-0.049	0.348*	-0.098*

Significance level: *5 percent
Source: see text

Table 3: Probit Results

Dependent variable: Pr(Y=1st entry)	(1)	(2)	(3)	(4)	(5)
Diversification	0.031**	0.064*	0.197***	0.077**	0.042*
	(0.012)	(0.034)	(0.080)	(0.045)	(0.030)
Diversification^2	-0.002**	-0.005	-0.028**	-0.010	-0.005
	(0.001)	(0.003)	(0.013)	(0.007)	(0.005)
Non-traded firm	0.181***	0.193***	0.018***	0.070***	0.028
	(0.068)	(0.071)	(0.096)	(0.048)	(0.033)
Innovative industry			0.071	-0.023	-0.031**
			(0.050)	(0.021)	(0.018)
Interaction terms					
Diversification · Non-traded		-0.043	-0.008	0.025	0.031*
		(0.034)	(0.029)	(0.026)	(0.023)
Diversification · Innovative			-0.187***	-0.093**	-0.061***
			(0.090)	(0.053)	(0.037)
Diversification^2 · Non-traded		0.003	-0.000	-0.003*	-0.003**
		(0.003)	(0.003)	(0.003)	(0.002)
Diversification^2 · Innovative			0.028***	0.013*	0.007
			(0.014)	(0.008)	(0.005)
Non-traded · Innovative			-0.019	-0.005	-0.004
			(0.035)	(0.024)	(0.021)
Industry fixed effects				included	included
Time fixed effects					included
Observations	1,184	1,184	1,184	1,184	1,184
Pseudo-R^2	0.108	0.112	0.158	0.325	0.406

Significance level: *10 percent **5 percent ***1 percent
Notes: Results reported as marginal effects, with robust standard errors in parentheses and clustered by 4-digit industry.
Source: see text

