Factory Productivity and the Concession System of Incorporation in Late Imperial Russia

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Abstract

In late Imperial Russia, commercial credit was scarce, and because the Empire had no general incorporation law, all firms wishing to incorporate needed to obtain the Tsar's signature on their charters, a time-consuming and expensive process. Yet, over four thousand firms incorporated between 1700 and 1914. I identify the characteristics of firms choosing to incorporate and measure the gains to productivity and growth in machine power enjoyed by corporations from a novel panel database of manufacturing enterprises I compiled from Imperial Russian factory censuses conducted in 1894, 1900, and 1908. In the cross section, factories owned by corporations have higher average revenue, bigger machines, and more workers. While the distribution of TFP for partnerships and single proprietorships has a long lower tail, the distribution for corporations does not. Factories that incorporate next period have higher average revenue per worker but not larger machines. After incorporating, however, factories have higher average revenue per worker and larger machines, suggesting the importance of incorporation for capital accumulation.

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1 Introduction

When credit markets are imperfect, the access to capital markets provided by incorporation could be a crucial prerequisite for productivity-enhancing investments. In late Imperial Russia, commercial credit was scarce. Because the Empire had no general incorporation law, all firms wishing to incorporate needed to obtain the Tsar's signature on their charters, a time-consuming and expensive process. Yet, over four thousand firms incorporated between 1700 and 1914. In this paper, I identify the characteristics of corporation-owned factories and argue that incorporation in the Russian Empire was motivated by scarcity of other sources of capital. These results come from a novel panel database of manufacturing enterprises I compiled from Imperial Russian factory censuses conducted in 1894, 1900, and 1908, the first large-scale effort to digitize these sources.

Since incorporation is endogenous, cross-sectional differences between corporation-owned factories and partnership-owned or single-proprietorship-owned factories embody both the patterns driving selection into incorporation and the returns to incorporation. I will not attempt to deal with this endogeneity by instrumenting for incorporation. Instead, I describe a model of incorporation and argue that the cross-sectional results are consistent with this model. To separate the characteristics that drive selection into incorporation from the benefits gained by incorporating, I take advantage of the fact that some factories become corporations within the sample frame and that many factories survive more than one period, allowing me to compare growth by factories owned by corporations with other factories.

By the early twentieth century, Russia had become very poor compared to its Western European neighbors: Russian per capita income in 1912 was less than a third of that in

Germany in 1905.[1] At the beginning of the First World War, the Russian economy remained mostly agricultural: according to Goldsmith's estimates, as late as 1913 about two thirds of Russia's population was engaged in agriculture, and agriculture accounted for almost half of national income.[2] Gerschenkron argued that a major obstacle to Russian industrialization was the country's extreme scarcity of capital and bank credit. According to Gerschenkron, "the scarcity of capital in Russia was such that no banking system could conceivably succeed in attracting sufficient funds to finance a large-scale industrialization; the standards of honesty in business were so disastrously low, the general distrust of the public so great, that no bank could have hoped to attract even such small capital funds as were available."[3]

On the other hand, by the early twentieth century the Russian economy was growing rapidly: Russian pig iron output more than quadrupled from 930,000 to 4,030,000 tons, coal output also more than quadrupled from 6,015,000 to 25,000,000 tons, and cotton consumption more than tripled from 136,000 to 424,000 tons between 1890 and 1910.[4] Russian GNP almost doubled between 1890 and 1914 and grew at an average annual rate of 2.1 percent; French GNP grew at an average annual rate of 1.37 percent, German at 1.05 percent, and U.S. at 1.62 percent.[5] Two aspects of the Russian economy discussed in this paper may

[1]Paul R. Gregory. "Some Empirical Comments on the Theory of Relative Backwardness: the Russian Case." (Economic Development and Cultural Change 22.4 1974), 658.

[2]Raymond W. Goldsmith. "The Economic Growth of Tsarist Russia 1860-1913. *Economic Growth and Social Change* (Vol. 9 No. 3 April 1961), 442. According to Gregory (1974), Russia's manufacturing divided by GNP was about 18 in 1912, while the U.S.'s in 1909 was 19, France's on average between 1896 and 1929 was 35, and Germany's in 1905 was 33; Russia lagged behind the U.S. and Western Europe in the proportion of GNP accounted for by manufacturing.

[3]Alexander Gerschenkron. *Economic Backwardness in Historical Perspective: A Book of Essays.* (Cambridge: Belknap Press, 1962), 20.

[4]Arcadius Kahan. Russian Economic History: The Nineteenth Century (Chicago: University of Chicago Press, 1989), 60.

[5]From Angus Maddison's estimates. Available: http://www.ggdc.net/maddison/maddison-project/data.htm.

explain some of this rapid growth: the number of corporations in this period expanded greatly, and factories owned by corporations outperformed other factories.

This paper contributes to the growing literature in economics that studies firms in developing countries by highlighting a possible role that enterprise form can play in explaining variation in factory productivity. Hsieh and Klenow (2009) argue that the misallocation of inputs between efficient and inefficient firms explains a great deal of output per worker difference between China or India and the United States. To motivate their argument, they point out that the distribution of total factor productivity in developing countries has a long lower tail, while the distribution in developed economies like the United States does not. One explanation of this difference in firm productivity in developing and developed countries, according to Bloom and Van Reenan (2007 and 2010), is that management practices vary more widely in developing countries. In the Russian Empire, incorporation was key to gaining access to foreign and domestic sources of capital, which I argue explains the differences in the distributions of productivity between factories owned by corporations and other establishments.

The results of this paper also relate to a literature in economics that studies how a country's legal institutions, in this case the available menu of enterprise forms, influence economic development by highlighting the relationship between enterprise form and factory productivity. La Porta et al (1998) argue that some laws are positively related to financial market outcomes, using common law as an instrument for a set of beneficial rules, but Guinnane et al (2007) point out that civil law systems tended to offer a more flexible menu of enterprise forms. They consider the cases of the United States, Britain, Germany, and France and argue that most small and medium-sized enterprises organized not as corporations

but as Private Limited Liability Companies, a form more commonly available in civil law countries, whenever possible. Their work relies on examples of developed economies and does not directly relate enterprise form law to firm outcomes. Owen (1991) and Kuran (2003 and 2005) argue that difficulty of incorporation contributed to economic stagnation in the Russian Empire and the Ottoman Empire respectively, but these studies make no explicit connection between enterprise form and firm performance.

Finally, the subject of factory performance in the Russian Empire has provoked little study despite the large amount of interest in Russian economic history in general.[6] Many economists have taken an interest in Russia because of its important standing in the past and present world economy and because of its long and varied history of economic reforms. Gerschenkron (1962) described the Russian economy as "backward," and he argued that the state substituted for lack of domestic demand for manufactured products. Kahan (1989) was less optimistic about the impact of government policies, which often contradicted one another. Others have compared the performance of the Russian Empire to that of the Soviet Union. Gregory's (1982) revised estimates of Russian net national product show that the Russian Empire grew at a rate higher than was previously believed, but Allen (2009) doubts that the Russian Empire could have ever industrialized as extensively as the Soviet Union. Recent work by Steven Nafziger (2010) and Tracy Dennison (2011) has described Russian agricultural institutions in detail and adds to what we know about the largest sector of the Russian economy. None of these studies has made extensive use of Russian manufacturing censuses or documented the performance of individual enterprises in the Russian Empire.

[6]The classic work on Imperial Russian factories is M.I. Tugan-Baranovsky's *The Russian Factory in the Nineteenth Century* (*Russkaia fabrika v proshlom i nastoiashchem*), first published in 1907. I provide a reference for an English translation in the References section.

The main results of the paper are that total factor productivity drives incorporation, and once incorporated, firms use their new access to capital markets to make productivity-enhancing investments in the form of added machine power. The paper proceeds as follows: In Section 2, I explain the menu of enterprise forms available to firms in the Russian Empire and explain the concession system of incorporation. Section 3 provides a description of the data on manufacturing establishments in the Russian Empire. Sections 4 and 5 describe hypotheses and results. Section 6 addresses several possible concerns with the interpretation of the results, and Section 7 concludes.

2 Background: Corporations in the Russian Empire

Businesses in the Russian Empire chose among a limited menu of enterprise forms. Entrepreneurs could organize their operations as a single proprietorship, a partnership, a limited partnership, or a corporation. Under each of these forms, Russian businesses possessed a set of privileges and limitations.

Table 1 shows the differences between corporations and all other enterprise forms in the Russian Empire. The Law of 1807 described three enterprise forms: the simple partnership (*tovarishchestvo polnoe*, lit. "full partnership") the limited partnership (*tovarishchestvo na vere*, lit. "partnership on trust"), and the corporation (*tovarishchestvo po uchastkam*, lit. "partnership in shares"). Simple partnerships consisted of two or more unlimitedly liable partners. Limited partnerships consisted of one or more unlimitedly liable partners with the addition of one or more investors (*vkladchiki*) who had limited liability. Under limited liability, an investor is only accountable for the amount invested; creditors can pursue unlimitedly

liable parties for their personal property. Simple partnerships and limited partnerships were often collectively referred to as "trading houses" (*torgoviie doma*).[7] According to the Law of 1807, full and limited partnerships are formed by signing a private contract among individuals. To formally establish the partnership, the partners needed to present their contract to a municipal clerk.[8]

Corporations, by contrast, shielded all investors from liability beyond the amount of their investments and could issue stock to be traded on domestic and international stock exchanges. The Imperial government only granted this special privilege of complete limited liability to firms that had obtained permission from the Ministry of Finance. Specifically, the law allows the founding of "joint-stock companies, which consist of many persons,investing pre-defined amounts, which come together as one store of capital."[9] However, according to the law, "such kinds of companies command such importance to the national economy, that they may only be founded with our permission."[10]

In other words, there was no general incorporation in the Russian Empire. Under a general incorporation system, any company meeting a limited set of requirements designated by law can incorporate through an inexpensive registration process. In the Russian Empire, firms wishing to incorporate submitted charters to the Ministry of Finance and agreed to any

[7]V. I Bovykin. *Formirovanie finansovogo kapitala v Rossii: konets XIX v. – 1908 g.* (Moscow: Nauka, 1984), 111.

[8]Thomas Owen. *The Corporation under Russian Law.* (Cambridge: Cambridge University Press, 1991), 11, and confirmed by archival evidence in, for example, the Russian State Historical Archive Collection 23, Inventory 11, File 794.

Company law in other countries specifies roles for managers vs. owners, but by my reading, Imperial Russian company law is largely silent on this issue.

[9]Polnoe Sobraniie Zakonov (Complete Collection of Laws) I-22418, Ot. 1, Ct. 1: "Сверхъ того бываетъ товарищесво по участкамъ, которое слагается изъ многихъ лицъ, складывающихъ во едино определенныя суммы, коихъ извесное число даетъ складочный капиталъ."

[10]Polnoe Sobraniie Zakonov (Complete Collection of Laws) I-22418, Ot. 1, Ct. 1: "Но какъ цель онаго служитъ важнымъ видамъ Государственнаго хозяйства, то сего рода компанія учреждается съ Нашего утвержденія..."

changes requested. In the end, if the firm satisfied the Ministry's demands, the Tsar signed the charter, which gave the document power as an independent piece of law and certified that the firm was now a corporation. Thus, there were significant legal differences between single proprietorships or partnerships and corporations. Given these legal restrictions, why did firms incorporate? One explanation is that corporations took advantage of limited liability and access to stock exchanges to raise capital, buy newer or better machines, and substitute capital for labor while increasing output. It is also possible, however, that founders of corporations took advantage of access to government officials to obtain special privileges and hoard capital, make unwise investments and shirk liability, or capture monopoly rents. The connection between legal form of organization and firm performance in any setting is an open question for research.

Despite the many legal obstacles facing firms wishing to incorporate, several thousand firms managed to incorporate in the history of the Russian Empire. Tables 2 through 4 present information from the RUSCORP Database (Owen 1992) showing how many firms incorporated over time and incorporations by industry. Table 2 shows how the number of incorporations in the Russian Empire increased at the end of the nineteenth century and beginning of the twentieth century. By 1894, 1437 firms passed corporate charters through the Ministry of Finance, but by 1908, over 3000 had successfully incorporated.

Tables 3 and 4 show how incorporation was distributed by industry. Over the entire period, the manufacturing sector accounted for a majority of incorporations. Within manufacturing, metals and machines, foods, chemicals, and textiles attracted the most incorporations. Some industries like foods were simply much larger in terms of the overall number of firms, so it is no surprise that the foods industry attracted a large number of incorporations.

In general, however, firms tended to incorporate in capital-intensive industries like textiles and metals. Descriptive statistics from the data on manufacturing establishments presented later in the paper will confirm this pattern.

3 Data

This paper's main data source is a new database of manufacturing establishments in the Russian Empire, which I collected from the Imperial Russian censuses of manufacturers of 1894, 1900, and 1908. While the Russian Empire conducted many surveys of factories, each for specific purposes, these three present the richest data with the widest coverage.[11] Most importantly, they each report data for individual factories with the factory's name, which allows me to identify each factory's enterprise form. In the following sections, I describe the construction of the database of manufacturers and the procedures used to identify factories belonging to corporations.

