Abstract

Factory Productivity, Firm Organization, and Corporation Reform in Late Imperial Russia

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This dissertation shows how firm organization affected factory performance in the Russian Empire. The first chapter documents the impact of incorporation on firms' production technology and productivity. The second chapter studies the effect of a change in Russia's commercial code in 1901, a reform that improved the rights of small corporate shareholders. In the third chapter, I show how geography and legal forms of organization determined horizontal and vertical integration in the Russian cotton textile industry. The dataset at the heart of the project allows for a rare empirical study of the effect of organization on production at the factory level.

Chapter 1: Factory Productivity and the Concession System of Incorporation in Late Imperial Russia, 1894-1908

In late Imperial Russia, long-term capital was scarce. Incorporation in the Russian Empire required a time-consuming and expensive Imperial concession, yet over four thousand Russian firms incorporated before 1914. I identify the characteristics of firms that chose to incorporate and measure the gains in productivity and growth in machine power enjoyed by corporations using a newly-constructed panel database of manufacturing enterprises I compiled from Imperial Russian factory censuses conducted in 1894, 1900, and 1908. Factories owned by corporations were larger, more productive, and grew faster. Higher productivity factories were more likely to incorporate, and after incorporating, they added machine power and became even more

productive. Results from an instrumental variables regression suggest that selection into incorporation was not determined solely by productivity and could be influenced, for example, by connections to government officials. Comparing two kinds of corporations shows that firms sought not just access to stock markets but the corporate form's full set of capital advantages.

Chapter 2: Shareholder Rights and Share Capital: The Effect of the 1901 Russian Corporation Reform, 1890-1905

The Russian 1901 corporation reform increased the rights of small shareholders and removed bankers from corporations' boards of directors. The reform affected one type of corporation (the A-Corporation) more than another type (called the Share Partnership) because one provision of the law created a loophole for Share Partnerships. I thus apply a differences-in-differences approach, studying the differences in corporations of these groups founded before vs. after the reform. The RUSCORP Database (Owen 1990) provides initial charter information from all Russian corporations and from all surviving Russian corporations in 1905. I find that, in response the reform, A-Corporations increased the par value of their shares, reduced their total capitalization, and reduced the number of shares they issued. The reform increased the cost to the firm of having small shareholders; thus, corporations affected by the reform began to resemble the more closely held Share Partnerships.

Chapter 3: Vertical and Horizontal Integration in Imperial Russian Cotton Textiles, 1894-1900

When do firms produce their own inputs instead of purchasing them on the market? In one explanation firms engage in vertical integration to save the cost of transacting on the market, especially when markets are thinner and therefore price risk is greater (Coase 1937). On the other hand, firms that wish to vertically or

horizontally integrate may be unable to do if they face financial constraints, because integration requires additional capital. In the third chapter, I find evidence for a thin markets explanation of integration within the Russian cotton textile industry in 1894 and 1900. The 1894 data provide especially rich information on firms' horizontal and vertical integration: the data list a complete description of each factory's internal activities and final products. Both vertically and horizontally integrated factories and firms were larger in terms of number of workers and tended to be located outside of European Russia, where markets were thinner. Vertically integrated firms were older, had more workers and machine power, and produced more revenue per worker given the same machine power. Corporations produced more revenue per worker than non-corporations, even controlling for vertical integration.

Data Appendix: Imperial Russian Manufacturing Establishments Database: 1894, 1900, and 1908

The dissertation includes an appendix in which I describe the formation of a new database of manufacturing establishments in the Russian Empire based on manufacturing censuses conducted in 1894, 1900, and 1908. The database will allow for new studies of the Russian economy and of factory performance in developing economies. This appendix provides a codebook with variable definitions and a description of the censuses' sampling frame. The database matches factories over time, so I include an analysis comparing matched to unmatched factories. Finally, I describe differences in results that use the enterprise-level data and the aggregate data.

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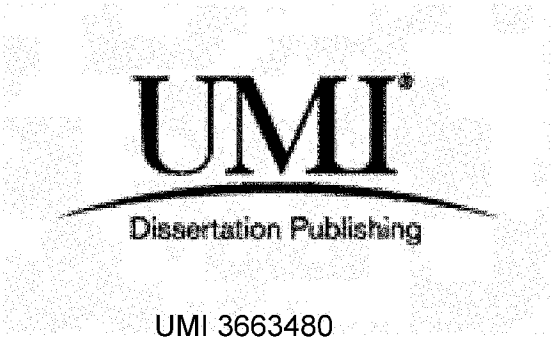

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Chapter 1

Introduction

This dissertation examines the ownership, production, and organization of manufacturing establishments in the Russian Empire to address two central questions in economics: the effect of institutions on economic performance and the nature of the firm. A large literature emphasizes the importance of institutions for economic growth, but exactly how institutions influence individuals' behavior remains unclear. Little empirical work, for example, studies how institutions can cause individual firms to produce more output given the same inputs. A second key question concerns a firm's boundaries: why do certain firms produce their own inputs while others purchase them on the market? Research clarifying how firms establish boundaries must address the characteristics of vertically integrated, multi-plant firms in a variety of environments. Firms' productivity and organization could have large effects on economic growth in countries like Imperial Russia.

I study how Russia's menu of legal forms of organization affected the shape of the country's developing industrial sector and Russian firms' financial decisions, and I study how and why Russian manufacturers chose to organize production across establishments. In the first chapter, I show how a specific institution, Russia's menu

of legal forms of organization, affected firms' production decisions. Russian firms could incorporate only by special Imperial concession, but incorporation granted firms advantages that helped them to raise long-term capital. These advantages included full limited liability, access to stock markets, and the ability to act as an entity. I argue that more productive firms chose to select into Russia's costly and time-consuming incorporation process to secure access to scarce long-term capital.

The second chapter studies how a change in Russia's corporate law in 1901 that increased the rights of small shareholders altered firms' financial decisions as reported on their charters. Affected corporations founded after the reform reduced their total share capital and issued fewer shares with larger par values, change that made them resemble more closely-held corporations.

The final chapter examines horizontal and vertical integration in Russian cotton textiles and the relationship of the organization of production to productivity. I find that both vertically and horizontally integrated factories and firms tended to be located outside of European Russia, where markets were thinner. I also show that vertically integrated factories were more productive and find additional evidence on corporation-owned factories' performance advantages.

The Russian economy at the turn of the twentieth century was poor and mostly agricultural, but its small industrial sector grew rapidly at the end of the nineteenth century.[1] Russia's manufacturing firms faced substantial obstacles to financing long-term capital investments. The small Imperial Russian financial sector offered few opportunities to obtain the kind of long-term capital necessary to finance large ma-

[1]In 1912 Russian per capita income was less than a third of Germany's as measured in 1905 (Gregory 1974, p. 658). Agriculture accounted for about half of Russian national income in 1913 (Goldsmith 1961, p. 442). Russian pig iron output increased from 930,000 to 4,030,000 tons between 1890 and 1910 (Kahan 1989, p. 60). Russian GNP almost doubled between 1890 and 1914 grew at an average annual rate of 2.1 percent (German GNP grew at 1.05 percent) (Maddison Project Database).

chine investments.[2] Limitations on long-term capital explain why incorporation's capital advantages were so valuable and why certain firms chose to vertically integrate.

A central contribution of the project is a new factory-level manufacturing database compiled from three Imperial Russian manufacturing censuses. The database provides information on each Russian factory's location, ownership, production, and organization. I connect this new factory database to the RUSCORP Database (Owen 1992), which describes all corporations founded in the Russian Empire.

This introduction describes the dissertation's main themes. I discuss the dissertation's contribution to the economics of institutions, to Russian economic history, and to understanding the determinants of productivity differences across firms and countries. I conclude with a brief description of the new Imperial Russian factory database.

1.1 Legal Institutions, Enterprise Forms, and Economic Growth

The causal effect of institutions on economic performance is always challenging to measure: rich places may have good institutions because those institutions cause growth, or rich places may be able to afford better institutions. The few studies that explicitly address institutions' endogeneity exploit variation across countries (Acemoglu et. al. 2011, La Porta et. al. 1998). However, economists have an

[2]Russia's financial sector accounted for only 26.9 percent of national assets, compared to 39.5 percent in Germany and 39.3 percent in France. Bank activity in Russia accounted for only 22.3 percent of national assets. By comparison, bank activity comprised 31.1 percent of German national assets (Goldsmith 1985).

interest in how individual agents within an economy confront institutions: we would like to understand the mechanism through which institutions change behavior.