Table 4: Robustness Checks

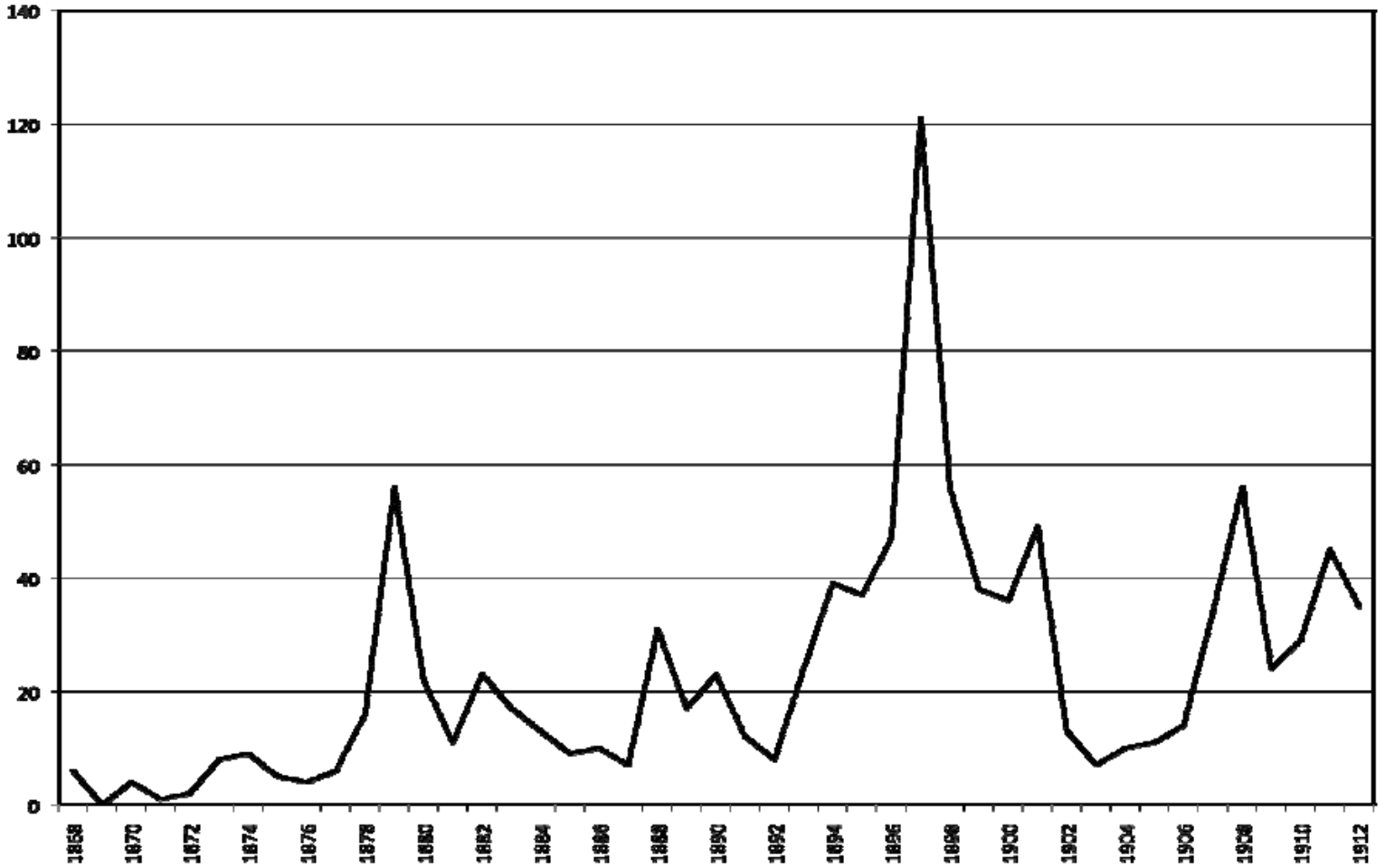
Dependent variable: Pr(Y=1st entry)	(A)	(B)	(C)	(D)	(E)	(F)
Diversification	0.414***	0.366	0.209	0.262***	0.304***	0.253***
	(0.128)	(0.271)	(0.246)	(0.087)	(0.117)	(0.088)
Diversification^2	-0.153***	0.002	0.002	-0.123***	-0.198***	-0.119***
	(0.054)	(0.006)	(0.006)	(0.036)	(0.074)	(0.042)
Non-traded firm	0.181**	0.044	-0.134	0.054*	0.039	0.055*
	(0.102)	(0.158)	(0.149)	(0.030)	(0.024)	(0.030)
Innovative industry	-0.099	0.110	-0.054	-0.086**	-0.052**	-0.095***
	(0.073)	(0.182)	(0.185)	(0.034)	(0.026)	(0.033)
Interaction terms						
Diversification · Non-traded	-0.274*	0.018	0.040			
	(0.137)	(0.554)	(0.376)			
Diversification · Innovative	-0.122	-0.391	-0.265			
	(0.120)	(0.542)	(0.256)			
Diversification^2 · Non-traded	0.153***	dropped	dropped			
	(0.053)					
Diversification^2 · Innovative	dropped	dropped	dropped			
Non-traded · Innovative	-0.062	-0.057	0.144			
	(0.063)	(0.283)	(0.270)			
Industry fixed effects	included	included	included	included	included	included
Time fixed effects	≥1876	≥1889	≥1893	included	included	included
Explained contribution/Difference				0.284/0.306	0.284/0.306	0.275/0.306
Observations	416	114	99	1,184	1,184	1,184
Pseudo-R^2	0.316	0.142	0.180	0.389	0.389	0.391

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

Notes: Results in columns A to C reported as marginal effects, with robust standard errors in parentheses and clustered by 4-digit industry. Results in columns D to F based on contributions averaged from 1,000 random samples, with standard errors in parentheses and calculated using the delta method.