3.1 The Manufacturing Censuses

I digitize data on manufacturers in the Russian Empire from several published and archival sources including census manuscripts, published factory-level volumes, and published aggregate volumes. From the available factory-level data, I construct stratified samples and match factories across years.

[11] Other country-wide data on factories in the Russian Empire include factory lists published in 1910 and 1914-1915, but these volumes have very few variables for each factory. The Ministry of Finance Department of Trade and Manufacture conducted several smaller surveys of factories, the manuscripts from some of which can be found in the Russian State Historical Archive. These smaller surveys have much smaller geographic coverage and include very few variables, sometimes even excluding any measure of output. Another source for factory data comes from provincial zemstva, which conducted their own factory surveys. The Vladimir and Moscow zemstva seemed to be particularly active in conducting factory surveys.

Table 5 shows the number of factories in each census and each sample, and Table 6 shows the available variables for each census year. The 1894 census describes approximately nineteen thousand factories in the Russian Empire, the 1900 describes about twelve thousand factories (fifteen thousand including factories not described in the aggregate volume) in European Russia, and the 1908 census describes about eighteen thousand factories in the Russian Empire.

For the 1894 census, the government published a factory-level volume describing the over nineteen thousand factories surveyed. This volume lists for each factory a description of what the factory produced; the factory's name and street address; total value of production in rubles; values of each kind of fuel; type, number, and horsepower of machines; number of adult, adolescent, and younger men and women; and number of working days per year. The Russian State Historical Archive holds approximately fifteen hundred of the original completed factory questionnaires, from which I collect total value of materials and working hours. It seems that the archivists chose to keep the manuscripts for only certain industries in certain provinces, but that when they did so, they kept almost every questionnaire for factories in that group. The 1900 and 1908 censuses, on the other hand, have factory-level volumes which list a few variables for each individual factory but also have aggregate volumes that list a large number of variables by finely-defined industries and by province. The 1900 factory-level volume lists each factory's name, street address, industry, total value of production, and total number of workers; the 1908 volume also lists types and total horsepower of machines. From the aggregate volumes, I collect total value of materials.[12]

[12]The only census manuscripts for these surveys that I have been been able to locate are the 1894 manuscripts located in the Russian State Historical Archive. I have been unable to locate manuscripts for 1900 or 1908 surveys despite my best efforts. I believe that the archives disposed of these manuscripts

Figure 1 shows an example from the 1900 factory list that describes two factories owned by the same firm, the Einem candy company. The entry for the first factory shows that the factory is a bakery; was founded in 1867; operates in Moscow in the Tverskaia section; produces cookies, cakes, pies, and ice cream; has a total yearly output of 98,300 rubles and has 27 workers. Entries from the 1908 factory list have a similar appearance but include information on each factory's machines. The 1894 factory list presents information in large tables.

The Ministry of Finance released the most detailed information for the largest number of factories for the 1900 census. Out of the twelve thousand factories in the 1900 census, I construct a sample of five thousand factories. The sampling scheme stratifies by province-industry groups in 1900 and over-samples Moscow and St. Petersburg to capture more of the relatively rare corporation-owned factories. I use these weights to construct a sample of five thousand factories from 1894, 1900, and 1908. Then, I match the factories sampled in 1894 forward to their record in 1900 and match factories sampled in 1900 forward to their record in 1908. Finally, I match all 1900 factories to their corresponding province-industry groups in the aggregate volumes.

3.2 Identifying Corporations

To study enterprise forms in Russia, I must identify which establishments belong to corporations. Thankfully, the factory lists include the complete name of each factory, and the Ministry of Finance required corporations to include the word "corporation" in their firm

since there were official publications of factory-level information, though the original surveys would have provided much more detailed information about each factory.

name. I identify corporations using the RUSCORP Database, which contains information on all corporations founded in the Russian Empire. I match the establishments in all three years of factory-level data to the corporations in RUSCORP by name, location, and industry. Table 5 shows many establishments I identify in each year as belonging to corporations and, of those, how many belong to distinct corporations. The number of corporation-owned factories I identify increases over time, which is consistent with the information presented in Table 2, which shows that the number of incorporations increases over time as well.

In the RUSCORP Codebook, Owen points out that the factory lists do not necessary show the name under which the firm incorporated, so it is likely I will never be able to identify certain factories that belong to corporations.[13] This only introduces a positive bias in the results I observe if the factories I fail to match to RUSCORP are significantly smaller than the factories I am able to match. It seems more likely, however, that I fail to match some corporations that have similar characteristics to the ones I identify, thus inducing a negative bias by making single-proprietorships and partnership-owned factories look larger and more productive. Additional data, for example a list of all corporation-owned manufacturers in existence in each factory survey year with descriptions of products, would allow me to test this argument.

[13]Thomas C. Owen. Codebook for RUSCORP: A Database of Corporations in the Russian Empire, 1700-1914. Third Release. (Baton Rouge, LA, 1992 [Producer]. Ann Arbor: Inter-university Consortium for Political and Social Research, 1992 [Distributor]), 41.

4 A Model of Incorporation

This paper considers the relationship between enterprise form, credit constraints, and productivity in the Russian Empire. In late Imperial Russia, where incorporation was costly and where firms were most likely credit constrained, enterprise form could have been crucial for predicting firm performance. Since borrowing was difficult, firms wishing to expand chose to incorporate to take advantage of limited liability and to gain access to stock markets in Moscow, St. Petersburg, Kiev, and foreign cities.

Consider the following simple model of a firm's decision to incorporate. Suppose that, each period, firms receive information about their performance in the form of total factor productivity (TFP) shocks. If there is some serial correlation among these shocks, a shock in the current period is also an indicator of the firm's future performance. Suppose that incorporation gives firms access to lower investment costs but that incorporation requires a fixed cost, F. If the firm shuts down, its owners receive some scrap value. If a firm receives a low enough productivity shock, a signal of poor performance, it should shuts down to obtain the scrap value rather than pay any fixed costs of remaining in operation. Similarly, if the firm receives a high enough productivity shock, a signal of good performance, it will incorporate to take advantage of low investment costs and expand.[14] Figure 2 shows the options available to firms. Firms can enter as corporations or partnerships (including single proprietorships), remain in business as corporations or partnerships, or exit as corporations or partnerships. Partnerships have an additional option: they can incorporate. Corporations

[14]The inspiration for this narrative comes from Olley and Pakes (1996) and Ericson and Pakes (1995). These papers introduce a dynamic model that generates cutoff value for TFP below which firms exit.

cannot change form and become partnerships, a restriction that seems to be supported by the data.

If this model correctly describes a firm's incorporation decision, in the cross section, several differences should be apparent between factories owned by corporations and factories owned by other enterprise forms. If incorporation is key to expansion, corporations should on average be larger, both in terms of total sales and number of workers. Also, if incorporation is helpful for firms wishing to make large capital investments, factories owned by corporations should have more and more powerful machines. Finally, I expect corporation-owned factories to have higher productivity than other factories, both because TFP determines which factories select into incorporation in the first place and incorporation allows factories to make productivity-enhancing investment.

The theory also carries predictions about how factories change over time. Since I predict that TFP is the main signal driving firms to choose to incorporate, firms that will incorporate in the next period should have higher TFP relative to other factories. Furthermore, these factories may be larger than the average factory, but they need not be more mechanized given their size than other factories, so these factories should not necessarily have more machines per worker than other factories. Finally, corporation-owned factories should grow faster on average than other kinds of factories, especially in terms of machine power.

I estimate TFP two ways: as revenue per worker and as the residual of a log Cobb-Douglass gross revenue production function of the form:

$$r_{ijt} = \beta^L l_{ijt} + \beta^K k_{ijt} + \sum_p \gamma^p 1_p + u_j + v_t + \epsilon_{ijt} \quad [5]$$

In this equation, for factory i, industry j, and year t, l_{ijt} is the log total number of workers, k_{ijt} is the log total machine power (in units of horsepower), and r_{ijt} is the natural log of the factory's total annual revenue, measured in Rubles. The variables u_j and v_t control for industry and year, respectively, and the $\sum_p \gamma^p 1_p$ represents controls for each province.

If firms select into incorporation based on information about their total factor productivity, then in pooled OLS, the distribution of residuals from this regression should be differently-shaped for factories owned by corporations. I also directly estimate:

$$r_{ijt} = \beta^L l_{ijt} + \beta^K k_{ijt} + \beta^C Corp_{ijt} + \textstyle\sum_p \gamma^p 1_p + u_j + v_t + \epsilon_{ijt} \text{ [6]}$$

In this equation, $Corp_{ijt} = 1$ when factory i is owned by a corporation. Here, incorporation enters the regression like a factor of production. To see how incorporation interacts with additional labor and capital, I estimate:

$$r_{ijt} = \beta^L l_{ijt} + \beta^K k_{ijt} + \beta^C Corp_{ijt} + \gamma^{lC} Corp_{ijt} * l_{ijt} + \gamma^{kC} Corp_{ijt} * k_{ijt}$$

$$+ \textstyle\sum_p \gamma^p 1_p + u_j + v_t + \epsilon_{ijt} \text{ [7]}$$

Finally, I estimate TFP as log revenue per worker $\ln(R_{ijt}/L_{ijt})$. I plot kernel densities and also estimate:

$$\ln(R_{ijt}/L_{ijt}) = \beta^L l_{ijt} + \beta^K k_{ijt} + \beta^C Corp_{ijt} + \textstyle\sum_p \gamma^p 1_p + u_j + v_t + \epsilon_{ijt} \text{ [8], and}$$

$$\ln(R_{ijt}/L_{ijt}) = \beta^L l_{ijt} + \beta^K k_{ijt} + \beta^C Corp_{ijt} + \gamma^{lC} Corp_{ijt} * l_{ijt} + \gamma^{kC} Corp_{ijt} * k_{ijt}$$

$$+ \textstyle\sum_p \gamma^p 1_p + u_j + v_t + \epsilon_{ijt} \text{ [9]}$$

In these regressions, the model predicts that in the cross section, I should find $\beta^c > 0$.

5 Results

Descriptive statistics and production function estimation show that, in the cross section, factories in the Russian Empire owned by corporations have higher average revenue, bigger machines, and more workers. Furthermore, while the distribution of TFP for partnerships and single proprietorships has a long lower tail, the distribution for corporations does not. Quantile regressions shows that this effect is greater towards the top of the distribution.

It is possible to forecast which factories will become corporations in the next period: factories that incorporate next period have higher average revenue per worker but not larger machines. After incorporating, however, factories have higher average revenue per worker and larger machines, suggesting the importance of incorporation for capital accumulation. This result is supported by examining factory growth across periods: factories owned by corporations add revenue and machine power faster than other kinds of factories.

5.1 Descriptive Statistics

Table 7 gives some information on how corporations are distributed by industry in the data and how that distribution changes over time. Chemicals, Cotton, and Metals and Machines are the industries with the largest percentage of enterprises that are corporation and the highest percentage of output from corporations. This is a similar result to what is shown in Table 4, which breaks down incorporations by industry. In almost every category, the percentage of enterprises that are corporations and the percentage of output produced by corporate factories increase over time, evidence that corporation-owned factories accounted for some significant share of Imperial Russia's rapid industrial growth in this period.

Table 8 shows descriptive statistics for all enterprises, corporation-owned factories, and other factories in the Russian Empire over all three sample years. There are striking differences between corporations and other factories. Mean and median revenue, number of workers, total machine power, and factory age are larger for factories owned by corporations, and these differences are highly statistically significant. Revenue per worker, a measure of total factor productivity, is also larger for corporation-owned factories: the p-value for a two-tailed two-group mean comparison t-test comparing mean revenue per worker for corporation-owned factories to that of other factories is smaller than .01. Power per worker is larger for corporation-owned factories, but the difference is not statistically significant (the t-score is only .8010). These results are similar for the weighted means and standard deviations. Figure 3 plots kernel densities of log revenue and log revenue per worker for factories owned by corporations vs. other factories: the distributions for corporation-owned factories sit to the right of those for other factories.

The cotton industry deserves special examination. Cotton production is capital-intensive, which makes incorporation particularly vital for firm expansion, and as shown in Table 7, the cotton industry has the largest proportion of corporation-owned factories. Table 9 shows that corporation-owned cotton factories had greater revenue, workers, total machine power, revenue per worker, and machine power per workers and that these differences are statistically significant (the smallest t-score from a two-group mean comparison test for any of these variables is 5). These results are similar for the weighted means and standard deviations.

5.2 Production Functions

Tables 10 and 11 shows estimates for log Cobb Douglas gross revenue production functions in the cross section using pooled OLS. To account for correlation among factories within sampling cells, standard errors are clustered by region-industry-year groups (the sampling cells). Columns 1, 2, and 3 shows estimates for Equation 5. Column 1 omits any measure of capital and does not include industry, year, or province controls. The coefficient on labor is very close to one, which is what we would expect for constant returns to scale. Column 2 introduces the industry, year, and province controls, and the coefficient grows slightly in magnitude, though the standard error also increases. Column 3 excludes 1900, because the 1900 factory-level volume does not include a capital measure for individual factories. The coefficients on labor, measured as total number of workers, and capital, measured as total machine power, add up to a bit more than 1 in Column 3, which is consistent with production with just slightly increasing returns to scale.