This dissertation studies how legal institutions affect firms' production and finance decisions. I focus on firms' legal form of organization, or enterprise form, especially the choice to organize as a partnership or corporation. 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 as Private Limited Liability Companies whenever possible, not as corporations. Their work presents a counterexample to La Porta et. al. (1998), who use common law as a proxy for a beneficial set of laws. The common law proxy allows La Porta et. al. (1998) to address legal institutions' endogeneity directly and argue that certain laws are causally related to positive financial market outcomes.

My first chapter addresses two central and outstanding questions in the economics of enterprise forms. I study how firms select an enterprise form and how a firm's choice of enterprise form affects its performance. The effect of choosing a certain enterprise form is difficult to measure: certain enterprise forms may cause better performance, or more productive firms may choose a certain legal form of organization. Several works imply the design of the menu of enterprise forms affects growth without directly relating enterprise forms to firm performance. Guinnane et. al. (2007) argue that flexible enterprise forms should have positive effects on economic growth, but their work does not directly relate laws on enterprise forms to individual firms' production or financial decisions. Owen (1991) and Kuran (2003 and 2005) claim that inflexible enterprise form menus contributed to economic stagnation in the Russian Empire and the Ottoman Empire respectively. They criticize both countries'

barriers to incorporation but stop short of directly relating firms' choice of enterprise form and performance, production decisions, or financial strategies.

The dissertation's second chapter exploits a peculiarity of Russian enterprise forms to address a longstanding question in law and corporate finance. The Russian Empire's only major corporation reform, the law of 1901, improved shareholder rights for one group of corporations but not another. This provides an opportunity to evaluate a change in governance rules, with the caveat that the reform cannot be considered a natural experiment. Though the Russian commercial code claimed to treat all corporations equally, in practice firms formed two main types of corporations, which I call A-corporations and share partnerships. Firms that successfully navigated the Empire's concession system paradoxically enjoyed a great deal of freedom in designing their enterprises. Firms chose which kind of corporation to become, and the corporation types had significant differences.[3] I show that the 1901 reform changed how affected firms allocated their share capital. The reform affected A-corporations more than share partnerships. I show that A-corporations founded after the reform reduced their overall share capital, increased the par value of shares, and issued fewer shares. In fact, A-corporations' division of capital into shares began to more closely resemble that of the more closely-held share partnerships.

The third chapter investigates enterprise forms, organization, and finance in Imperial Russia within individual firms and plants. Echoing the first chapter, corporations tended to produce more revenue per worker, even controlling for their degree of integration. Furthermore, I find evidence for explanations of integration based on thin markets. Coase (1937) argued that firms engage in vertical integration to save the cost of transacting on the market, especially when markets are thinner and

[3]The first and second chapters provide extensive descriptions of these differences. Briefly, A-corporations were larger and more likely to sell shares on stock markets. Share partnerships were more likely to raise capital within a tight family group with the addition of a small number of outside investors.

therefore price risk is greater. Vertically and horizontally integrated cotton textile factories and firms tended to be located on the Empire's periphery, where markets were less integrated.

1.2 Russian Manufacturing and Imperial Economic Policy

Russia's industrial sector has remained largely neglected by recent scholarship, despite continuing improvements in access to sources that have permitted scholars to address enduring questions in Russian economic history.[4] A central debate in Russian history concerns the role of the Imperial government in shaping the country's small but growing industrial sector. My dissertation reveals some of the unintended consequences of Imperial Russian industrial policy: restriction of incorporation limited capital accumulation for medium-sized, unincorporated enterprises, and improving shareholder rights decreased corporations' overall share capital.

Alexander Gerschenkron considered the Imperial government's interventions in the industrial economy to be necessary, since Russian markets were not sufficiently developed to support large-scale industrial development.[5] Kahan (1989) depicted a more nuanced and less rosy picture of Imperial policy: he pointed out that the Imperial government's policies often contradicted one another. For example, the government adopted the gold standard in 1897 and enacted protective tariffs but also

[4]The classic volume describing Russia's industrial development is M.I. Tugan-Baranovsky's 1907 work *The Russian Factory in the Nineteenth Century* (*Russkaia fabrika v proshlom i nastoiashchem*).

[5]"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" (Gerschenkron 1962 p. 20).

taxed peasants and industrialists sufficiently heavily to effectively eliminate domestic demand for finished consumer goods.

Russia's concession system of incorporation similarly contradicted other policies designed to stimulate industrial growth. My dissertation's first chapter shows that Russia's concession system of incorporation introduced several distortions to the industrial sector. First, though on average more productive firms chose to incorporate, I also show that productivity was not the only variable that determined selection into incorporation. A social planner might have chosen a different set of firms to receive additional access to capital. Second, costly incorporation restricted access to long-term finance for firms on the margin that might have chosen to incorporate had costs been lower.

Discussions of Imperial industrial policy often compare the Empire's performance to the Soviet Union's. Implicitly, studies ask how developed Russia would have been by the middle of the twentieth century had Tsarist economic policies persisted. Gregory's (1982) re-assessment of Imperial Russian economic growth presented an optimistic assessment of Imperial policy: his estimates showed that Imperial Russian national income grew faster than was previously believed. Allen, however, (2009) explicitly compared Tsarist and Soviet economic policies and concludes that the Russian Empire could never have industrialized as extensively as the Soviet Union. My dissertation shows that Imperial Russia's restrictive incorporation laws undoubtedly limited industrial growth.

Research on Russia's distorted labor market may explain why incorporation could be so valuable. Russian factories may have struggled to substitute labor for capital, making long-term machine investments especially crucial. Nafziger (2010) and Dennison (2011) describe Russia's complex agricultural institutions in detail. Chernina, Dower, and Markevich (2014) argue that the 1906 Stolypin reform, which finally

granted peasants property rights to their farms, stimulated massive migration to Siberia where labor productivity in agriculture was higher.

1.3 Industrialization, Technology, and Productivity

My dissertation demonstrates the effects of firms' enterprise forms and organization of production on productivity in Russia, a late-industrializing country. Explaining the large productivity differences among firms in developing economies remains an active area of research. Productivity differences between producers, even within the same narrowly defined industry, can be large and persistent (Syverson 2011). The sources of these productivity differences remain poorly understood. Moreover, firm productivity can have a large impact on a country's economic performance overall. 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.

My dissertation points out the important role that legal institutions and organization can play in explaining productivity differences across plants in the same industries. In the Russian Empire, incorporation provided access to the long-term capital necessary for the purchase of large machines, which gave corporations large productivity advantages and allowed corporations to grow faster than their unincorporated peers. The large effect of enterprise forms on productivity in Russia supports Hall and Jones's (1999) hypothesis that productivity differences across countries could be due to policies or institutions (Hall and Jones (1999)). Hall and Jones point to the importance of enforcing contracts, eliminating corruption, reducing trade barriers, and minimizing government interventions in the economy (such as, perhaps, granting special concessions for incorporation).

My dissertation's third chapter find that vertically integrated factories and firm are more productive. Bloom and Van Reenen (2007 and 2010) similarly emphasize the importance of organization of production: they show that firms in developing countries use more varied management practices. Over time, changes in organization can have large effects on productivity and economic growth. Adam Smith's pin factory example illustrated how changes in organization, even without accompanying changes in technology, could lead to large increases in productivity. Sokoloff (1984) studies Smith's assertion in the early nineteenth century United States and shows that non-mechanized factories did indeed have productivity advantages compared to artisanal shops. Chapter 3 confirms organization's importance: vertically integrated Russian factories were more productive, even after controlling for total machine power. Legal institutions and organization play an important role in explaining productivity differences across firms and countries.

1.4 A New Russian Factory Database

This dissertation's centerpiece is a new database of Imperial Russian factories, the Gregg Imperial Russian Manufacturing Database. The database includes information from the 1894, 1900, and 1908 Imperial Russian manufacturing censuses, and I have matched factories across years to form an unbalanced panel. The censuses surveyed factories located in European Russia (in 1900) or the entire Empire (1894 and 1908) and excluded small workshops. Factories reported their location, ownership, yearly revenue, number of workers (by month and by gender and age), number and types of machines, and many other production details. The database includes approximately 45,000 factory-level observations, or about fifteen thousand in each year. The first and third chapters represent the first large-scale uses of these Imperial

Russian manufacturing censuses. The dissertation's fourth chapter is an extended appendix describing the database's composition and content.

Factory-level data that includes individual firms' legal form of organization and production methods are crucial for studying firms' enterprise form choices, the effect of choosing a certain enterprise form on production, and variation in vertical integration: enterprise form and internal organization are firm-level and factory-level characteristics. Because factories are matched over time, I can study firm growth and selection into enterprise forms.