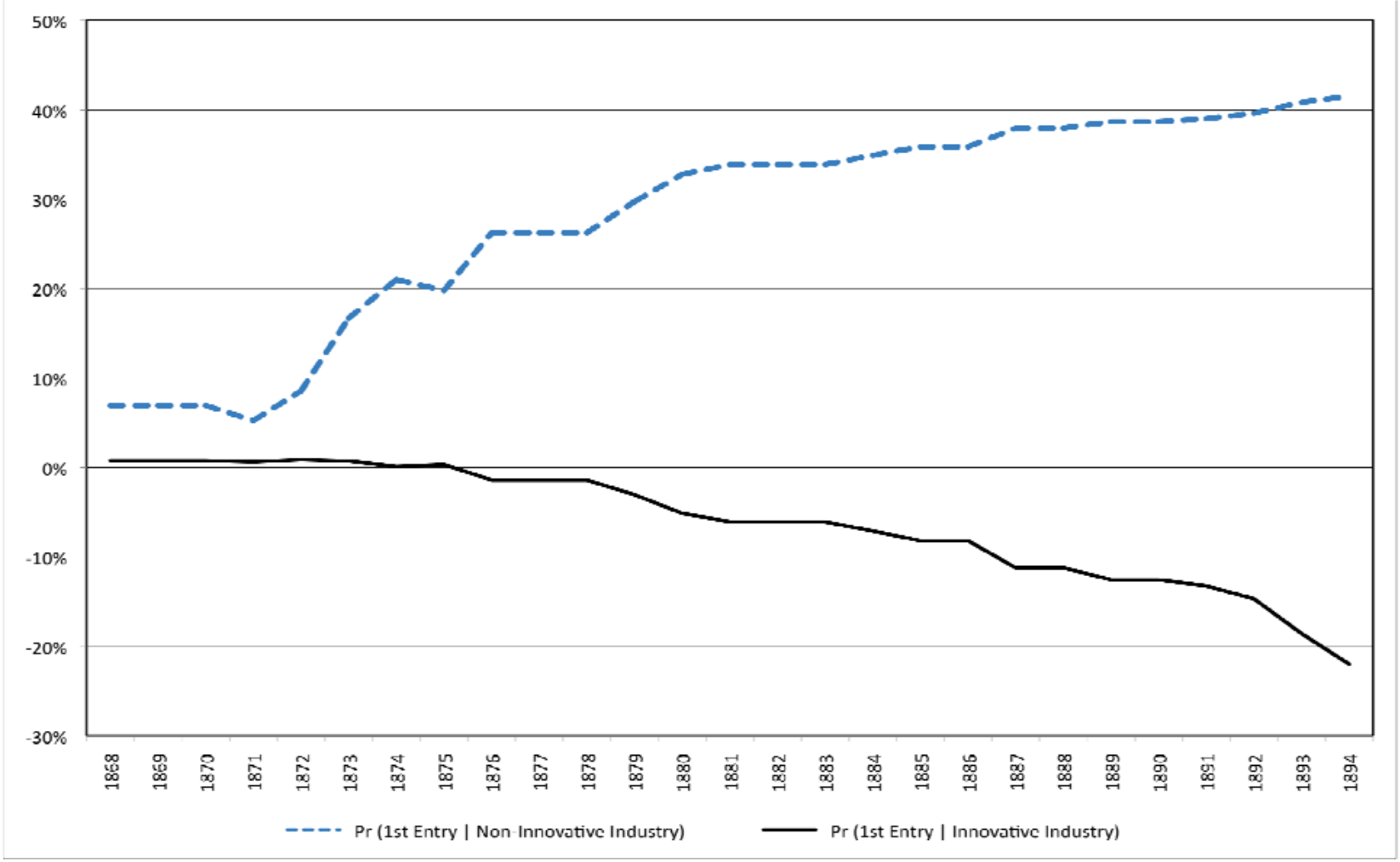
Source: see text

Figure 1: Firm startups in the Meiji Period



Source: see text

Figure 2: Relative First Entry Probabilities



Source: see text

Appendix: List of New Industries in Meiji Period

Industry Name	JSIC4	Year
Coal mining	611*^	1868
Cotton/spun rayon fabric weaving	1441*^	1868
Beer	1322	1869
Foreign exchange bank	6124*	1869
Joint-stock life insurance company	6711*	1869
Machine-reeled raw silk	1411*	1870
Glass containers	2514*	1871
Valves and fittings	2992^	1871
Fabricated pipe and fittings	2993^	1871
Ball and roller bearings	2994^	1871
Piston rings	2995*^	1871
Mold and dies, parts, and accessories	2996^	1871
Coastwise freight transport	4323*^^	1871
National railway	4011*^	1872
Postal services	4711*	1872
Water supply installation, draining work	1133*	1873
Cement	2521*^	1873
Ocean transport	4311^^	1873
Ordinary bank	6121^^	1873
Fired bricks	2551*	1875
Foreign style paper	1821	1876
Food processing machinery	2961*^	1876
General civil engineering, building works	911*	1877
Other silk reeling plant	1419^	1877
Construction and mining machinery	2931*^	1877
Spinning machinery	2951*^	1877
Wood working machinery	2962^	1877
Wool spinning mill	1423*^	1878
Rice cleaning	1261	1879
Wheat flour	1263*^	1879
Nitric, phosporitic fertilizers	2011*	1879
Credit cooperative association	6313*	1879
Joint-stock fire/marine insurance company	6721*^^	1879
Flat glass	2511	1880
Water supply	3911*^^	1880
Overseas loan and investment institution	6142*	1880
Credit association and related federation	6312^^	1880
Merchandise forwarding	4621*	1881
Commercial and industrial cooperative bank	6314	1881
Paperboard	1822	1882