Columns 4 and 5 present estimates Equation 6, with and without the capital measure, which adds a dummy that equals one when the factory is owned by a corporation. In both of these columns, the coefficient on $Corp$ is positive, which means that corporation-owned factories have higher revenue than factories not owned by corporations, even when controlling for total number of workers and total machine power (though the p-value for the coefficient on $Corp$ in Column 5 is just above .05).

Corporations, then, have a different production process than other kinds of factories. How does enterprise form interact with labor and capital? Columns 6 and 7 estimate Equation 7, which includes these interaction terms. The interaction terms are negative (though

only the corporation-capital interaction term is statistically significant in Column 7), which means that for corporation-owned factories, adding more workers or capital does not increase revenue. This suggests that corporation-owned factories are already operating at an optimal scale: expansion is not profitable at this point. Finally, because total revenue is at least zero, I present a Tobit regression in Column 8, and the results are similar as for pooled OLS.

In Figure 4, I have plotted kernel density estimates for the residuals of Columns 1 and 2 from Table 11 for factories owned by corporations versus other kinds of factories.[15] The residuals of these regressions can be interpreted as a measure of total factor productivity. Some interesting differences in the shapes of the distributions are apparent. In this first figure, the distribution for corporations is clearly shifted to the right, stands tighter about the median, and lacks the long lower tail of unproductive firms shown in the distribution for other factories. The p-value of a Kolmogorov-Smirnov test[16] for equality of distributions has a p-value of approximately zero: we can reject that the residuals for corporation-owned factories and non-corporation owned factories have the same distributions. The second figure is from a regression which includes the measure of machine power. The difference in shapes is much reduced, which makes sense if the corporation effect acts mainly through machines, though the distribution for corporation-owned factories lacks some of the lower tail of the non-corporation-owned factories' distribution. The p-value of a Kolmogorov-Smirnov test for equality of distributions, though, has a p-value of .04: we can reject that the residuals for corporation-owned factories and non-corporation owned factories have the same distributions at the .05 level. Below these densities appear cumulative densities, which highlight the

[15]These kernel densities, and all others used in the paper, use Gaussian kernels with Stata's optimal bandwidths.

[16]I use Stata's built-in two-sample Kolmogorov-Smirnov test.

differences in the distributions: the distributions for corporation-owned factories have much more positive mass.

Table 14, row groups [1] and [2] show summary statistics for these residuals. Row group [1] shows the statistics for residuals from Column 2 of Table 10, and row [2] shows the statistics for the residuals for Column 3 of Table 10. A two-group mean comparison test for the first set of residuals has a t-score with an absolute value of 10.99, while the t-score of the residuals is much smaller (1.14). Thus, much of the difference in the residuals between corporation-owned factories and non-corporation-owned factories in Column 2 of Table 10 was really a difference in machine power.

Table 11 presents the same results as shown in Table 10, though with weighted regressions. The results are similar to those presented in Table 10, though the coefficient for corporation-owned factories loses significance in Columns 4 and 5. The coefficient regains statistical significance when the capital-corporation interaction term is included in Column 6.

As mentioned previously, perhaps the most corporate industry in the Russian Empire was the cotton industry. Table 12 presents weighted regressions for factories in the cotton industry alone. Here, in Column 2, the coefficient on Corporation is again positive and significant. How does the value of this coefficient in similar regressions vary by industry? See the first column of Table 18. In the most capital intensive industries (Cotton, Metals and Machines, Paper, Wool), the coefficient on Corporation in a weighted regression of the form of Table 11 Column 3 is positive and significant. In other, less capital-intensive industries, the coefficient is not significant and is sometimes even negative.

5.3 Translog Production Functions

Tables 10, 11, and 12 report estimates from log Cobb Douglas production functions. Table 13 considers a more flexible more, the translog Cobb Douglas production function, which allows for interactions among the labor and capital measures. The general form of a translog production function is:

$$log(Revenue_{ijk}) = \alpha + \beta_L log(Workers) + \beta_K log(Power) + \beta_{LL} log(Workers)^2$$

$$+\beta_{KK} log(Power)^2 + \beta_{LK} log(Workers) log(Power) \text{ [10]}$$

Table 13 presents results from estimating this translog form of the production function. Columns 1 and 2 present estimates of the translog form without including a dummy variable for whether the factory is owned by a corporation or not. In these regressions, the labor squared coefficient is negative but statistically very small. In Column 3, I run the same regression as presented in Column 2 but without Industry, Year, and Province dummies: the coefficient on machine power is now much larger and statistically significant: the controls absorb much of the variance across factories.

Beginning in Column 4 of Table 13, I include a dummy variable for whether a factory is owned by a corporation. In general, the coefficient is positive and statistically significant. Significance is lost in Column 6 when I include an interaction term for whether a factory is corporation-owned and the number of workers, though the corporation dummy is again significant in Columns 7, 9, and 10 when additional controls are included. In Columns 9 and 10, I include interactions between certain variables and a dummy variable for the year 1894. The coefficient on $Workers * \mathbf{1}_{Year=1894}$ is positive and statistically significant though small in magnitude: having more workers had some additional effect on revenue in 1894.

Figure 4 shows kernel density estimates for the residuals of Columns 1 and 2 for factories owned by corporations and factories owned by other kinds of firms. As in the regressions using the Cobb-Douglas form, the different is more pronounced without controls for total machine power. For both sets of distributions, the p-value of a Kolmogorov-Smirnov test comparing distributions for corporation-owned factories and non-corporation-owned factories is approximately zero. The cumulative distributions make the differences between corporation-owned factories and other factories even more apparent.

Table 14, row groups [3] and [4] show summary statistics for these residuals. Row group [1] shows the statistics for residuals from Column 1 of Table 13, and row group [2] shows the statistics for the residuals for Column 2 of Table 13. A two-group mean comparison test for the first set of residuals has a t-score with an absolute value of 11.40, while the t-score of the residuals is much smaller, though the difference in means is still statistically significant (the t-score is 2.89). Thus, when a translog specification is used, though much of the difference in the residuals between corporation-owned factories and non-corporation-owned factories comes through machine power, a significant difference still remains.

5.4 Determinants of Revenue per Worker

Tables 15 and 16 show results for estimating Equations 8 and 9. In Columns 1 and 2, we see that total factor productivity as measured as revenue per worker is increasing in firm scale, though in Column 2, it is decreasing in number of workers when we control for total machine power. In Columns 3 through 5, the coefficient on the enterprise form dummy is positive: corporation-owned factories have higher total factor productivity than other factories on

average. The interaction terms are negative and statistically significant, as they were in the production functions. Finally, because there are a large number of zeros in the Total Workers and Total Power variables,[17] I present a Tobit regression in Column 6, and the results are similar as for pooled OLS. In the weighted regressions in Table 14, the results are similar, though some coefficients lose statistical significance.

Table 18 Column 2 shows how the Corporation coefficient of a weighted regression of the form of Column 3 varies by industry. The pattern is the same as that found in the previous section: in the capital-intensive industries (bolded), the coefficient is positive and statistically significant.

5.5 Calculating Productivity by Imposing Shares

In all production functions estimated so far in the paper, the coefficient on labor is rather large, and the coefficient on machine power is rather small. As a general rule, one expects the coefficient on labor to be about .7 and the coefficient on a capital measure to be about .3. Another way to calculate total factor productivity is to impose these shares in a Cobb-Douglas production function and estimate total factor productivity as:

$$TFP_{ijk} = \left(\frac{Rev_{ijk}}{L_{ijk}}\right)^{.7} \left(\frac{Rev_{ijk}}{K_{ijk}}\right)^{.3} \text{ [11]}$$

In Table 17, I show estimates in which I regress this measure of total factor productivity on similar variables as I did in Tables 15 and 16. Column 1 regresses total factor productivity on a dummy variable for corporation-owned factories alone. The coefficient is positive and

[17] Some factories have no workers, and a large number of factories have no machines.

statistically significant at the .001 level. In the other columns, the coefficient on *Corp* is statistically significant when I control for interactions between form and workers and capital.

5.6 Quantile Regressions

From the previous exercises, we know that corporation-owned factories tend to be bigger than other kinds of factories. Whether a factory is owned by a corporation, then, should be most relevant at higher quantiles of log Revenue. Quantile regressions presented in Table 19 largely confirm this prediction: the table shows how the coefficient on Corporation predicts several quantiles of log Revenue. At low quantiles, once machine power is controlled for, the coefficient on Corporation is small and generally not statistically significant, because the quantile increases, we see that the corporation coefficient becomes large and significant, and the effect is largest in the cotton industry.[18]

5.7 Characteristics of Factories That Become Corporations

Within the sample, I was able to identify several dozen factories that become corporation-owned factories in the next period. Since some partnerships completely change their name once incorporated and because many corporations are de novo enterprises, the number of such factories that I was able to identify by matching to the names of corporations in RUSCORP is small. In 1894, I found 66 partnership-owned establishments that become corporation-owned factories in 1900, and in 1900, I found 57 partnership-owned factories that become corporation-owned in 1908 (see Table 20). Although the number of such establishments

[18]Keep in mind that the absolute magnitudes of the coefficients in a quantile regression have no meaning.

is small, they reveal the characteristics of the firms that choose to incorporate and what happens to them once they have incorporated.

The left-hand column of Figure 5 shows plots of kernel densities estimates for the natural log of revenue per worker and power per worker for these factories before they have incorporated with those densities for other non-corporation-owned factories. Even though the sample size is very small, the future corporations' density of revenue per worker is clearly shifted to the right of that for other factories. The p-value of a two-sample Kolmogorov-Smirnov test is approximately 0, so the difference is statistically significant. On the other hand, the distributions for power per worker are similarly shaped: the p-value of a two-sample Kolmogorov-Smirnov test is approximately .93. The bottom row shows the distribution of power per worker for the cotton industry alone, and it is difficult to detect a difference in the shapes of the distributions because the sample size is so small (the p-value of a two-sample Kolmogorov-Smirnov test is .34). The right-hand column shows kernel density estimates that were already presented in Figure 3: once factories belong to corporations, all distributions are shifted to the right of those for other factories. The most interesting result here, then, concerns power per worker: before the factories belong to corporations, we cannot detect a difference between future corporations and other factories, but once the factories belong to corporations, differences become apparent. This is consistent with a model in which revenue per worker or productivity motivates selection into incorporation, and the benefit of incorporation is the ability to make productivity-enhancing investments in machines.

Figure 6 reports a more "apples to apples" comparison for the factories that become corporations. This figure presents kernel density estimates that compare factories that will be corporations in the next period to other factories that will survive to the next period. The

results are the same as discussed above: the distributions of revenue per worker for factories that become corporations are shifted to the right, but the distributions of power per worker are nearly identical. The p-value for a two-sample Kolmogorov-Smirnov test for each of the distributions in the left column is .004. For the distributions of power per worker is .414.

5.8 Factory Growth

In this section, we study whether factories owned by corporations change over time differently from factories owned by different kinds of firms. The main regression equation is:

$$\Delta r_{ijt} = \beta_l l_{ijt} + \beta_{\Delta L} \Delta l_{ijt} + \beta_{\Delta k} \Delta k_{ijt} + \beta_C Corp_{ijt} + \epsilon_{ijt} \text{ [12]}$$

If the revenue of corporations is faster than it is for other factories, we should see $\beta_C > 0$. Here, we are controlling for the scale of the factory with the term $\beta_l l_{ijt}$ and for changes in labor and capital with the terms $\beta_{\Delta L} \Delta l_{ijt}$ and $\beta_{\Delta k} \Delta k_{ijt}$.

Furthermore, we are specifically interested in whether corporations obtain machine power faster than other kinds of factories, so the following equation is also of interest:

$$\Delta k_{ijt} = \beta_l l_{ijt} + \beta_{\Delta R} \Delta r_{ijt} + \beta_{\Delta L} \Delta l_{ijt} + \beta_C Corp_{ijt} + \epsilon_{ijt} \text{ [13]}$$

Note, however, that this difference is between 1908 and 1894, since 1900 has no information on machine power. Again, if capital is growing faster for corporations than for other kinds of factories, we should see $\beta_C > 0$. The other terms in the equation control for scale and changes in labor and revenue as above.

Table 21 presents estimates for these regressions, and the results are encouraging. The coefficient on the Corporation dummy variable is always positive and statistically significant

(except for Column 3, where it is only significant at the ten percent level). This means that corporation-owned factories on average grow faster in terms of revenue and that they add machine power faster than other kinds of factories.

6 Robustness Checks

One possible caveat to the results in this paper is that the production functions use total sales as the measure of output, rather than either gross physical output or value added. Because we do not know the value of materials for each individual factory, traditional methods for estimating value added production functions are not available, but we can consider the kinds of biases that using total sales may introduce, estimate value added production functions for those factories for which materials are known, and estimate aggregate productions functions.