The database includes impressive detail on tens of thousands of factories and provides additional variables that describe factories at the province-industry level in 1900 and 1908, since for those census years the government published aggregate volumes with additional information. The 1894 factory-level data provide each factory's name and location; founding date; total yearly revenue; number of workers by age and gender; value of fuels consumed; number, type, and horsepower of all machines; and a description of all productive activities the factory performed. The 1900 and 1908 provide each factory's name, location, total yearly revenue, and number of workers; the 1908 data also provides information on each factory's machine number, type, and horsepower. The 1900 and 1908 aggregates add information on factories' machines, fuels, materials, workforce composition, and expenses (including the total wage bill, taxes, and insurance). This dissertation focuses on the factory-level data but includes some analysis using the province-industry level volumes.

1.5 Conclusion

This dissertation uses newly collected Russian factory data to address central questions in the economics of institutions, development economics, and corporate

finance. The three chapters reveal strong relationships among Russian firms' decisions over production, finance, and organization. The following three chapters address Russia's concession system of incorporation, 1901 corporate reform, and organization of production. The database at the heart of the project will be of interest to economists studying economic development, industrial organization, economics of institutions, and economic history. The dissertation's fourth chapter provides a complete description of the database in preparation for public release.

Chapter 2

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

2.1 Introduction

The corporate form of organization's role in industrial growth remains controversial. Yet there is little research that explicitly studies the relationship of incorporation to performance or production decisions at the enterprise level. Even less is known about the relationship between a firm's legal form of organization and production technology in developing economies. In late-industrializing countries, incorporation may be especially valuable for productivity-enhancing investments when choices of legal form of organization and alternative methods of long-term finance are limited. This paper examines incorporation in the Russian Empire and shows that more productive firms selected into a costly incorporation process to gain access to additional long-term capital.

The Russian Empire had no general incorporation law. Firms wishing to incorporate needed to obtain a time-consuming and expensive Imperial concession.[1] Over four thousand Russian firms incorporated between 1700 and 1914. Why did these firms undertake the costly investment of incorporating? Figure 2.1 provides part of the answer: in the cross section, factories owned by corporations were more productive and had more capital in terms of machine power.[2] But the differences between corporations and non-corporations shown in this picture embody both the differences that motivated selection into incorporation and the causal effect of incorporation on performance.

This paper studies the decision to incorporate and the returns to incorporation using a newly constructed panel database of manufacturing enterprises from Russian factory censuses of 1894, 1900, and 1908. Crucially, I match individual factories over time and can thus study selection into incorporation directly. I show that firms that incorporated in period $t+1$ were in period t already more productive than their non-corporate peers. The corporate form then gave Russian firms advantages in raising capital, including access to foreign and domestic stock and bond markets, full limited liability, and locked-in capital. In late Imperial Russia, the long-term capital necessary for firms to expand was scarce. Incorporation allowed firms to acquire more powerful machines, grow faster, and become even more productive than they were before incorporating.

I begin with a simple model. More productive firms incorporate to gain access to lower investment costs. But incorporation requires payment of a large fixed cost. Results under pooled OLS are consistent with this model. Corporation-owned factories were more productive and had more machine power. Because incorporation

[1]The Tsar signed corporate charters personally.

[2]The data for Figure 2.1 come from three Russian manufacturing censuses, the main data source for this paper. Section 2.3 describes the new database in detail.

is endogenous, OLS results may overstate incorporations' benefits. To separate the characteristics that drive selection into incorporation from the benefits gained by incorporating, I examine factories that became corporations within the sample frame, present results using factory fixed effects, and compare growth by factories owned by corporations with other factories. I also construct an instrument for a factory's enterprise form: the relative difference in revenue per worker between corporations and other forms in a given province, industry, and year. The instrument represents corporations' advantage in a given location and industry; where the quantity was large, more firms incorporated. Results from IV regressions suggest that productivity alone did not motivate selection into the corporate form. Firms faced additional obstacles to incorporation.

Finally, Russian commercial law allowed two types of corporations, one of which did not float shares on equity markets. I treat all corporations identically for most of the paper. In the final section, I compare the two types and find only small differences in performance between them. Comparing these two kinds of corporations shows that firms sought not just access to stock markets but the corporate form's full set of capital advantages.

Russian per capita income in 1912 was less than a third of that in Germany in 1905. The Imperial Russian economy remained mostly agricultural. Gerschenkron argued that a major obstacle to Russian industrialization was the country's extreme scarcity of capital and bank credit. Russia's poor, largely agricultural economy began to grow rapidly at the end of the nineteenth century. Between 1890 and 1910, Russian pig iron and coal output more than quadrupled, and cotton consumption more than tripled. Russian GNP almost doubled between 1890 and 1914.[3] This

[3]See Gregory (1974, p. 658) for Russian per capital GDP comparisons. As late as 1913 about two thirds of Russia's population was engaged in agriculture, and agriculture accounted for almost half of national income (Goldsmith 1961, p. 442). According to Gregory (1974), Russia's manufacturing

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

A large literature in economics studies how a country's legal institutions influence economic development. This paper presents a rare factory-level analysis of legal institutions' economic effects. Measuring the effect of institutions on economic performance is challenging, because institutions are endogenous to economic conditions, and most work that deals with this endogeneity involves country-level studies. La Porta et al. (1998) argue that some laws are positively related to financial market outcomes, using common law as a proxy 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. Their work relies on examples of developed economies and does not directly relate enterprise form law to individual firms' productivities or production choices. 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.[4]

divided by GNP was about 18 in 1912. In the United States in 1919, that ratio was 19, in France between 1896 and 1929 it was 35, and in Germany in 1905 it was 33. Russia, then, lagged behind the United States and Western Europe in the proportion of GNP accounted for by manufacturing. Gerschenkron (1962, p. 20) describes industrialization and Russia's underdeveloped capital markets. Pig iron output increased from 930,000 to 4,030,000 tons, coal output increased from 6,015,000 to 25,000,000 tons, and cotton consumption increased from 136,000 to 424,000 tons between 1890 and 1910 (Kahan 1989, p. 60). Between 1890 and 1914 Russian GNP grew at an average annual rate of 2.1 percent. By comparison, French GNP grew at an average annual rate of 1.37 percent, German at 1.05 percent, and U.S. at 1.62 percent. From Angus Maddison's estimates. Available: `http://www.ggdc.net/maddison/maddison-project/data.htm`.

[4]Atack and Bateman (2008) and Hilt (2014) connect enterprise form to firm size and performance in the nineteenth-century United States. Neither explicitly measures selection into enterprise forms.

This paper's results show significant differences in performance for factories owned by corporations. The legal structure of a firm, then, can play a role in explaining variation in productivity across firms in developing countries. In the Russian Empire, incorporation was key to gaining access to foreign and domestic sources of capital. I argue that access to capital explains differences in labor productivity between factories owned by corporations and by other forms. Hsieh and Klenow (2009) argue that the misallocation of inputs between efficient and inefficient firms explains a great deal of the difference in output per worker between China or India and the United States. Differences in firm organization could be important to explaining these large productivity differences.[5]

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) famously described the Russian economy as "backward," and he argued that the state substituted for lack of domestic demand for manufactured products. None of the many studies of the Russian economy, however, has made extensive use of Russian manufacturing censuses or documented the performance of individual enterprises in the Russian Empire.[6]

The paper proceeds as follows: Section 2.2 explains the Russian incorporation process. Section 2.3 provides a description of the data on manufacturing establish-

[5]Bloom and Van Reenen (2007 and 2010), for example, argue that management practices vary more widely in developing countries, which contributes to differences in firm productivity.

[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. Several scholars have compared economic performance in Imperial Russia 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. Kahan (1989) was less optimistic than Gerschenkron about the impact of government policies, which often contradicted one another. Recent work by Nafziger (2010) and Dennison (2011) has described Russian agricultural institutions in detail and has added to what we know about the largest sector of the Russian economy.

ments in the Russian Empire. Sections 2.4 and 2.5 describe hypotheses and results. Section 2.6 concludes.[7]

2.2 Incorporation in the Russian Empire

Businesses in the Russian Empire chose from a limited menu of enterprise forms. Entrepreneurs could organize their operations as single proprietorships, partnerships, limited partnerships, or a corporations. Under each of these forms, Russian businesses possessed a set of privileges and limitations. Crucially, 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. By the late nineteenth century, Germany, France, the United Kingdom, and the United States had all introduced general incorporation.[8] By contrast, firms in the Russian Empire wishing to incorporate submitted charters to the Ministry of Finance and agreed to any changes requested.