Central bank	6111*^	1882
Small business finance corporation	6315	1882
Securities exchange	6631	1882
Medical product preparations	2062*	1883
Canned seafood, seaweed	1221*	1884
Manufactured ice	1341*	1884
Hemp spinning mill	1425	1884
Copper smelting and refining, primary	2711*^^	1884
Power station	3611*	1884
Soda bicarbonate	2021*	1885
Dairy products	1212*	1886
Other paper products	1849	1886
Matches	3486*^	1886
Other electricity establishment	3619	1886
Lead and zinc metal mining	522*^^	1887
Steel pipes and tubes	2644	1887
Lead pencils	3443*	1887
Postal order and transfer savings institution	6141^	1887
Crude petroleum extraction	711*	1888
Twisting yarns	1431*	1888
Paints	2054*	1888
Watches, clocks, and parts, not watchcases	3271*	1888
Other musical instruments	3429*	1888
Local railway	4021*	1888
Light vehicle passenger transport	4141*	1888
Silk spinning mill	1424	1889
Building brick	2532*	1889
Public financial institution for agriculture, forestry, and fishing	6241*^	1889
Unrefined sugar	1251	1890
Soft drinks, carbonated water	1311*	1890
Transport agency	4631*	1890
Textile sanitary fabric	1498*	1892
Machine dyed/finished silk, rayon fabrics	1462	1893
Mutual life insurance company	6712	1894
Plastics	2037*	1895
Asbestos mining	892*	1896
Sugar refining	1252	1896
Wool fabric weaving	1443	1896
Printing ink	2055	1896
Railroad cars	3121	1896

Long term credit bank	6123	1896
Development financial institution	6143	1896
Agricultural cooperative	6231*	1896
Canvas products	1593*	1897
Printing, not mimeograph	1931	1897
Synthetic dyes, organic pigments	2036	1897
Petroleum refining	2111*	1897
Wire drawing	2648	1897
Coke	2131*^^	1898
Aluminum smelting and refining, primary	2716	1899
Trust bank	6122*	1899
Basic petrol chemicals	2031	1900
Taxicab operators	4112	1900
Telephone and telegraph, not broadcast	4721*	1901
Other industrial organic chemicals	2039	1902
Motor vehicle bodies and trailers	3112	1896
Bicycles and parts	3131*	1903
Metallic springs	2892*	1904
Power and distribution transformer	3012	1904
Other stone, sand, gravel quarrying	819*	1905
Compound chemical fertilizers	2012*^^	1905
Nails	2871*	1905
Other metal smelting and refining, secondary	2729*^	1906
Electric bulbs	3031	1906
Sulphur mining	831*	1907
Distilled alcohol	1324	1907
Basic livestock feed	1352*	1907
Leather tanning, finishing	2411*	1907
Looms, knitting machinery	2952	1907
Dyeing and finishing machinery	2953	1907
Generators, motors, rotating electrical machinery	3011	1907
Tramway	4022	1907
Refrigerated warehousing	4521*	1907
Fire and marine reinsurance company	6724	1907
General sawing and planning mill	1611	1908
Rayon, acetate fiber	2041	1908
Coating metal products	2862*	1908
Medical material preparations	2061	1910
Call loan and bill brokerage, not securities	6411	1909
Pastries, cakes	1272	1910

Other fabric weaving	1449	1910
Compressed, liquefied gases	2024	1910
Soaps and synthetic detergents	2052	1910
Internal combustion engine	2913*^^	1910
Other chemical fertilizer mining	839	1911
Organic fertilizer	1353	1912
Other industrial inorganic chemicals	2029	1912
Fatty acids, hydrogenated oils, glycerin	2051	1912
Ferro-alloys	2623	1912

*: innovative industry
^: government pioneered
^^: zaibatsu pioneered

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