6.1 Relationship of Value of Materials to Enterprise Form

When estimating production functions in this paper, we have been using the basic form:

$$r_{ijt} = \beta^L l_{ijt} + \beta^k k_{ijt} + \beta^c Corp_{ijt} + \epsilon_{ij} \text{ [14]}$$

In terms of value-added, then, we are estimating:

$$r_{ijt} = m_{ijt} + va_{ijt} = \beta^L l_{ijt} + \beta^k k_{ijt} + \beta^c Corp_{ijt} + \epsilon_{ij} \text{ [15]},$$

where va_{ijt} is value-added and m_{ijt} is the total value of materials. Let m_{ijt}^C denote the total value of materials for corporation-owned factories and m_{ijt}^{NC} denote the total value of materials for other kinds of factories. If we have $m_{ijt}^C > m_{ijt}^{NC}$, then revenue would be higher for corporations than for non-corporations with the same value-added. In this case, if we

are interested in value-added, estimation using revenue alone overstates the performance of factories owned by corporations relative to other kinds of factories. If, on the other hand, we have $m_{ijt}^{C} < m_{ijt}^{NC}$, the bias works in my favor, and I am in fact understating the performance of corporations.

Data on total value of materials are known at the enterprise-level for a subset of the factories in the 1894 census. As described in Section 3.1, the Russian State Historical archive holds approximately 1,500 census manuscripts for the 1894 census. It appears that they selected to keep manuscripts from certain industries and certain provinces. In the sample of about 250 factories currently matched and entered, Moscow province and the cotton industry are overrepresented. Thus, a caveat to any result using the 1894 manuscripts data is that the sample suffers from some selection bias.

Another source that contains the total value of materials for factories are the aggregate volumes for the 1900 and 1908 census. For the purpose of this robustness check, I will run regressions on the aggregate measures from the 1900 aggregate volume.

Table 22 shows regressions for the determinants of factories' total value of materials. Columns 1 through 5 use the 1894 manuscripts data, and Columns 6 through 11 use the aggregates. Columns 1 and 2 suffer from omitted variable bias: when the total value of materials is regressed on a dummy for whether an enterprise is owned by a corporation, the coefficient is positive and statistically significant, but we know that there are other variables associated with incorporation that also may determine the total value of materials. See, then, Columns 3 through 5: the introduction of controls for value added and number of workers removes statistical significance from the Corporation coefficient. A regression on the cotton

industry alone shows the same pattern. Though not shown, adding log total machine power to the regressions using the 1894 factory-level data changes nothing.

Columns 6 through 11, which show these regressions on the aggregate data, produce similar results. Note, however, that these measures are the aggregate number divided by the number of enterprises in each cell. Also, in Columns 10 and 11, when the cotton industry is isolated, the coefficient on Corporation is actually negative. This is encouraging: in the 1900 data, in general the bias understates the performance of corporations in an industry where corporation already perform much better than other kinds of firms.

6.2 Value Added Production Functions

Although we know little about the value of materials for the factories in the censuses, as explained above, this data is available for some factories and for the aggregates of others. Using this data, it is possible to estimate value added production functions on a selected sample of the factories in the 1894 census and on the aggregate data for 1900 and 1908.

In Table 23, I present regressions for the 1894 factories with manuscripts and for the 1900 aggregate data. Because there is so few observations in the manuscripts and so little variation in the aggregate volume, while many of the patterns here confirm what is seen in the earlier parts of the paper, some coefficients lose statistical significance. The same is true for the regressions involving aggregate data. There is little variation in the number of corporations per cell, so it is difficult to identify differences between corporation-owned factories and other factories using the aggregate data. However, in Column 9, the coefficient on Corporation is significant in the cotton industry.

6.3 Factories per Firm

Throughout this paper, I have considered each factory as an independent observation. However, factories belong to firms; and firms may own more than one factory. Corporations commonly own more than one factory. By ignoring the correlation among the factories owned by the same corporation, I could be introducing an upward bias in the coefficient on the corporation dummy variable throughout the paper.

Matching partnership or single-proprietorship-owned factories to firms is difficult, because these factories take the name of the owner, and many of the names of these owners are common Russian surnames. However, since I have already matched corporations to the RUSCORP database to identify which factories are owned by corporations, I already know which factories are owned by which firms when the firm is a corporation. Since we only worried about the bias introduced by treating corporations as uncorrelated observations, controlling for the number of factories per firm in corporations along will more than compensate for any bias.

Columns 6 and 7 of Tables 15 and 16 show how controlling for firm size changes estimates of the determinants of revenue per worker. The coefficient on the number of factories per firm is small and lacks statistical significance in both regressions. Clustering standard errors by corporation also does not change any of the results (not reported).

6.4 Survival

One commonly cited reason for firms to become corporations is that incorporation allows firms to avoid the problem of untimely dissolution because the corporation exists outside

the identities of its founders, unlike a partnership, which dies if any partners decide to leave the firm.[19] Thus, an alternative explanation for the differences between corporation-owned factories and other factories is that these factories are more likely to survive in order to be counted in more than factory census. According to this alternative explanation, the results we see are really the differences between factories that belong to longer-lived firms and factories that exit after two or fewer observations.[20]

However, the data show that factories owned by corporations have very different characteristics from factories owned by similarly-lived non-corporation-owned factories. Figures 7 and 8 compare corporation-owned factories to non-corporation-owned factories. In Figure 7, I present kernel density estimates for revenue, number of workers, machine power, and revenue per worker for all factories that live one year, two years, and three years; and I also plot the density for all corporations, regardless of lifespan. For all variables, the distribution for corporations is to the right of that of other factories, no matter how long they live. Thus, it is unlikely that the differences between corporation-owned factories and other factories shown in this paper is merely the result of differences in lifespan. This is confirmed by Figure 8, which shows differences between corporation-owned factories and other factories for each year of lifespan. Again, no matter how long the factories live, corporation-owned factories have higher revenues, more workers, more machine power, and greater revenue per worker.

[19] See Guinnane et al (2007) for a discussion of the untimely dissolution problem

[20] Or, corporations are not more likely to survive but are just more conspicuous and hence counted in more than one census. I cannot distinguish between being counted because of survival or because of not being missed by enumerators.

7 Conclusion

A lack of commercial credit in the Russian Empire led Alexander Gerschenkron to hypothesize that the state substituted for private enterprise in order to stimulate industrialization. This paper has shown one aspect of how firms behaved in an environment characterized both by credit constraints and a possible institutional obstacle to growth, the difficulty of obtaining corporate charters.

In this paper, I have shown that more productive firms chose to incorporate to take advantage of the capital made available by the selling of stock. It is difficult, however, to infer the effect of the concession system on the Russian Empire's economic growth. The Russian Empire believed in restricting the availability of incorporation because they recognized that the limited liability of corporations placed great downside risk upon society. When stock bubbles forced numerous corporations into bankruptcy, the Imperial government tended to abandon projects that aimed to reform or abolish the concession system or tightened restrictions on corporations.[21] They might have had a point: had incorporation been easier, less productive firms might have incorporated, and it is likely that we would not observe such differential good performance for corporations in these data. On the other hand, there is no doubt that restricting the access to capital markets provided by incorporation kept the smallest firms small: in production functions estimated in this paper, the sum of the labor and capital coefficients is greater than one, suggesting room for expansion to take advantages

[21] See, for example, Owen, Corporation, Chapters 3 and 6. The Butovskii Bill, which rode the Russian Empire's wave of reforms of the 1860s and which aimed to abolish the concession system, was abandoned in 1874 after a stock market crash, and the Timashev Conference, which grew out of the reforms of 1905, also failed to produce lasting results.

of economies of scale. The concession system of incorporation, then, may have been one of many forces constraining Russian economic growth before the First World War.

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Tables and Figures

Table 1: Menu of Enterprise Forms in the Russian Empire

Form	Requirements for Establishment	Liability
Single Proprietorship	Registration	Unlimited Liability
Ordinary Partnership	Written Contract among Partners, Registration	Unlimited Liability for All Partners
Limited Partnership	Written Contract among Partners (usually with a description of investors), Registration	Unlimited Liability for All Partners, Limited Liability for Investors
Corporation	Special Permission: Law (Charter) Signed by the Tsar	Limited Liability for All Investors

Sources: Thomas Owen, *The Corporation under Russian Law*, *Polnoe Sobraniie Zakonov Rossiiskoi Imperii* [Complete Collection of Laws of the Russian Empire], *Svod Zakonov Rossiiskoi Imperii* [Code of Laws of the Russian Empire].

Table 2: Number of Incorporations (New Charters) in the Russian Empire (1894, 1900, 1908)

Year	No. of Incorps. to Year	New Incorps.	No. of Incorps. including Year	New Incorps.
1894	1437		1533	
		902		950
1900	2339		2503	
		829		779
1908	3168		3282	

Source: RUSCORP Database, which is based on corporate charters accepted by the Russian Ministry of Finance.

Table 3: Incorporations by Industry

	1700-1914		1890-1914		1894-1908	
Industry	Number	Percent	Number	Percent	Number	Percent
Construction	91	2.00	73	2.21	20	1.16
Finance	345	7.60	176	5.33	65	3.76
Manufacturing	2892	63.71	2164	65.52	1225	70.81
Mining	269	5.93	220	6.62	122	7.05
Public Administration	15	.33	4	.12	3	.17
Retail	10	.22	10	.30	6	.35
Services	122	2.69	97	2.94	51	2.95
Transportation	532	11.72	328	9.93	151	8.73
Wholesale	260	5.73	228	6.90	84	4.86
Nonclassified	3	.07	3	.09	3	.17
Totals	4539	100	3303	100	1730	100

Source: RUSCORP Database, which is based on corporate charters accepted by the Russian Ministry of Finance.

Table 4: Incorporations by Industry within Manufacturing

	1700-1914		1890-1914		1894-1908	
Industry	Number	Percent	Number	Percent	Number	Percent
Animal Products	74	2.61	52	2.45	26	2.17
Chemicals	368	12.98	301	14.20	173	14.42
Foods	701	24.73	476	22.46	259	21.58
Metals and Machines	578	20.39	484	22.84	295	24.58
Minerals	228	8.04	197	9.30	118	9.83
Paper	218	7.69	172	8.12	85	7.08
Textiles	532	18.77	322	15.20	179	14.92
Wood	136	4.80	115	5.43	65	5.42
Totals	2835	100	2119	100	1200	100

Source: RUSCORP Database, which is based on corporate charters accepted by the Russian Ministry of Finance.

Table 5: Enterprises and Corporate Enterprises by Year

Year	Population Number of Enterprises	Sampled Number of Enterprises	Corporation-Owned Factories in Sample	Unique Corporations in Sample
1894	17534	5022	218	89
1900	15637	5073	405	215
1908	19597	5303	470	305

Source: Stratified samples from the 1894, 1900, and 1908 Factory Lists. Corporate enterprises are identified by matching enterprise names, locations, and industries to the RUSCORP Database. The "Corporate Enterprises" category lists all factories owned by corporations, while the "Unique Corporations" category denotes the number of distinct corporations that own those factories.

Table 6: Variables by Year

Year	Enterprise-Level	Province and Industry-Level
1894	Revenue, Total Workers, Product Description Also: Workforce Composition, Fuels, Machines	N/A
1900	Revenue, Total Workers, Product Description	Revenue, Workforce Comp., Fuels, Machines, Expenditures (Incl. Wage Bill, Materials)
1908	Revenue, Total Workers, Product Description Also: Total Power	Revenue, Workforce Comp., Fuels, Machines, Expenditures (Incl. Wage Bill, Materials)

Sources: 1894, 1900, and 1908 factory lists and aggregate volumes. Revenue denotes the total value of output, in Rubles. Total Workers is the total number of workers employed by the factory. From the 1894 manuscripts, this seems to be an annual average. Product Description is the description of what each factory makes, which is given in the factory lists. Total Power is the total horsepower of all machines in the factory.

Table 7: Enterprises and Corporate Enterprises by Industry

Industry	Year	No. of Est.	Est. in Corps.	% of Est. in Corps.	% of Output from Corps.
	1894	510	1	.2	3.94
Animal	1900	514	7	1.36	9.85
	1908	407	9	2.21	21.47
	1894	170	11	6.47	57.50
Chemicals	1900	171	27	15.79	45.18
	1908	191	41	21.47	28.99
	1894	424	92	21.7	77.71
Cotton	1900	427	107	25.06	80.57
	1908	472	132	27.97	83.19
	1894	190	12	6.32	58.06
Flax/Hemp/Jute	1900	195	21	10.77	49.30
	1908	171	24	14.04	67.68
	1894	690	8	1.16	5.00
Foods	1900	696	27	3.88	19.70
	1908	795	35	4.40	20.06
	1894	766	29	3.79	41.79
Metals/Machines	1900	776	80	10.31	62.90
	1908	842	93	11.05	60.30
	1894	618	17	2.75	19.74
Minerals	1900	623	39	6.26	33.49
	1908	651	31	4.76	21.91
	1894	158	2	1.27	9.28
Mixed Materials	1900	165	10	6.06	38.24
	1908	159	13	8.18	37.53
	1894	441	21	4.76	30.69
Paper	1900	443	33	7.45	32.48
	1908	487	29	5.59	39.67
	1894	188	1	.53	7.62
Silk	1900	190	2	1.05	11.93
	1908	174	8	4.60	13.74
	1894	532	8	1.5	1.26
Wood	1900	539	32	5.94	15.12
	1908	590	22	3.73	17.20
	1894	332	16	4.82	21.90
Wool	1900	334	20	5.99	30.81
	1908	364	32	8.79	38.40

For this table, enterprise form comes from matching to Ruscorp. Numbers all years come from stratified samples of factories. The Foods category in 1894 includes both taxed and untaxed food factories and in 1900 and 1908 includes only factories producing untaxed foods. Note that these numbers are unweighted.