Table 2.1 shows the differences between corporations and all other enterprise forms in the Russian Empire.[9] Simple partnerships consisted of two or more unlimitedly liable partners. Limited partnerships consisted of one or more unlimitedly

[7]A short appendix is included at the end. The appendix presents a counterfactual exercise, additional model details, and additional empirical results. I show that Russia's high incorporation costs greatly reduced industrial output. I also show that the paper's results are consistent when I use different forms of the production function, such as translog production functions, and quantile regressions. I also show that results are unchanged when total factor productivity is estimated by imposing labor and capital shares. I analyze the sensitivity of the production function estimates to the inclusion of the smallest factories. Finally, I show that corporation-owned factories did not use more expensive materials, and I estimate a value-added production function for a small subset of the data for which I have data on the value of materials.

[8]General incorporation was introduced in the German states in the 1860s and 1870s, in France in 1867, in the United Kingdom in 1855-56, and in the United States "mostly in the middle third" of the nineteenth century (Guinnane et al. 2007 p. 692).

[9]The Law of 1807 described three enterprise forms: the simple partnership, the limited partnership, and the corporation. The law used the Russian terms *tovarishchestvo polnoe* (lit. "full partnership"), *tovarishchestvo na vere* (lit. "partnership on trust"), and *tovarishchestvo po uchastkam* (lit. "partnership in shares") for the partnership, limited partnership, and corporation.

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*).[10] Full and limited partnerships could be formed by signing a private contract among individuals.[11]

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.[12] However, the Imperial government only granted this special privilege of complete limited liability to firms that had obtained permission from the Ministry of Finance.[13] Though obtaining permission made incorporation costly, the corporate form provided advantages in raising long-term capital, which allowed firms to buy newer or better machines and substitute capital for labor while increasing output. Corporations could sell shares on domestic and foreign stock and bond markets, though many corporations chose not to. Corporations' full limited liability encouraged additional equity investment, though limited liability also increased risk to the company's potential creditors. Finally, corporations could act as entities, which al-

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

[11]To formally establish the partnership, the partners needed to present their contract to a municipal clerk. 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 Fond 23, Opis 11, Delo 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.

[12]I use the terms "joint stock company" and "corporation" interchangeably, since Imperial Russian law did not distinguish these forms. 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." Polnoe Sobraniie Zakonov (Complete Collection of Laws) I-22418, Ot. 1, St. 1: "Сверхъ того бываетъ товарищесво по участкамъ, которое слагается изъ многихъ лицъ, складывающихъ во едино определенныя суммы, коихъ извесное число даетъ складочный капиталъ."

[13]According to the law, "such kinds of companies command such importance to the national economy, that they may only be founded with our permission." Polnoe Sobraniie Zakonov (Complete Collection of Laws) I-22418, Ot. 1, St. 1: "Но какъ цель онаго служитъ важнымъ видамъ Государственнаго хозяйства, то сего рода компанія учреждается съ Нашего утвержденія..."

lowed them to use capital in a reasonable way more cheaply, and corporations did not dissolve when the identities of the firm's principals changed.[14]

Firms budgeted large sums for the incorporation process (McKay 1970), which funded any fees and the hiring of lawyers or agents to prepare necessary documents.[15] 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.[16] The Russian incorporation system actually granted firms a great deal of flexibility in their operations, since each firm had its own individual charter. This flexibility allowed for the emergence of two types of corporations, which I describe in more detail in Section 2.5.7.

Incorporating Russian firms of this period faced a complex bureaucratic incorporation procedure. Consider the example of the Ramiba Bentwood Furniture Company of Penza, which incorporated in 1905. Its application traveled smoothly through the Imperial bureaucracy and reflects the process's complexity. The company sent its first application to the Ministry of Finance Commerce Department on March 31,

[14]While each of these corporation characteristics presented advantages for raising equity capital, they could also have created governance problems. For example, managers may not respect the interests of small corporate shareholders. I assume these governance problems are small compared to the advantages in raising additional capital.

[15]Bribery may have been part of the process, though I have encountered no documentary evidence of bribes.

[16]The law of 1836, the Empire's most important corporation law, dictated that "proposed charters underwent review by the appropriate ministries and the Committee of Ministers (from 1905 onward, the Council of Ministers) before being submitted to the tsar for his signature," a procedure that "remained in force to the end of the tsarist period" (Owen, *Corporation*, 18-9). The only corporations ever exempted from this system were small firms that issued credit like pawn shops, warehouses, and small banks, which after 1872 could incorporate by registration. 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]., 50.

1905 asking to found a corporation with 600,000 rubles[17], divided into 250 shares.[18] On May 4, the Credit Department certified the company's financial standing to the Commerce Department.[19] Next, on June 13, the Penza police inventoried the company's immovable property to the Ministry of Finance.[20] In late September, the Commerce Department advised Ramiba that the Department planned to send the charter to the Council of Ministers for approval.[21] Finally, on October 15, the Ministry of Finance formally approved the charter, and on November 13, 1905, the Ramiba Company became a corporation when the charter was published as law.[22] Under a general incorporation system, none of these steps would have been necessary: a firm that would have met a general incorporation law's requirements could have simply registered at a government office.

Firms in the Russian Empire had few sources of long-term capital. Credit institutions developed slowly and focused on short- and medium-term financing, primarily by discounting bills of exchange. Once banks began to provide long-term financing, they did so by buying stock in corporations.[23] In all, the Russian financial sector was small, only representing 26.9 percent of national assets, compared to 39.5 percent in Germany, 39.3 percent in France, or 42.9 percent in the United States (1912). Russian bank activity comprised 22.3 percent of its small economy, compared to 31.1 percent in Germany (Goldsmith 1985).

[17]A ruble in 1900 was worth approximately $15 in today's USD (Denzel 2010 and `www.measuringworth.com`, using the St. Petersburg to London gold ruble exchange rate, 1900 GBP to dollar rate, and the CPI).

[18]RGIA Fond 23 Opis 12 Delo 28 List 1: Об учреждении Общества первой Пензенской паровой фабрики гнутой венской мебели "Рамиба" [On the founding of the First Penza Bentwood Furniture Corporation].

[19]RGIA Fond 23 Opis 12 Delo 28 List 16.

[20]RGIA Fond 23 Opis 12 Delo 28 List 21.

[21]RGIA Fond 23 Opis 12 Delo 28 List 24.

[22]RGIA Fond 23 Opis 12 Delo 28 List 26 and 39: Об учреждении Общества первой Пензенской паровой фабрики гнутой венской мебели "Рамиба" [On the founding of the First Penza Bentwood Furniture Corporation].

[23]See Crisp (1976), Chapter 5.

Firms emphasized incorporation's advantages in capital access and long-term survival when explaining why they incorporated. For example, the Nikol'skaia Manufaktura Savvy Morozova incorporated in 1872 "for the continuation and development" of the firm's enterprises.[24] For Savva Morozov, incorporation aided both "continuation" through the corporation's ability to act as an entity and "development" through additional capital. Similarly, the Babaev Fireproof Brick Company incorporated in 1888 because, before incorporating, "the distribution and marketing of my new material [was not] able to move forward on any significant dimension in the absence of large-scale capital for the development of [their] project."[25]

Several thousand firms incorporated in the history of the Russian Empire, despite the many legal obstacles facing firms wishing to incorporate. Table 2.2 Panels A and B document the number of corporations created over the history of the Russian Empire and present rates of incorporation by industry. A large number of corporations were founded between 1890 and 1914, a period of rapid industrial growth in the Empire. 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.[26] Capital-intensive industries like textiles and metals attracted large numbers of corporations relative to the number of firms in these sectors. Descriptive statistics from the data on manufacturing establishments presented later in the paper will confirm this pattern.

[24]"...учреждено Товарищество под фирмою «Никольская Мануфактура Саввы Морозова Сын и Ко» для продолжения и развития деятельности всех этих учреждений." From the *Partnership of Nikol'skaia Manufaktura Savvy Morozova and Son for the All-Russia Industrial and Artistic Exhibition of 1896 in Nizhny Novgorod* (1896), page 6.

[25]"Распространение и сбыть моего огнеупорного состава до сих пор не могли двинуться вперед в широким размере, за неимением крупного капитала для развития этого дела." From: *Explanatory Notes on the Founding of Babaev's Share Partnership for the Production and Distribution of Fireproof Materials* (1888), page 7.

[26]The foods industry has a large number of corporations because the industry overall has a large number of firms. Table 2.5 shows that the concentration of corporations in this industry is actually quite small.