Table 8: Descriptive Statistics

		Mean	Mean (W)	Std. Dev	Std. Dev (W)	Median	Min	Max	|t|
Revenue:	All Est.	232,660.4	160,252.5	1,036,135	748,160.9	26,827	0	39,000,000	
	Non-Corporate	112,580.5	94,579.38	438,414.1	377,226.8	23,286	0	25,000,000	
	Corporate	1,741,577	1,359,446	3,114,297	2,582,837	633,098	0	39,000,000	54.84
Number of Workers:	All Est.	122.31	96.24	517.88	428.02	23	0	13498	
	Non-Corporate	65.53	60.80	204.07	230.46	21	0	8400	
	Corporate	925.52	755.17	1668.51	1464.79	335	0	13498	60.62
Revenue per Worker	All Est.	1675.85	1897.78	4352.31	4367.86	857.14	0	340000	
	Non-Corporate	1622.73	1864.80	4445.25	4418.16	809.20	0	340000	
	Corporate	2336.76	2492.92	2882.02	3277.50	1488.72	0	28459.74	5.22
Total Machine Power:	All Est.	49.98	34.12	337.93	239.62	0	0	12772	
	Non-Corporate	21.04	19.75	112.64	99.27	0	0	3243	
	Corporate	459.27	301.24	1171.17	931.15	17	0	12772	45.55
Machine Power per Worker	All Est.	.511	.69	1.64	2.06	0	0	61.2	
	Non-Corporate	.508	.70	1.68	2.09	0	0	61.2	
	Corporate	.549	.50	1.05	1.18	.208	0	12.31	.8010
Factory Age:	All Est.	21.15	19.28	22.68	21.17	15	0	267	
	Non-Corporate	20.60	18.90	22.20	20.79	14	0	267	
	Corporate	28.93	26.47	27.54	26.42	21	0	182	8.81

Data comes from stratified samples of factories from 1894, 1900, and 1908. Corporation-owned factories are identified by matching to the RUSCORP Database. $|t|$ denotes the absolute value of t obtained from a two-group mean comparison test using unweighted variables, where the groups are corporate and non-corporate factories. Mean (W) and Std. Dev (W) denote the weighted mean and standard deviation, respectively.

Table 9: Descriptive Statistics for the Cotton Industry

		Mean	Mean (W)	Std. Dev	Std. Dev (W)	Median	Min	Max	|t|
Revenue:	All Est.	1,140,678	949,393.1	2,634,303	2,349,351	77,858	0	26,000,000	
	Non-Corporate	280,601.4	224,978	742,586.6	622,288.3	28,610	0	8,455,032	
	Corporate	3,503,879	3,325,953	4,111,868	3,874,972	2,206,635	0	26,000,000	22.3171
Number of	All Est.	623.52	584.67	1428.01	1381.59	91	0	13498	
Workers:	Non-Corporate	205.56	192.13	499.63	460.80	49	0	5512	
	Corporate	2025.88	1982.52	2345.63	2336.171	1213	12	13498	24.25
Revenue	All Est.	1336.69	1299.63	1688.03	1652.69	924.22	0	14000	
per	Non-Corporate	1095.41	1118.71	1624.50	1630.99	528.89	0	14000	
Worker	Corporate	1971.84	1874.98	1689.70	1590.88	1485.95	0	11021.84	8.14
Total	All Est.	285.27	213.57	901.44	785.34	0	0	10423	
Machine	Non-Corporate	66.17	49.85	272.00	223.88	0	0	2820	
Power:	Corporate	1020.42	796.58	1610.84	1484.54	273	0	10423	18.99
Machine	All Est.	.32	.27	.61	.57	0	0	9.5	
Power per	Non-Corporate	.24	.22	.49	.49	0	0	6.1	
Worker	Corporate	.55	.44	.81	.76	.41	0	9.5	8.37
Factory	All Est.	27.20	25.14	23.63	22.84	21	0	182	
Age:	Non-Corporate	24.79	22.78	21.27	20.40	20	0	144	
	Corporate	34.83	33.53	28.65	28.47	30	0	182	5.20

Data comes from stratified samples of factories from 1894, 1900, and 1908. Corporation-owned factories are identified by matching to the RUSCORP Database. $|t|$ denotes the absolute value of t obtained from a two-group mean comparison test using unweighted variables, where the groups are corporate and non-corporate factories. Mean (W) and Std. Dev (W) denote the weighted mean and standard deviation, respectively.

Table 10: Production Function Estimation

	Dependent Variable: Log Revenue							
	Pooled OLS	OLS	OLS	OLS	OLS	OLS	OLS	Tobit
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Log (Workers + 1)	1.063	1.10	.92	1.07	.92	1.07	.93	.92
	(.020)	(.023)	(.036)	(.024)	(.037)	(.024)	(.037)	(.036)
Log (Machine Power + 1)			.20		.19		.20	.19
			(.015)		(.015)		(.016)	(.015)
Corporation				.42	.14	.65	1.01	.14
				(.059)	(.073)	(.18)	(.26)	(.073)
Corporation * log (Workers + 1)						-.043	-.14	
						(.038)	(.069)	
Corporation * log (Power + 1)							-.019	
							(.041)	
Intercept	6.58	6.74	7.09	6.84	7.12	6.83	7.07	7.12
	(.10)	(.29)	(.33)	(.29)	(.33)	(.30)	(.33)	(.33)
Ind., Year, Prov. Dummies	N	Y	Y	Y	Y	Y	Y	Y
1900 Included?	Y	Y	N	Y	N	Y	N	N
N	13796	13796	9194	13796	9194	13976	9194	9194
R2	.6550	.7486	.7669	.7513	.7672	.7514	.7682	.3506

Source: 1894, 1900, and 1908 factory lists. Regressions are unweighted. Standard errors clustered by Region-Industry-Year groups in parentheses. Workers denotes the total number of workers the factory, Power denotes the total horsepower of machines in the factory, and Revenue is the total value of output produced by the factory in that year, measured in Rubles. The Tobit regression in Column 7 is left censored at zero.

Table 11: Production Function Estimation (Weighted)

Pooled OLS	Dependent Variable: Log Revenue					
	[1]	[2]	[3]	[4]	[5]	[6]
Log (Workers + 1)	1.08	.91	1.06	.92	1.06	.92
	(.024)	(.038)	(.026)	(.040)	(.027)	(.041)
Log (Machine Power + 1)		.22		.20		.21
		(.022)		(.022)		(.023)
Corporation			.36	.087	.33	.84
			(.062)	(.073)	(.23)	(.33)
Corporation * log (Workers + 1)					.0055	-.077
					(.042)	(.10)
Corporation * log (Power + 1)						-.074
						(.062)
Intercept	6.67	7.03	6.72	7.04	6.72	7.013
	(.24)	(.26)	(.23)	(.30)	(.24)	(.30)
Ind., Year, Prov. Dummies	Y	Y	Y	Y	Y	Y
1900 Included?	Y	N	Y	N	Y	N
N	13796	10077	13796	9194	13796	9194
R2	.7077	.7389	.7095	.7320	.7095	.7327

Source: 1894, 1900, and 1908 factory lists. Regressions are weighted. Standard errors, clustered by Region-Industry-Year groups, in parentheses. Workers denotes the total number of workers the factory, Power denotes the total horsepower of machines in the factory, and Revenue is the total value of output produced by the factory in that year, measured in Rubles.

Table 12: Production Function Estimation (Weighted): Cotton

Pooled OLS	Dependent Variable: Log Revenue			
	[1]	[2]	[3]	[4]
Log (Workers + 1)	.94	.64	.92	.62
	(.087)	(.12)	(.10)	(.11)
Log (Machine Power + 1)		.25		.26
		(.062)		(.061)
Corporation	.73	.45	.14	-.42
	(.089)	(.10)	(.72)	(.25)
Corporation * log (Workers + 1)			.088	.22
			(.11)	(.061)
Corporation * log (Power + 1)				-.10
				(.038)
Intercept	7.87	6.82	7.91	8.85
	(.22)	(.39)	(.26)	(.36)
Year, Prov. Dummies	Y	Y	Y	Y
1900 Included?	Y	N	Y	N
N	1008	677	1008	677
R2	.8148	.8205	.8152	.8214

Source: 1894, 1900, and 1908 factory lists. Regressions are weighted. Standard errors clustered by Region-Industry-Year groups in parentheses. Workers denotes the total number of workers the factory, Power denotes the total horsepower of machines in the factory, and Revenue is the total value of output produced by the factory in that year, measured in Rubles.

Table 13: Production Function Estimation (Translog)

	Dependent Variable: Log Revenue									
Pooled OLS										
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Log (Workers	1.09	1.34	1.24	1.25	1.13	1.15	1.34	1.35	1.06	1.06
+ 1)	(.12)	(.17)	(.15)	(.15)	(.12)	(.15)	(.17)	(.052)	(.14)	(.16)
Log (Machine		.075	.18	.20			.082	.052		
Power + 1)		(.072)	(.065)	(.065)			(.072)	(.071)		
Log (Workers	-.0010	-.058	-.047	-.049	-.010	-.013	-.059	-.061	-.0051	-.0051
+ 1)^2	(.016)	(.034)	(.028)	(.027)	(.017)	(.021)	(.033)	(.034)	(.017)	(.020)
Log (Machine		.050	.061	.060			.050	.056		
Power + 1)^2		(.011)	(.013)	(.013)			(.011)	(.011)		
Log (Power + 1) *		-.021	-.045	-.047			-.023	-.020		
Log (Workers + 1)		(.029)	(.026)	(.026)			(.029)	(.028)		
Corporation				.26	.40	.13	.15	.38	.43	.43
				(.082)	(.081)	(.43)	(.077)	(.40)	(.076)	(.090)
Corp. * log						.052		.15		
(Workers + 1)						(.092)		(.13)		
Corp. * log								-.24		
(Power + 1)								(.080)		
Corporation *									-.12	-.12
Year = 1894									(.18)	(.12)
Workers *									.083	.083
Year = 1894									(.058)	(.059)
Intercept	6.65	6.51	6.23	6.21	6.61	6.59	6.52	6.52	6.54	6.54
	(.28)	(.31)	(.22)	(.22)	(.28)	(.29)	(.31)	(.31)	(.21)	(.27)
Controls	Y	Y	N	N	Y	Y	Y	Y	Y	Y
1900 Included?	Y	N	N	N	Y	Y	N	N	Y	Y
Standard Errors	C	C	C	C	C	C	C	C	R	C
N	13796	13796	9194	9194	13795	13796	9194	9194	13979	13796
R2	.7077	.7403	.6712	.6718	.7096	.7079	.7405	.7417	.7104	.7103

Source: 1894, 1900, and 1908 factory lists. Regressions are weighted. Standard errors clustered by Region-Industry-Year groups in parentheses. Workers denotes the total number of workers the factory, Power denotes the total horsepower of machines in the factory, and Revenue is the total value of output produced by the factory in that year, measured in Rubles. "Controls" are Industry, Year, and Province dummies.

Table 14: Summary Statistics for Residuals

		Corp.-Owned Factories	Non-Corp.-Owned Factories	Specification: Controls Included	Years Included
[1]	Mean	.34	.0090	Labor	1894,1900,1908
	Std. Dev	.84	.95		
	|t|		11.21		
	Median	.34	.021		
	Smallest	-4.56	-7.55		
	Largest	4.97	6.30		
	N	1065	12732		
[2]	Mean	.060	.025	Labor, Capital	1894,1908
	Std. Dev	.89	.95		
	|t|		.9223		
	Median	.046	.041		
	Smallest	-4.97	-7.40		
	Largest	3.90	5.09		
	N	654	8541		
[3]	Mean	.35	.0086	Labor, Labor^2	1894,1900,1908
	Std. Dev	.84	.95		
			11.34		
	Median	.34	.020		
	Smallest	-4.56	-7.53		
	Largest	4.99	6.31		
	N	1065	12732		
[4]	Mean	.12	.015	Labor, Capital	1894,1908
	Std. Dev	.89	.94	Labor^2, Capital^2,	
	|t|		2.78		
	Median	.16	.032		
	Smallest	-5.39	-7.32		
	Largest	4.40	5.24	Labor*Capital	
	N	654	8541		

|t| comes from a two-group mean comparison test.

Table 15: Determinants of Revenue per Worker

Pooled OLS	Dependent Variable: Log (Revenue / Workers)						
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Log (Workers + 1)		.074	-.053	.078	-.042	-.053	-.042
		(.018)	(.028)	(.019)	(.029)	(.028)	(.029)
Log (Machine Power + 1)			.17		.18	.17	.18
			(.014)		(.015)	(.014)	(.015)
Corporation	.53	.39	.13	.57	.90	.12	.90
	(.088)	(.089)	(.072)	(.17)	(.24)	(.073)	(.24)
Corporation * log (Workers + 1)				-.032	-.12		-.13
				(.036)	(.065)		(.064)
Corporation * log (Power + 1)					-.016		-.015
					(.040)		(.040)
Number of Factories per Firm						.000016	.000022
						(.000021)	(.000017)
Intercept	7.13	6.87	7.09	6.86	7.05	7.097	7.056
	(.28)	(.28)	(.32)	(.29)	(.32)	(.032)	(.32)
Ind., Year, Prov. Dummies	Y	Y	Y	Y	Y	Y	Y
1900 Included?	Y	Y	N	Y	N	N	N
N	13713	13713	9115	13713	9115	9115	9115
R2	.3024	.3081	.3408	.3082	.3432	.3408	.3433

Source: 1894, 1900, and 1908 factory lists. Regressions are unweighted. Standard errors clustered by Region-Industry-Year groups in parentheses. Workers denotes the total number of workers the factory, Power denotes the total horsepower of machines in the factory, and Revenue is the total value of output produced by the factory in that year, measured in Rubles.