2.3 A Panel of Russian Manufacturing Establishments

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. These are not the only factory surveys from Imperial Russia, but they provide the richest data and widest coverage. The factory-level data are matched to a list of all corporations founded in the Russian Empire to identify which factories are owned by corporations. In the following sections, I describe the construction of the database of manufacturers and the procedures used to identify corporate factories.[27]

2.3.1 The Manufacturing Censuses

The sources underlying the data (henceforth the Gregg Imperial Russian Manufacturing Database) that allow me to test these hypotheses are census manuscripts, published factory-level volumes, and published aggregate volumes. Table 2.4 documents the number of factories in the dataset, and Table 2.3 shows the available variables for each census year. Variables at the factory-level, the focus of this study, include factory name, revenue (in rubles), total workers, industry, location, and, in 1894 and 1908, total machine power. The factory-level dataset describes 16,885 factories in 1894, 12,855 in 1900, and 13,489 in 1908. I collect all available factory-level

[27] A complete codebook and data appendix is available from the author upon request.

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.

data from European Russia and match factories across years. The census's authors sought to include only true factories, not small workshops. Since small workshops were unlikely to incorporate, the data cover the population of potential corporations.[28]

The government published a factory-level volume describing the over nineteen thousand factories surveyed in the 1894 census. 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;[29] 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.[30] The 1900 and 1908 censuses, on the other hand, have factory-level volumes which list several 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.[31]

[28]The data describe machines in the sense of engines that provide power. For example, the data might describe a steam engine with a certain quantity of horsepower that provides power to a loom. In additional to matching factories over time, I also match all 1900 factories to their corresponding province-industry groups in the aggregate volumes. See the appendix at the end of the paper for more detail on census coverage.

[29]In all three years of the data (1894, 1900, and 1908), machines are power-delivering engines such as steam engines, gas engines, windmills, and horses. Each type of machine's power is measured in standardized horsepower units (even horses, which have approximately 1 horsepower each).

[30]The archive holds manuscripts for almost every factory in certain province industry groups and no manuscripts at all for most province industry groups, which suggests that the archivists chose to keep manuscripts only for certain industries and locations.

[31]The Russian State Historical archive unfortunately only holds manuscript census records for the 1894 census and not for the 1900 or 1908 censuses.

The 1894 factory list presents information in large tables in which each row describes a single factory. The 1900 and 1908 factory lists, however, present information in the form of short paragraphs. Figure 2.4, an example from the 1900 factory list, 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.

2.3.2 Identifying Corporations

The factory lists include the complete name of each factory, which includes the name of the proprietor, partners, or corporation that owned the factory.[32] I identify corporations using a list of all corporations founded in the Russian Empire.[33] I match individual factories in all three years of factory-level data to the corporation list by name, location, and industry.[34] Table 2.4 shows many establishments I identify in each year as belonging to corporations and, of those, how many belong to distinct corporations (a corporation is a firm and thus may own several factories). The number of corporation-owned factories I identify increases greatly between 1894 and 1900, because many new corporations were founded in this period. Corporation-

[32]One could identify the majority of corporations simply by their name, since the Ministry of Finance required that corporations use the word "corporation" in their firm name. Matching to RUSCORP, however, guarantees that I capture as many corporations as possible.

[33]Thomas C. Owen. *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].)

[34]By contrast, Atack and Bateman (2008) identify enterprise forms only according to firm names: single proprietorships are firms with one person's name, partnerships are those with more than one person's name, and corporations are firms without person's names attached. This paper identifies corporation-owned factories with greater certainty thanks to the existence of a list of all Imperial Russian corporations.

owned factories were relatively rare: corporations owned only 807 of the 13,489 factories in 1908.

2.4 The Decision to Incorporate

Consider the following simple model of a firm's incorporation decision.[35] Suppose there are two kinds of firms: corporations (subscript C) and non-corporations ("partnerships," subscript P). Firms are price-takers in the price of output p, the cost of labor w, and the cost of capital (r_c or r_p). Corporations have a lower cost of capital than partnerships ($r_c < r_p$), but partnerships can only become corporations by paying a fixed cost T. Profits for corporations and partnerships are thus given by:

$$\pi_c = pQ(A, L_c, K_c) - wL_c - r_cK_c - T \text{ [1]}$$

$$\pi_p = pQ(A, L_p, K_p) - wL_p - r_pK_p \text{ [2]}$$

A firm chooses to be a corporation if $\pi_C > \pi_p$. Suppose that the quantity of output is given by $Q = AF(, L, K) = AL^{\alpha}K^{\beta} = AL^{7/10}K^{2/10}$, and set $p = 1$.[36] After taking first order conditions to find firms' optimal use of labor and capital given their profit functions, plugging in the expressions for labor and capital into $\pi_c > \pi_p$, and solving for T, I find:

$$T < Const * \left(\frac{2}{10}\right)^2 A^{10} \left(\frac{7/10}{w}\right)^7 \left[\frac{r_p^2 - r_c^2}{r_p^2 r_c^2}\right] \text{ [3]}$$

[35] Many of the implications would be similar in a model adapting Melitz (2003), in which firms pay a fixed cost to access additional input markets rather than paying a fixed cost to access export markets.

[36] I use these values for α and β because they are approximately equal to the coefficients on log labor and capital in an OLS log Cobb-Douglas production function, including controls for a factory's legal form of organization.

T increases in corporations' capital cost advantage ($r_p - r_c$,) and in productivity A. The model, then, predicts that higher productivity firms are more likely to incorporate. Also, since $\frac{K}{L} = \frac{\beta w}{\alpha r}$, corporations will use relatively more capital per unit of labor than non-corporations.[37] Finally, notice that in the expression for T above, 2/10 is β, the weight on capital.[38] Thus, the fixed cost firms are willing to pay is increasing in the capital weight β, so I expect more corporations in more capital-intensive industries.

Testing the predictions of the model proceeds in several steps. First, I examine cross-sectional differences between factories owned by corporations and by non-corporations and show how these differences vary by industry. I begin by treating a factory's enterprise form as exogenous, acknowledging that differences between factories owned by corporations must embody both selection into incorporation and the effects of having the corporate form itself. Later I examine selection explicitly by documenting the characteristics of factories that change form in the sample (switching form is not exogenous, but switchers' characteristics are informative) and by using an instrumental variables approach.

My baseline specifications for much of the paper are the following regressions:

$$log(Rev/Worker)_{ijt} = \gamma_1 Corp_{ijt} + \phi_1 X_{ijt} + \epsilon_{ijt} \text{ [4]}$$

$$log(Power/Worker)_{ijt} = \gamma_2 Corp_{ijt} + \phi_2 X_{ijt} + \nu_{ijt} \text{ [5]}$$

In this equation, for factory i, industry j, and year t, $log(Rev/Worker)_{ijt}$ is log revenue (measured in Rubles) per worker, $log(Power/Worker)_{ijt}$ is log total machine power (measured in horsepower) per worker, and $Corp$ is a dummy variable

[37] See the appendix (available from the author) for additional details from the model and its solution.

[38] Elsewhere in the derivation of T, β appears in the denominator of powers with a negative sign, so T generally increases in β.

indicating that the factory is owned by a corporation. The variable X_{ijt} represents controls for a factory's province, industry, and year.

The model predicts $\gamma_1 > 0$ and $\gamma_2 > 0$ under pooled OLS: corporations should have more revenue per worker and machine power per worker in a given location, industry, and year. A panel regression with factory fixed effects should also show $\gamma_1 > 0$ and $\gamma_2 > 0$, with a different interpretation: with factory fixed effects, the coefficients γ_1 and γ_2 reflects the change in revenue per worker and power per worker experienced by a factory that switches form to become a corporation.[39] Factories that become corporations should become more productive (in a revenue per worker sense) and should add machine power, and the increase in labor productivity should act primarily through the addition of machines.[40]

2.5 Incorporation: Implications for Productivity and Capital

Tables 2.6 through 2.14 show that factories in the Russian Empire owned by corporations have higher average revenue, bigger machines, and more workers. Corporation-owned factories are also more productive and use more powerful machines.

[39]Regressions with factory fixed effects do not include province, industry, or year controls. Information on a factory's province and industry is contained in the factory fixed effect.

[40]This paper focuses on labor productivity (revenue per worker) and machine power per worker rather than total factor productivity, because measuring individual firm productivity presents many challenges. Marschak and Andrews (1944) first pointed out that measuring productivity as the residual of a regression like Equation 5 is plagued by simultaneity and selection biases, which motivate input proxy methods like those in Olley and Pakes (1996), Levinsohn and Petrin (2003), or Ackerberg et. al. (2006). I present results using log Cobb-Douglas production functions in the appendix, because as Syverson (2011) argues, "the inherent variation in establishment- or firm-level micro data is typically so large as to swamp any small measurement-induced differences in productivity metrics" (332).

2.5.1 Overview of Corporate and Non-Corporate Factory Characteristics

Table 2.5 shows the number of corporations and their contributions to total output for each industry. The chemicals, cotton, and metals and machines industries have the largest percentage of corporate factories and the highest percentage of output from corporations. This is a similar result to what is shown in Table 2.2, 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. Corporation-owned factories contributed to Imperial Russia's rapid industrial growth in this period.

While entrepreneurs founded corporations in even the most remote parts of the Russian Empire, Figures 2.2 and 2.3 show how corporations' number and concentration varied by province. The Empire's industrial center (including Moscow and Vladimir Provinces), St. Petersburg Province, and parts of Poland had both the highest numbers and highest concentrations of corporations. Corporations also owned large numbers of industrial enterprises in the Baku oil region (Bakinskaia Province).

Table 2.6 presents 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. Factories owned by corporations were older and had more revenue, more workers, and more machine power. These differences are highly statistically significant. Revenue per worker was also larger for corporation-owned factories.[41] In these descriptive statistics, which do not control for factories' industries or size, corporations had less power per worker. The power per worker comparison distorted by the inclusion of very small factories

[41]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.

that have a high power per worker quotient only because they have so few workers. When factories with fewer than fifteen workers are excluded, corporation-owned factories have significantly more power per worker. Figure 2.5 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.

Cotton production is capital-intensive, which makes incorporation particularly vital for firm expansion. Table 2.5 shows that the cotton industry has the largest proportion of corporation-owned factories. Table 2.7 reports that corporation-owned cotton factories had greater revenue, workers, total machine power, and revenue per worker and that these differences are statistically significant (the smallest t-score from a two-group mean comparison test for any of these variables is 4.46). Significantly, corporations had more machine power per worker in the cotton industry: the use of machine power varied greatly across industries.

2.5.2 Corporations Had More Revenue per Worker and Power per Worker: Regression Results

The previous section showed that factories owned by corporations had more revenue per worker and more machine power overall. This section shows that these relationships hold even controlling for a factory's location, industry, and year of observation. Table 2.8 shows results from pooled OLS regressions in which the dependent variable is revenue per worker or total machine power per worker. Standard errors are clustered by region, industry, year groups.

Corporations were more productive and used a more capital-intensive production method. Columns 1 and 2 show that Russian corporations had more revenue per

worker and more power per worker than non-corporations. Furthermore, the model predicts that the differences between corporations and non-corporations should vary by industry: incorporation should be most valuable in capital-intensive industries. Table 2.9 shows that corporations have the highest advantages in industries that require large capital investments like silk, chemicals, cotton, paper, and metals and machines (though the interaction coefficient is only statistically significant in the cotton case). However, these regressions treat each factory's enterprise form as exogenous. The coefficient on the "corporation" variable, then, may overstate the effect of incorporation if factories that chose to become corporations had more revenue per worker or power per worker before incorporating. The following sections separate differences between corporations and non-corporations due to selection from those due to the effects of incorporation itself.

2.5.3 Characteristics of Factories That Became Corporations

Within the database, I identify several hundred factories that became corporations in the next period. The characteristics of factories that switch form reveals a great deal about selection into incorporation. I show that factories that became corporations in later period already had more revenue per worker than their non-corporate peers but did not have significantly more power per worker until after they incorporated. Changes experienced by factories that switch form, however, may overstate the effect of incorporation, since such factories may have possessed a more positive growth path than their non-corporate peers.

Many corporations were new enterprises, and some partnerships changed their name once incorporated, so the number that change form to become corporations in the next period is small. 149 partnership-owned factories in 1894 became corporation-owned factories by 1900. 118 partnership-owned factories present in the 1900 data

became corporation-owned in 1908 (see Table 2.10). Table 2.10 Panel B displays a greater proportion of factories that switch form in capital-intensive industries, especially cotton and metals and machines.

The left-hand column of Figure 2.6 shows plots of kernel density estimates for the natural log of revenue per worker and power per worker for these factories before they incorporated with those densities for other non-corporation-owned factories. The future corporations' revenue per worker density is clearly located to the right of that for other factories.[42] Furthermore, factories that became corporations in the next period had less power per worker compared to the "non-switchers," which suggests that those factories that became corporations had been capital-constrained. Table 2.11 shows similar patterns. Before incorporation, factories that will switch form had more revenue per worker and less power per worker (Panel A). Panel B introduces controls for industry, province, and year: factories that will switch form had more revenue per worker before incorporating, but they did not have more power per worker. Incorporation allowed factories to add machine power. Panels A and B in Table 2.11 include data only from years 1894 and 1900 for a proper comparison of factories that switch form to factories that do not, since there are by definition no firms that switch form in 1908. However, results do not change substantially if non-switching factories from 1908 are included.

The right-hand column of Figure 2.6 shows kernel density estimates that show how the "switchers" changed once they became corporations. Revenue per worker has moved to the right, and power per worker has changed shape. Median power per worker has increased, though the difference in means is not statistically different from

[42]The difference is statistically significant according to a two-sample t-test or a Wilcoxon rank-sum test.

zero.[43] Factories that switched form were more productive and had more machine power after incorporating. The fixed effects regressions shown in Section 2.5.4 provide stronger evidence that this is the case.

Figure 2.7 reports comparisons that take into account the fact that factories that switched form must be observed in at least two periods. 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.[44] More productive factories chose to incorporate, and once they incorporated, they added machine power. The corporate form offered capital advantages that allowed factories to use a more capital-intensive mix of inputs.

2.5.4 Outcomes for Factories that Changed Form: Fixed Effects Regressions

So far, this paper has presented results that show differences between corporations and non-corporations in pooled OLS, that follow firms that switch form to become corporations, and differences in factory growth. In panel regressions I control for the fixed but unobserved characteristics of firms, which may underlie both the selection into incorporation and also the benefits firms derive. This section presents fixed effects regressions for the determinants of factory revenue and total machine power, controlling for the time-invariant characteristics of individual factories.

[43]The p-value of a two-sample mean comparison test is .06. A small number of factories have a large quantity of power per worker before incorporating, which is why the change in medians is larger than the change in means.

[44]The p-value for a two-sample Kolmogorov-Smirnov test for each of the distributions in the left column is at most .007, and the p-value for the distribution of power per worker is .409.

The fixed effects regression estimates are presented in Table 2.12. In Column 1, corporation-owned factories have greater revenue per worker. A factory's enterprise form remains fixed unless a factory changes form, so the coefficient on "corporation" reflects the effect experienced by a factory that changes form to become a corporation. There are no factories that change form from corporations to partnerships or other forms within the sample. Furthermore, factories that switch form to become corporations have more machine power once incorporated (Column 2), even with factory fixed effects. Standard errors clustered by region-industry groups are reported in brackets. With clustered standard errors, factories that change form to become corporations still add significantly more revenue per worker, but the coefficient on Corporation in Column 2 has become noisy: there are only two years with measured machine power per worker and only 128 factories that switch form included in the regression.

2.5.5 Corporation-Owned Factories Grow Faster

The model implies that corporations should grow faster because of the corporations' advantages in raising the long-term capital necessary for firm expansion. This section compares growth in revenue and machine power for corporations and non-corporations. Table 2.13 shows that the median percentage change in revenue and power are higher for factories owned by corporations. Median regressions are appropriate due to a large number of very small factories that grow quickly relative to their small size by adding very small amounts of revenue or capital.[45]

[45]For example, a factory with one worker and one horse (and hence one horsepower) that adds one horse doubles its capital.

2.5.6 Instrumental Variables Approach: Additional Obstacles to Incorporation

Studying incorporation in the Russian Empire presents a measurement problem: because incorporation is costly, differences between factories owned by corporations and other forms contain information about both the pre-existing characteristics of firms that drive the selection into incorporation and the advantages of incorporation itself. Though studying factories that switch form is informative, whether a factory changes form is also endogenous, and effects experienced by factories that switch form may reflect the different growth paths of incorporating firms. Here I present an instrumental variables approach to separate the selection into incorporation from the effect of incorporation itself.

In the estimates of the effect of enterprise form on a factory's revenue per worker or power per worker, an instrument for whether a firm is owned by a corporation or not must both predict whether a factory is owned by a corporation and be uncorrelated with the error term in the second stage. The variable, then, must predict a factory's legal form of organization but not be related to that factory's production decisions (except through enterprise form).