Table 16: Determinants of Revenue per Worker (Weighted)

Pooled OLS	Dependent Variable: Log (Revenue / Workers)						
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Log (Workers + 1)		.043	-.093	.041	-.088	-.093	-.088
		(.026)	(.042)	(.027)	(.044)	(.042)	(.044)
Log (Machine Power + 1)			.20		.20	.20	.20
			(.022)		(.023)	(.022)	(.023)
Corporation	.44	.36	.11	.22	.67	.098	.67
	(.061)	(.062)	(.072)	(.23)	(.33)	(.075)	(.33)
Corporation * log (Workers + 1)				.026	-.042		-.045
				(.042)	(.097)		(.096)
Form * log (Power + 1)					-.074		-.073
					(.062)		(.061)
Number of Factories per Firm						.000022	.000030
						(.000030)	(.000027)
Intercept	7.013	6.86	7.18	6.847	7.16	7.18	7.16
	(.21)	(.23)	(.30)	(.23)	(.30)	(.30)	(.30)
Ind., Year, Prov. Dummies	Y	Y	Y	Y	Y	Y	Y
1900 Included?	Y	Y	N	Y	N	N	N
N	13713	13713	9115	13713	9115	9115	9115
R2	.3138	.3154	.3412	.3155	.3478	.3413	.3426

Source: 1894, 1900, and 1908 factory lists. Regressions are weighted. Standard errors clustered by Region-Industry-Year groups in parentheses. Workers denotes the total number of workers the factory, Power denotes the total horsepower of machines in the factory, and Revenue is the total value of output produced by the factory in that year, measured in Rubles.

Table 17: Determinants of TFP (Calculated by Imposing Shares)

	Dependent Variable: Log (TFP)			
	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS
	[1]	[2]	[3]	[4]
Log (Workers + 1)		.15	.22	.22
		(.029)	(.040)	(.041)
Log (Machine Power + 1)			-.096	-.090
			(.022)	(.023)
Corporation	.25	-.032	.087	.84
	(.068)	(.072)	(.73)	(.33)
Corporation * log (Workers + 1)				-.077
				(.097)
Corporation * log (Power + 1)				-.074
				(.062)
Intercept	7.70	7.15	7.04	7.013
	(.26)	(.28)	(.30)	(.30)
Ind., Year, Prov. Dummies	Y	Y	Y	Y
1900 Included?	N	N	N	N
N	9194	9194	9194	9194
R2	.1974	.2199	.2336	.2357

Source: 1894, 1900, and 1908 factory lists. Regressions are weighted. Standard errors clustered by Region-Industry-Year groups in parentheses. Workers denotes the total number of workers the factory, Power denotes the total horsepower of machines in the factory, and Revenue is the total value of output produced by the factory in that year, measured in Rubles.

Table 18: Coefficients on Corporation by Industry

Industry	Coefficient on Corp in Prod. Function [1]	Coefficient on Corp for Rev / Workers [2]
Animal	-.27	-.18
	(.24)	(.22)
Chemicals	.50	.54
	(.29)	(.29)
Cotton	**.45**	**.39**
	(.10)	**(.11)**
Flax/Hemp/Jute	-.096	-.39
	(.18)	(.17)
Foods	-.24	-.22
	(.25)	(.24)
Metals and	**.30**	**.31**
Machines	**(.074)**	**(.075)**
Minerals	.28	.29
	(.24)	(.24)
Mixed Materials	.53	.54
	(.31)	(.31)
Paper	**.45**	**.37**
	(.11)	**(.11)**
Silk	.38	.26
	(.34)	(.46)
Wood	-.37	-.41
	(.35)	(.34)
Wool	**.35**	**.30**
	(.16)	**(.14)**

Column 3 of weighted production functions as in Table 11 and Column 3 of weighted regressions of log Revenue per Worker (Table 15). 1900 is omitted since it does not have a capital measure for each factory.

Table 19: Quantile Regressions

	Dependent Variable: Log (Revenue)					
	Quantile: .25 [1]	Q: .25 [2]	Q:. 50 [3]	Q: .75 [4]	Cotton Q: .50 [5]	Cotton Q: .75 [6]
Corporation	.32	.041	.061	.11	.21	.30
	(.039)	(.050)	(.041)	(.047)	(.11)	(.13)
Log (Workers + 1)	1.16	1.05	.97	.89	.61	.53
	(.0081)	(.012)	(.0095)	(.0109)	(.037)	(.043)
Log (Machine Power + 1)		.16	.17	.18	.31	.29
		(.0082)	(.0067)	(.0077)	(.026)	(.031)
Intercept	6.04	6.35	7.09	7.65	8.52	8.66
	(.19)	(.22)	(.18)	(.20)	(1.022)	(1.21)
Ind., Year, Prov. Dummies	Y	Y	Y	Y	Y	Y
1900 Included?	Y	N	N	N	N	N
N	14682	10080	10080	10080	719	719
Pseudo R2	.5072	.5262	.5520	.5766	.6464	.6417

Regressions are unweighted. Robust standard errors in parentheses.

Table 20: Number of Enterprises Matched to Corporations Next Year

Year	Total Number of Enterprises	Number of Enterprises in Corps. Next Obs.
1894	5022	66
1900	5073	57

Sources: 1894, 1900, and 1908 factory lists and the RUSCORP Database. I say that a factory is owned by a corporation in the next period if it is not a corporation this period and the RUSCORP Database lists a firm of that name as incorporating in the years between that period and the next period.

Table 21: Determinants of Change in Revenue and Capital

OLS	Dependent Variable: Log (Δ Revenue)				Dependent Variable: Log (Δ Machine Power)		
	[1]	[2]	[3]	[4]	[5]	[6]	[7]: Cotton
Corporation	.37	.68	.25	.25	.86	.86	1.51
	(.18)	(.15)	(.14)	(.10)	(.21)	(.18)	(.45)
Log (Workers + 1)	.95	.72	.75	.75	.53	.53	1.45
	(.12)	(.090)	(.091)	(.077)	(.15)	(.21)	(.20)
Log (Δ Workers +1)	.28	.35	.093	.093	-.010	-.010	-.23
	(.10)	(.072)	(.071)	(.063)	(.094)	(.13)	(.16)
Log (Δ Machine Power + 1)			.22	.22			
			(.037)	(.032)			
Log (Δ Revenue +1)					.51	.51	
					(.085)	(.11)	
Intercept	6.83	6.09	6.09	6.094	-6.78	-6.79	-4.18
	(.36)	(.37)	(.22)	(.18)	(.50)	(.58)	(.55)
Ind., Prov. Dummies	Y	Y	Y	Y	Y	Y	N
Change in Years:	1894,1900	1900,1908	1894,1908	1894,1908	1894,1908	1894,1908	1894,1908
Standard Errors	R	R	R	C	R	C	R
N	977	756	370	370	370	370	89
R2	.5458	.6992	.8672	.8672	.7645	.7645	.8251

Log (Workers + 1) refers to the number of workers the factory has in the later year. Regressions are weighted."R" means robust standard errors are in parentheses. "C" means standard errors are clustered by Region-Industry-Year groups.

Table 22: Determinants of Total Value of Materials

OLS	Dependent Variable: Log (Value of Materials)										
	1894 Micro [1]	1894 Micro [2]	1894 Micro [3]	1894 Micro [4]	1894 Micro: Cotton [5]	1900 Agg [6]	1900 Agg [7]	1900 Agg [8]	1900 Agg [9]	1900 Agg: Cotton [10]	1900 Agg: Cotton [11]
Corporation	4.12	4.15	.49	.012	.37	10.70	8.07	.28	.19	-34.32	-18.42
	(.30)	(.38)	(.36)	(.34)	(.46)	(5.19)	(4.60)	(.89)	(1.09)	(14.09)	(20.02)
Log (Value Added)			.88	.58	.75			.89	.67	.47	.30
			(.050)	(.091)	(.089)			(.027)	(.066)	(.17)	(.19)
Log (Workers)				.52	.30				.33	.52	.35
				(.091)	(.13)				(.078)	(.17)	(.31)
Log (Total Machine Power)											.29
											(.33)
Intercept	9.53	8.57	.90	1.92	1.71	3.09	3.24	1.38	.86	.73	.98
	(.14)	(.77)	(.87)	(.83)	(.59)	(.069)	(.17)	(.12)	(.15)	(.35)	(.51)
Industry Controls	N	Y	Y	Y	N	N	Y	Y	Y	N	N
N	245	245	219	72	72	686	686	669	667	24	18
R2	.2892	.3289	.6863	.8408	.8408	.0151	.1227	.7325	.7445	.9021	.9269

Sources for Columns 1 through 4 are the 1894 factory list and 1894 archival manuscripts. The source for Columns 5 through 8 is the 1900 Aggregate volume. For the columns using the aggregate data, all values are per establishment, and "Corporation" is the proportion of enterprises in that cell that are owned by corporations. Robust standard errors in parentheses.

Table 23: Value Added Production Functions

OLS	Dependent Variable: Log (Revenue - Value of Materials)							
	1894 Micro [1]	1894 Micro [2]	1894 Micro [3]	1894 Micro: Cotton [4]	1900 Agg [6]	1900 Agg [7]	1900 Agg [8]	1900 Agg: Cotton [9]
Log (Workers)	1.08	.87	.86	.78	1.06	.97	.97	5.10
	(.072)	(.069)	(.072)	(.12)	(.023)	(.045)	(.045)	(.72)
Log (Total Machine Power)		.22	.22	.067		.11	.11	-4.87
		(.07)	(.072)	(.14)		(.036)	(.036)	(.87)
Corporation			.11	.57			.56	1716.87
			(.30)	(.39)			(1.15)	(381.93)
Intercept	7.00	5.70	5.76	6.77	-.78	.08	.082	-10.04
	(.69)	(.21)	(.23)	(.67)	(.21)	(.26)	(.26)	1.38
Industry Controls	Y	Y	Y	N	Y	Y	Y	N
Province Controls	Y	Y	Y	Y	Y	Y	Y	Y
N	215	116	116	35	674	377	377	19
R2	.7513	.8527	.8530	.8086	.8370	.8771	.8772	.9858

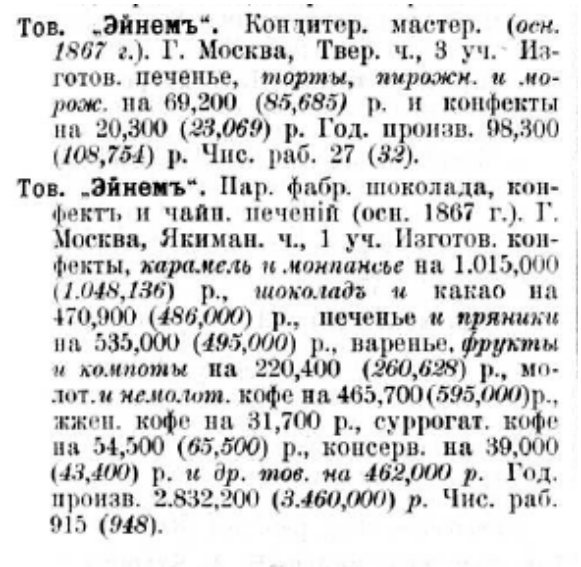
Sources for Columns 1 through 4 are the 1894 factory list and 1894 archival manuscripts. The source for Columns 5 through 8 is the 1900 Aggregate volume. For the columns using the aggregate data, all values are per establishment, and "Corporation" is the proportion of enterprises in that cell that are owned by corporations. Robust standard errors in parentheses.

Table 24: Survivorship by Enterprise Form

	1894	1900
Percentage of Corporation-Owned Factories that Survive Only One Year	34.86	14.95
Percentage of Non-Corporation Owned Factories that Survive Only One Year	57.51	32.27
Percentage of Corporation-Owned Factories that Survive Two or More Years	65.14	69.86
Percentage of Non-Corporation Owned Factories that Survive Two or More Years	42.49	51.93
Percentage of Corporation-Owned Factories that Survive Three Years	50.92	x
Percentage of Non-Corporation Owned Factories that Survive Three Years	24.52	x

In the Column for 1900 in the category of factories that live two or more years, I only count the factories that survive to the next year, not those who have survived from 1894.