A quantity that predicts whether a factory is owned by corporation is given by:

$$\left(\frac{Mean(Rev/Worker)_{Corps} - Mean(Rev/Worker)_{NonCorps}}{Mean(Rev/Worker)_{NonCorps}}\right)_{-i}, \quad [6]$$

for each province, industry, year cell this period, though excluding the factory in question $(-i)$. This quantity is a measure of the advantage to incorporation in a given place, industry, and point in time. According to the model presented in Section 2.4, the fixed cost firms are willing to pay to incorporate is increasing in incorporation's benefits: there should be more corporations in cells where this number (Equation 6) is large. The instrument's exclusion restriction requires that a given factory's

production decision cannot be correlated with the difference in labor productivity between corporations and partnerships in a given location, industry, and year (except through that factory's enterprise form). Indeed, The quantity in Equation 6 should be a poor predictor of that firm's revenue or power per worker once enterprise form is taken into account.[46]

Corporations' competitive environment may present a threat to the exclusion restriction. If cells with large numbers of corporations are less competitive, prices will be higher, which will make revenue per worker appear higher for neighboring firms as well. Indeed, cells containing corporations do appear to be less competitive: Herfindahl indices for province industry cells with relatively more corporations have higher Herfindahl indices.[47] However, for the exclusion restriction to be violated, corporations must face higher prices than non-corporations in the same cell, which would require that corporations and non-corporations consistently sort into different industries in a manner not captured by industry controls. In the data, corporations and non-corporations share similar products in almost every province industry cell.

Because enterprise form is a binary variable, I estimate the production function with instruments as follows: the first stage is estimated as logit, then I use the predicted values from the first stage as instruments in a traditional two stage least squares regression. The estimates are reported in Table 2.14. The coefficient on Corporation is consistently higher than it was under pooled OLS, though the effect is no longer statistically significant in the case of revenue per worker. However, the magnitude is certainly higher in Column 2, in which the left hand side variable is

[46]This instrument is similar in spirit to the BLP or Hausman instruments (Berry, Levinsohn, and Pakes 1995), which use the characteristics of other products. The instrument I propose uses the average characteristics of other firms in a location, industry, and year.

[47]In an OLS regression of the Province Industry Herfindahl index of the top 50 factories by revenue share, controlling for the total number of factories in the cell and the year, cells with more corporations per factory have significantly higher Herfindahl indices (the coefficient is .12 with a standard error of .0047).

machine power per worker. If the selection into incorporation were based solely on performance, the magnitudes of these coefficients should have decreased in the IV regressions. Since the coefficients increased, I conclude that, if selection into incorporation were based solely on the kind of performance measured by the instruments, corporations' revenue per worker and power per worker advantages should have been larger.[48] Russian firms faced additional obstacles to incorporation.[49]

2.5.7 Channels: Analysis of Two Corporation Types

This paper has thus far documented large differences between factories owned by corporations and other forms of organization. Comparing two kinds of corporations allows me to investigate the sources of capital underlying these differences.

While the Russian commercial code did not distinguish among types of corporations, in practice there emerged two kinds of corporations in the Russian Empire: A-Corporations (*Aktsionerniie obshchestva)* and Share Partnerships (*Tovarishchestva na paiakh).* Both A-Corporations and Share Partnerships were corporations under Russian law and passed through the same incorporation process.[50] A-Corporations, however, were more likely to issue shares on stock markets than Share Partnerships. A-Corporations also tended to be firms with larger overall share capital divided into a large number of shares of small amounts to a large and dispersed circle of shareholders. By contrast, Share Partnerships tended to issue a small number of shares

[48]Card (2001, p. 1156) suggests that IV estimates of the return to education may be higher than OLS estimates if individuals that have low schooling have less education because they face higher than average costs to education. In such cases, OLS underestimates the effect of education after a supply side reform. The interpretation here is similar: in the face of a supply side reform (general incorporation), the returns to incorporation could have been higher.

[49]Similar results are obtained using propensity score matching: when factories are assigned to the corporation group based on number of workers, year, and industry, the effect of incorporation on revenue per worker or power per worker is higher than under OLS. The interpretation is similar to that explained in the text: the return to labor productivity or physical capital accumulation would have been higher had firms not faced additional obstacles to incorporation.

[50]See Owen, *Corporation*, 12-3.

with large denominations to a small group of shareholders, often family members.[51] Finally, A-Corporations tended to be new firms, while Share Partnerships more often existed as partnerships before reorganizing as corporations.

The data display some differences between A-Corporations and Share Partnerships. According to Table 2.15, Share Partnerships were larger in terms of number of workers, revenue, and total machine power (though that difference is not statistically significant) but had smaller overall share capital values as shown in the RUSCORP Database. Share Partnerships were probably larger on the factory floor because they were older. Furthermore, although A-Corporations had more machine power per worker, they were not more productive in terms of revenue per worker.

Differences between A-Corporations and Share Partnerships, then, permit an examination of the channels through which incorporation affects firm performance. The access to stock markets that characterized A-corporations was not the crucial advantage that allowed corporations to add physical capital. Table 2.16 shows partial evidence that A-Corporations outperformed Share Partnerships. A-Corporations have more revenue per worker but not more power per worker, controlling for industry, location, and year of observation. Furthermore, the difference between A-corporations and Share Partnerships is not nearly as large as the difference between all corporations and all non-corporations.

Russian corporations, then, did not outperform non-corporations simply because they had access to formal stock and bond markets. Since corporations overall outperformed non-corporations, the corporate form itself provided a set of advantages that allow firms to raise capital, including legal personhood, limited liability, and the ability to lock capital in the enterprise.[52]

[51] Ibid., 152.

[52] Unfortunately, the data does not allow me to distinguish among each of these advantages of the form itself.

2.6 Conclusion

Alexander Gerschenkron hypothesized that the Russian Empire's lack of large-scale capital sources for investment led the state to substitute for private enterprise in order to stimulate industrialization. This paper has shown one aspect of how firms behaved in an environment characterized both by capital scarcity and an institutional obstacle to growth, the difficulty of obtaining corporate charters. Corporations, however did not obtain more capital simply because they had access to formal domestic and foreign stock and bonds markets. The corporate form offered firms a bundle of advantages that included limited liability and locked-in capital that allowed incorporated factories to add machine power.

In this paper, I have shown that more productive firms chose to incorporate because of the corporate form's financial advantages. The Imperial Russian government, however, recognized that corporations' limited liability placed great downside risk upon society. When financial market crises forced numerous corporations into bankruptcy, the government tightened restrictions on corporations and abandoned projects that aimed to reform or abolish the concession system.[53] Furthermore, had incorporation been easier, less productive firms might have incorporated, and many of the differences between corporations and non-corporations observed in this paper would be smaller.

On the other hand, restricting the access to capital markets provided by incorporation limited expansion for a certain mass of firms. The smallest firms would probably have remained small, but medium-sized firms that began to encounter capital constraints might have chosen to incorporate had the concession been cheaper.

[53]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.

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

Tables

Table 2.1: 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 2.2: Incorporations by Industry

Panel A: Incorporations by Industry, Overall

	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	2,892	63.71	2,164	65.52	1,225	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	4,539	100	3,303	100	1,730	100

Panel B: 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	2,835	100	2,119	100	1,200	100

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

Table 2.3: Variables by Year

Variable	Factory Level			Province and Industry Level		
Years:	1894	1900	1908	1894	1900	1908
Total Workers	x	x	x		x	x
Total Revenue (Rubles)	x	x	x		x	x
Total Machine Power	x		x		x	x
Industry (Product)	x	x	x		x	x
Province	x	x	x		x	x
Street Address	x	x	x			
Total Value of Materials	x				x	x

Sources: 1894, 1900, and 1908 factory lists and aggregate volumes (Gregg Imperial Russian Manufacturing Database). Revenue denotes the total value of output, in Rubles. Total Workers is the total number of workers employed by the factory. Product Description is the description of what each factory makes, which is given in the factory lists. Total Machine Power is the total horsepower of all machines in the factory. The Province and Industry Level column is empty for 1894 because the 1894 census had no aggregate volume.

Table 2.4: Factories and Corporate Factories by Year

Year	No. of Factories in the Database	Corporation-Owned Factories
1894	16,885	508
1900	12,855	822
1908	13,489	807

Source: Gregg Imperial Russian Manufacturing Database. Corporate enterprises are identified by matching factory names, locations, and industries to the RUSCORP Database.