Figure 1: Example of Entry for Two Factories from the 1900 Factory List

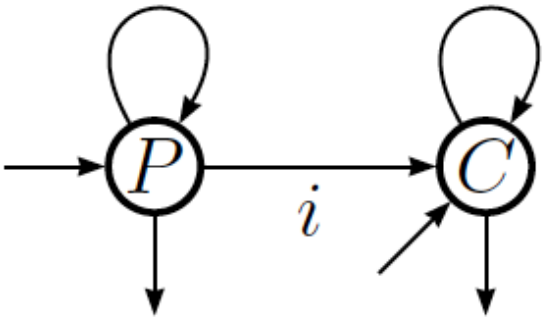


Тов. „Эйнемъ". Кондитер. мастер. (*осн. 1867 г.*). Г. Москва, Твер. ч., 3 уч. Изготов. печенье, *торты, пирожн. и морож.* на 69,200 (*85,685*) р. и конфекты на 20,300 (*23,069*) р. Год. произв. 98,300 (*108,754*) р. Чис. раб. 27 (*32*).

Тов. „Эйнемъ". Пар. фабр. шоколада, конфектъ и чайн. печеній (осн. 1867 г.). Г. Москва, Якиман. ч., 1 уч. Изготов. конфекты, *карамель и монпансье* на 1.015,000 (*1.048,136*) р., *шоколадъ и* какао на 470,900 (*486,000*) р., печенье *и пряники* на 535,000 (*495,000*) р., варенье, *фрукты и компоты* на 220,400 (*260,628*) р., молот. *и немолот.* кофе на 465,700 (*595,000*) р., жжен. кофе на 31,700 р., суррогат. кофе на 54,500 (*65,500*) р., консерв. на 39,000 (*43,400*) р. *и др. тов. на 462,000 р.* Год. произв. 2.832,200 (*3.460,000*) *р.* Чис. раб. 915 (*948*).

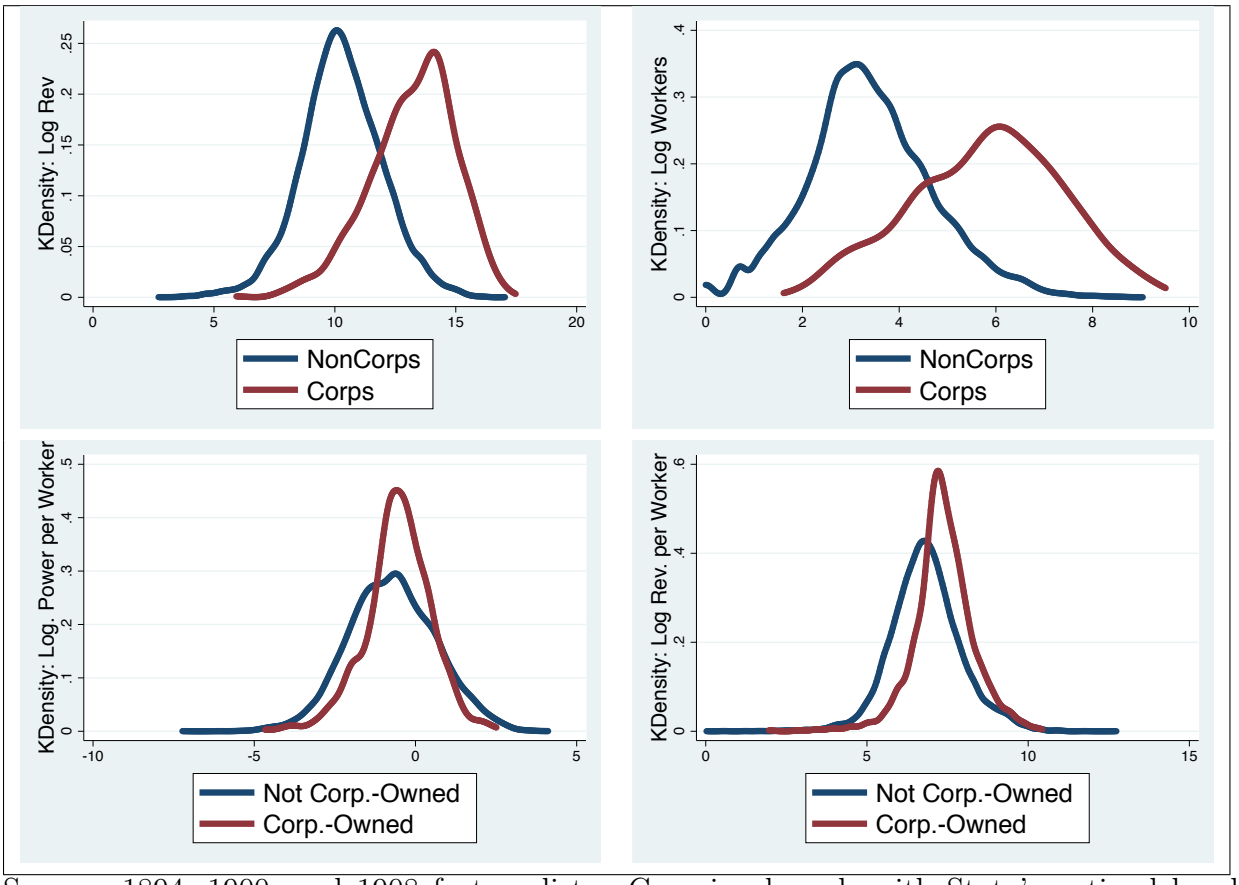
Source: List of Factories and Plants in European Russia

Figure 2: Incorporation Diagram



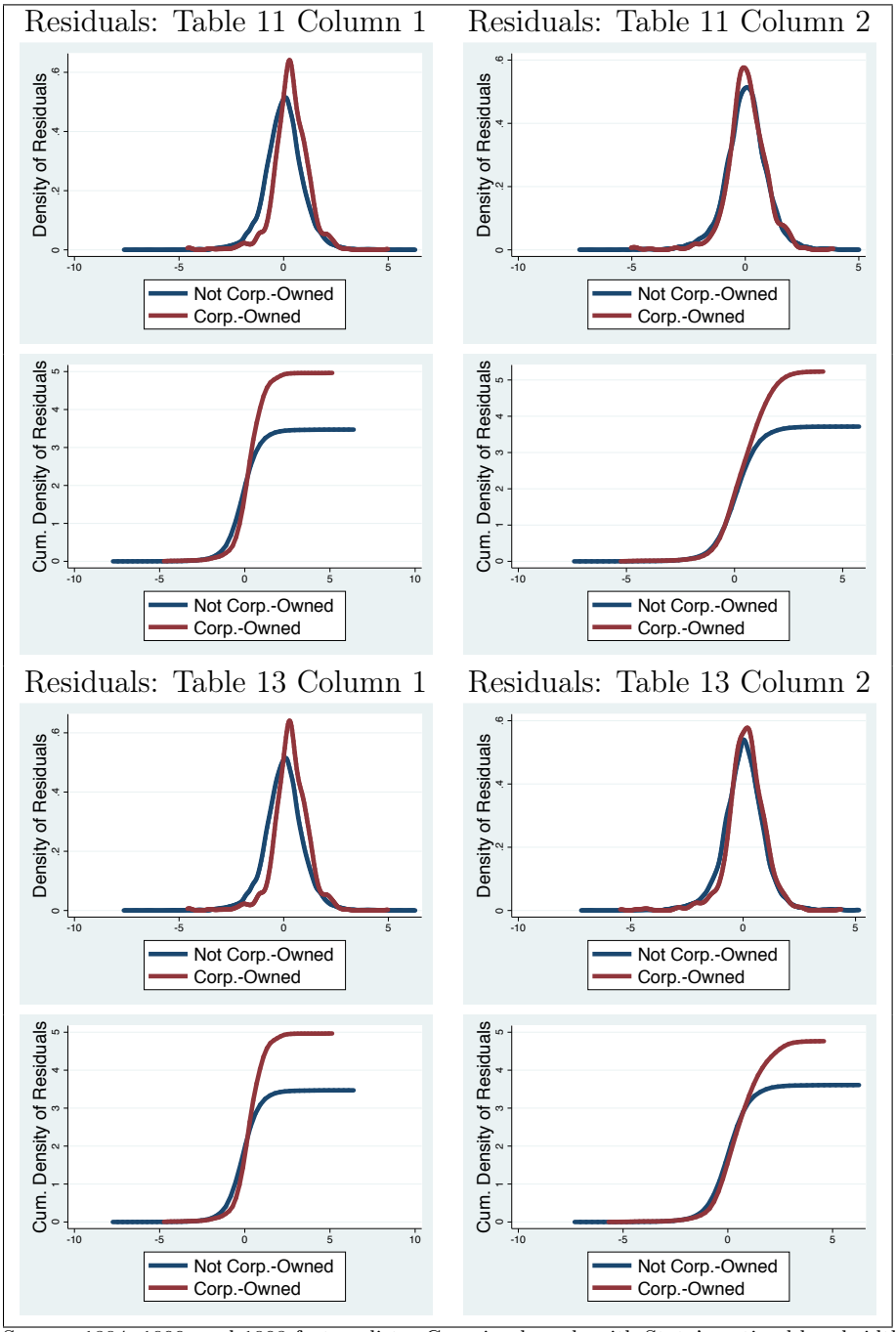
This diagram shows the options available to firms. Firms can enter as partnerships or corporation. Firms can exit as partnerships or corporations. Firms can decide to remain as partnerships or corporations. Partnerships have an added option: they can decide to incorporate (the arrow labeled "i").

Figure 3: Kernel Densities for Corporations and Non-Corporations



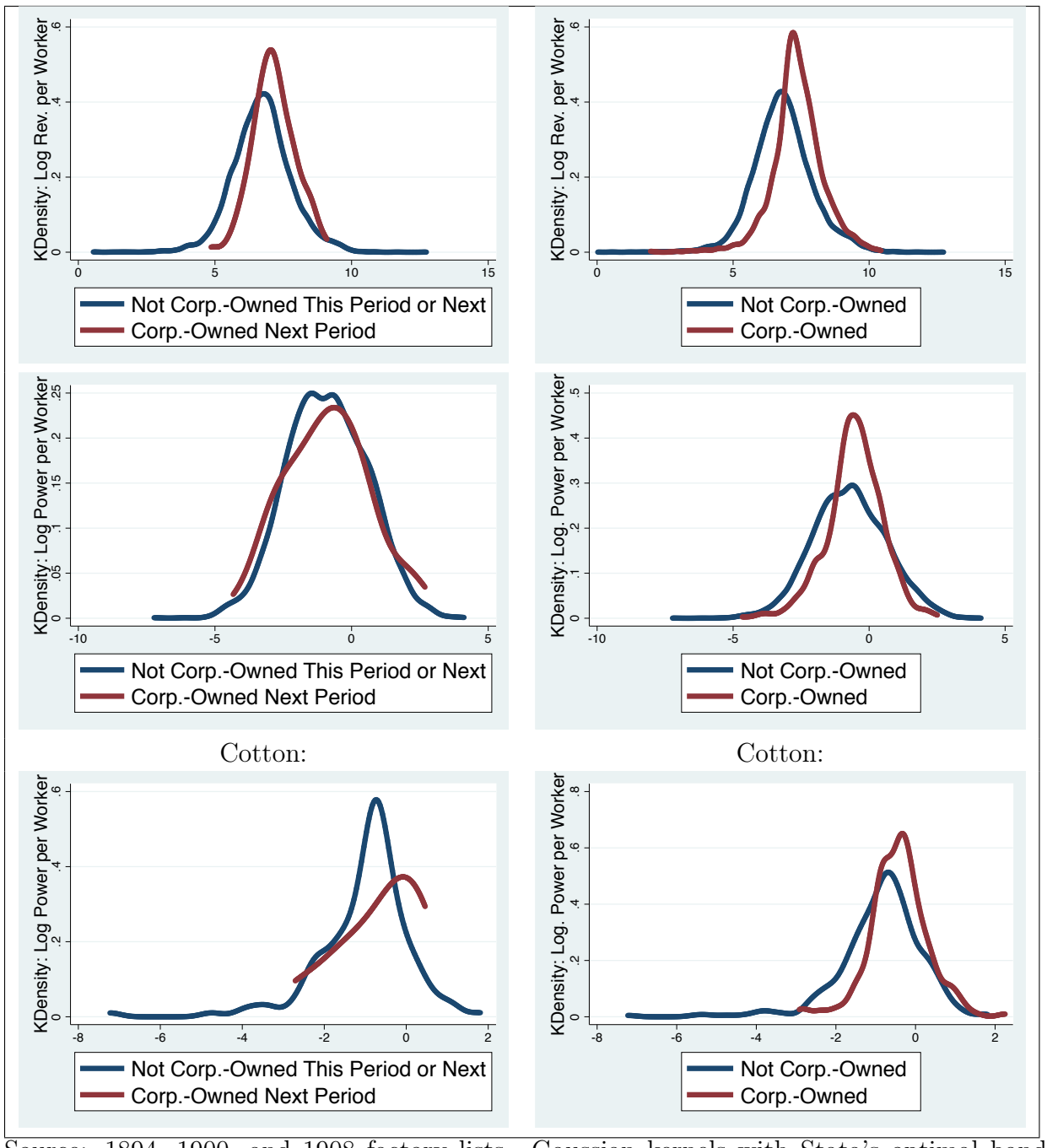
Source: 1894, 1900, and 1908 factory lists. Gaussian kernels with Stata's optimal bandwidths. The line labeled "Corps" is for corporation-owned factories only. The line labeled "NonCorps" is for factories owned by partnerships or single proprietorships.

Figure 4: Kernel Density Estimates of Residuals



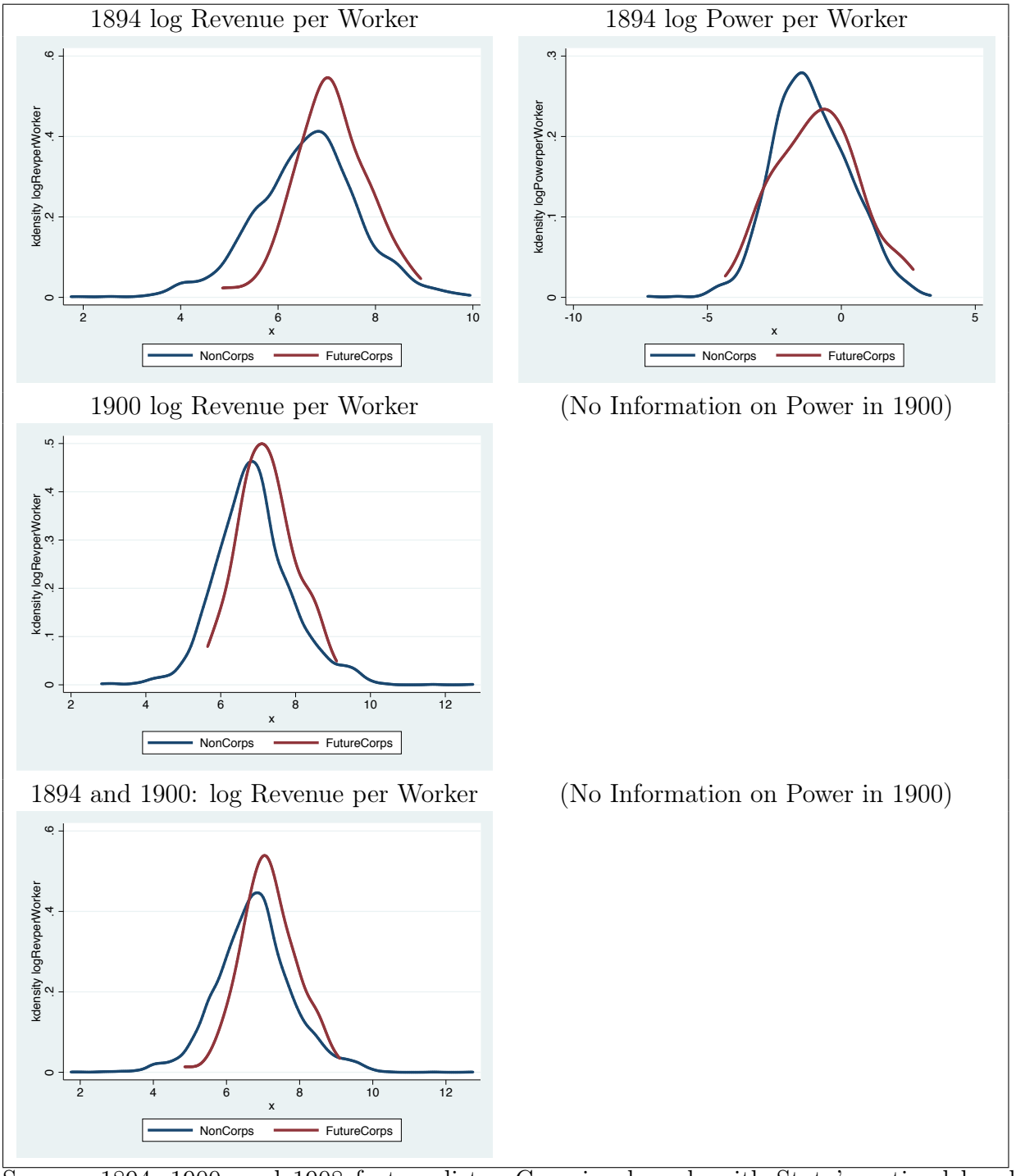
Source: 1894, 1900, and 1908 factory lists. Gaussian kernels with Stata's optimal bandwidths. The line labeled "Corps" is for corporation-owned factories only. The line labeled "NonCorps" is for factories owned by partnerships or single proprietorships.

Figure 5: Kernel Densities for Firms Incorporating within the Sample



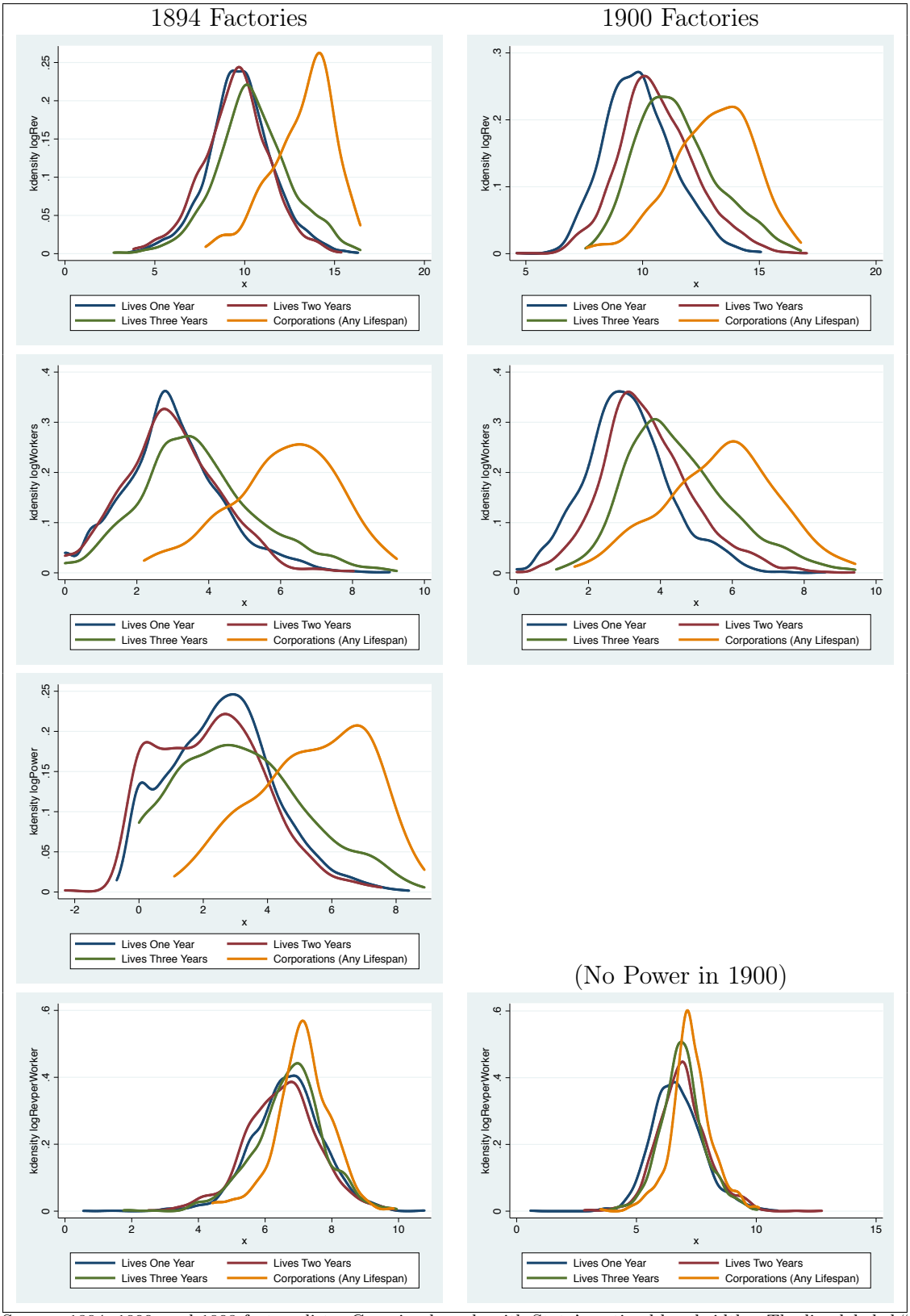
Source: 1894, 1900, and 1908 factory lists. Gaussian kernels with Stata's optimal bandwidths. The line labeled "Corps" is for corporation-owned factories only. The line labeled "NonCorps" is for factories owned by partnerships or single proprietorships. All kernels showing information about machine power excluded 1900, since the 1900 volume has no information about machine power.

Figure 6: Kernel Densities Comparing Future Corporations to Factories that Survive Two or More Periods



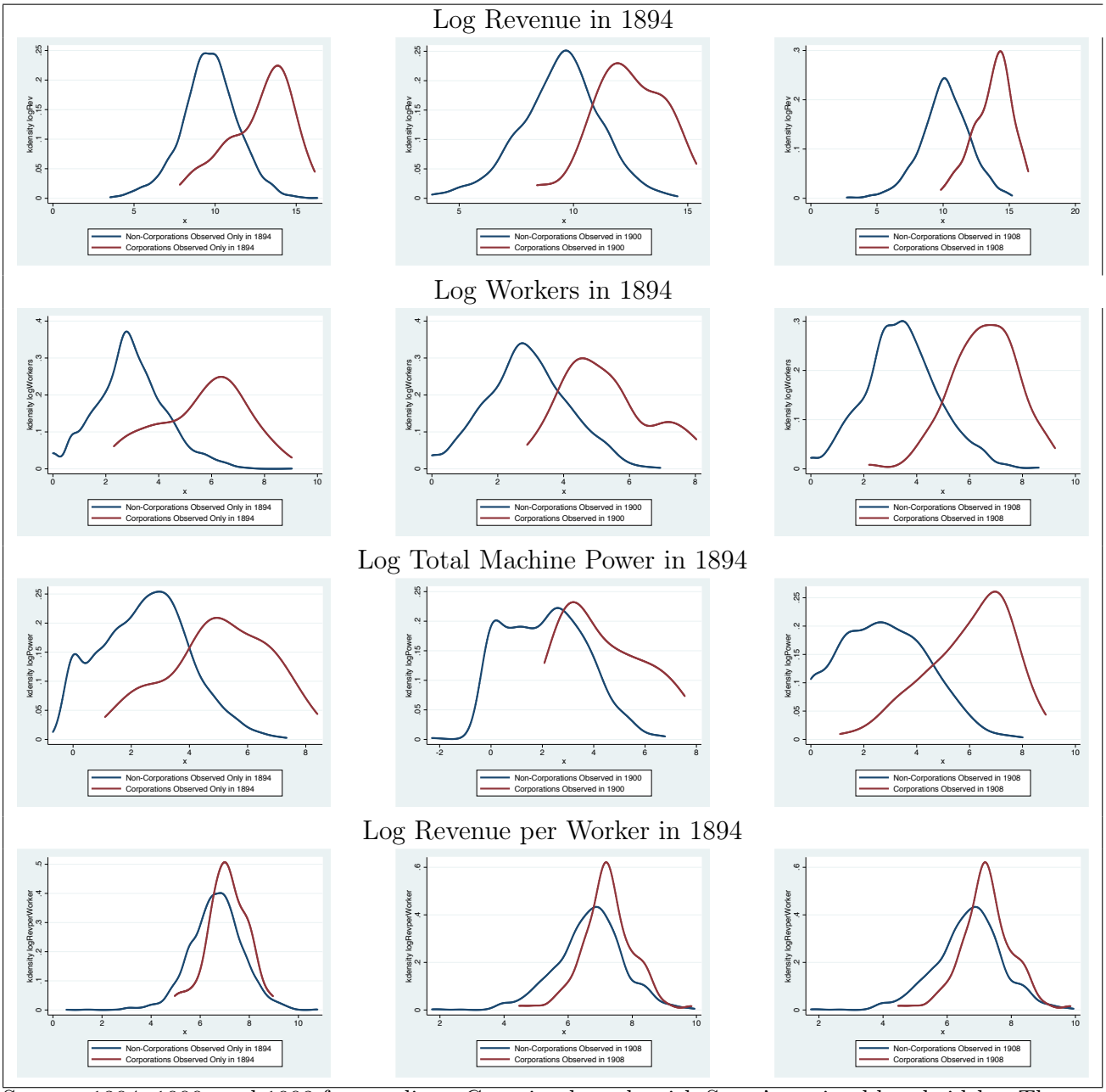
Source: 1894, 1900, and 1908 factory lists. Gaussian kernels with Stata's optimal bandwidths. The line labeled "Corps" is for corporation-owned factories only. The line labeled "NonCorps" is for factories owned by partnerships or single proprietorships. The 1900 volume has no information on power per worker, so any kernels describing machine power exclude 1900.

Figure 7: Variables by Years Survived and by Enterprise Form



Source: 1894, 1900, and 1908 factory lists. Gaussian kernels with Stata's optimal bandwidths. The line labeled "Corps" is for corporation-owned factories only. The line labeled "NonCorps" is for factories owned by partnerships or single proprietorships. The 1900 volume has no information on power per worker, so any kernels describing machine power exclude 1900.

Figure 8: Kernel Density Estimates: Corporation-Owned Factories vs. Other Factories by Years Survived



Source: 1894, 1900, and 1908 factory lists. Gaussian kernels with Stata's optimal bandwidths. The line labeled "Corps" is for corporation-owned factories only. The line labeled "NonCorps" is for factories owned by partnerships or single proprietorships. The 1900 volume has no information on power per worker, so any kernels describing machine power exclude 1900.