Table 2.5: Factories and Corporate Factories by Industry and Year

Industry	Year	No. of Factories	Factories in Corps.	% of Factories in Corps.	% of Output from Corps.
	1894	1,649	9	.55	18.89
Animal	1900	1,254	23	1.83	23.55
	1908	982	21	2.14	17.76
	1894	721	45	6.24	47.31
Chemicals	1900	530	82	15.47	49.88
	1908	462	92	19.91	65.22
	1894	605	122	20.17	76.16
Cotton	1900	731	158	21.61	79.68
	1908	782	164	20.97	78.97
	1894	365	20	5.48	52.41
Flax/Hemp/Jute	1900	414	35	8.45	49.51
	1908	276	30	10.87	64.72
	1894	7,196	143	1.99	20.18
Foods	1900	2,500	60	2.40	15.21
	1908	2,669	81	3.03	11.99
	1894	1,494	49	3.28	32.06
Metals/Machines	1900	1,804	180	9.98	58.62
	1908	2,035	182	8.94	47.65
	1894	1,255	26	2.07	16.35
Minerals	1900	1,590	88	5.53	29.81
	1908	1,480	52	3.51	20.60
	1894	421	4	.95	8.38
Mixed Materials	1900	341	17	4.99	33.05
	1908	380	18	4.74	24.37
	1894	841	30	3.57	27.40
Paper	1900	1,072	63	5.88	30.71
	1908	1,300	66	5.08	35.60
	1894	267	1	.37	6.51
Silk	1900	308	3	.97	10.27
	1908	276	17	6.16	21.56
	1894	993	23	2.32	7.28
Wood	1900	1,426	69	4.84	15.62
	1908	1,830	39	2.13	11.04
	1894	1,078	36	3.34	21.68
Wool	1900	879	44	5.01	33.17
	1908	1,016	45	4.43	26.06

Source: Gregg Imperial Russian Manufacturing Database.

Table 2.6: Descriptive Statistics: All Factories, Non-Corporate Factories, and Corporate Factories

		Mean	Std. Dev	Median	Min	Max	|t|
Revenue:	All Est.	163,864.4	742,621.8	22,232.5	0	39,000,000	
	Non-Corporate	98,412.9	358,499.8	20,000.5	0	25,000,000	
	Corporate	1,388,133.0	2,624,288.0	468,297.0	0	39,000,000	83.93
Number of	All Est.	94.54	392.12	22	0	16,500	
Workers:	Non-Corporate	60.25	190.72	21	0	16,500	
	Corporate	753.82	1,398.04	288	0	13,498	86.32
Revenue	All Est.	1,978.87	6,288.49	906.09	0	777,777.8	
per	Non-Corporate	1,926,72	6,096.64	872.56	0	777,777.8	
Worker	Corporate	2,946.87	9,093.84	1532.43	0	340,000	7.24
Total	All Est.	58.36	309.37	6	0	12,772	
Machine	Non-Corporate	33.70	127.86	6	0	5,056	
Power:	Corporate	603.16	1,241.09	163	0	12,772	70.41
Machine	All Est.	1.10	2.68	.25	0	150	
Power per	Non-Corporate	1.11	2.72	.24	0	150	
Worker	Corporate	.98	1.58	.56	0	19.17	1.65
Factory	All Est.	19.42	21.12	13	0	300	
Age (Years):	Non-Corporate	19.08	20.86	13	0	300	
	Corporate	26.13	24.80	20	0	182	11.42

Source: Gregg Imperial Russian Manufacturing Database. 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, where the groups are corporate and non-corporate factories.

Table 2.7: Descriptive Statistics for the Cotton Industry: All Factories, Corporate Factories, and Non-Corporate Factories

		Mean	Std. Dev	Median	Min	Max	|t|
Revenue:	All Est.	948,403.0	2,341,711.0	63,879	0	26,000,000	
	Non-Corporate	263,041.5	727,613.1	30,342	0	11,000,000	
	Corporate	3,288,584.0	3,917,116	1,988,600	0	26,000,000	27.91
Number of Workers:	All Est.	558.40	1,290.59	85	0	13,498	
	Non-Corporate	205.31	484.61	51	0	5,908	
	Corporate	1,899.63	2,196.71	1,126	0	13,498	28.85
Revenue per Worker	All Est.	1,383.21	1,767.75	939.36	0	19,375	
	Non-Corporate	1,196.33	1,705.92	629.68	0	19,375	
	Corporate	2,002.93	1,828.83	1,485.95	0	13,233.48	8.42
Total Machine Power:	All Est.	402.27	1,059.67	20	0	10,423	
	Non-Corporate	113.06	369.55	6	0	5,056	
	Corporate	1,515.63	1,834.86	938	0	10,423	23.61
Machine Power per Worker	All Est.	.56	1.03	.35	0	24	
	Non-Corporate	.48	1.06	.20	0	24	
	Corporate	.85	.83	.68	0	9.5	5.37
Factory Age (Years):	All Est.	26.91	23.02	21	0	144	
	Non-Corporate	24.71	21.77	20	0	144	
	Corporate	35.36	25.71	31	1	105	4.46

Source: Gregg Imperial Russian Manufacturing Database. 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, where the groups are corporate and non-corporate factories.

Table 2.8: Corporations Have Greater Revenue per Worker and Power per Worker (OLS)

	Pooled OLS	
Dependent Variable:	log (R/L)	log (K/L)
	[1]	[2]
Corporation	.46***	.18*
	(.044)	(.071)
Intercept	7.31***	-1.97***
	(.20)	(.37)
Ind., Year, Prov. Dummies	Yes	Yes
1900 Included?	Yes	No
N	38,048	20,073
N Corps	2,053	1,238
R2	.2945	.3413

* $p < .05$, ** $p < .01$, *** $p < .001$. Source: Gregg Imperial Russian Manufacturing Database. Standard errors, clustered by Region-Industry-Year groups, in parentheses. L (Workers) denotes the total number of workers the factory, K (Power) denotes the total horsepower of machines in the factory, and R (Revenue) is the total value of output produced by the factory in that year, measured in Rubles.

Table 2.9: Revenue per Worker Regression with Industry Interactions (OLS)

Dependent Variable:		Pooled OLS log (R/L) [1]
	Corporation	.36***
		(.099)
Corporation Interacted with Industries:	Silk	.19
		(.16)
	Flax	-.21
		(.13)
	Wool	.028
		(.11)
	Chemicals	.056
		(.12)
	Cotton	.23*
		(.11)
	Mixed Materials	.37
		(.21)
	Wood	-.017
		(.12)
	Paper	.26*
		(.11)
	Metals	.11
		(.11)
	Foods	-.015
		(.12)
	Mineral Products	.11
		(.11)
	Intercept	7.32***
		(.080)
Ind., Year, Prov. Dummies		Yes
1900 Included?		Yes
N		38,050
N Corps		2,053
R2		.2950

* $p < .05$, ** $p < .01$, *** $p < .001$. Source: Gregg Imperial Russian Manufacturing Database.. Robust standard errors in parentheses. L (Workers) denotes the total number of workers the factory, K (Power) denotes the total horsepower of machines in the factory, and R (Revenue) is the total value of output produced by the factory in that year, measured in Rubles. The omitted industry is Animal Products.

Table 2.10: Number of Factories that Are Not Corporations in Year t but Are Corporations in Year $t+1$ ("Switchers")

Panel A: Total Number of "Switchers" by Year

Year	Total Number of Factories	Number of Factories Owned by Corps.	Number of Factories in Corps. Next Year
1894	16,885	508	149
1900	12,855	822	118

Panel B: Number of "Switchers" by Industry

Industry	Total Factories (1894 and 1908)	Factories in Corps Next Year	Percentage
Silk	575	13	2.26
Cotton	1,336	28	2.10
Metals and Machines	3,298	59	1.79
Wool	1,957	30	1.53
Chemical	1,251	18	1.43
Mixed Materials	762	10	1.31
Paper	1,913	25	1.31
Flax	779	6	.77
Animal	2,903	19	.65
Mineral Products	2,845	18	.63
Wood	2,419	9	.37
Foods	9,696	32	.33

Source: Gregg Imperial Russian Manufacturing Database and the RUSCORP Database. A factory is a "switcher" 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. In Panel B, Total Number of Factories includes factories in all three years, and Number of Factories in Corps Next Year includes switchers from both years 1894 and 1900.

Table 2.11: "Switchers" Have More Revenue per Worker and Less Power per Worker in Year t (Before Incorporating)

Panel A: Mean log Revenue per Worker and Power per Worker, "Switchers" vs "Non-Switchers"

Variable	Mean for Non-Switchers	Mean for Switchers	Two-sample t test p-value	Rank-Sum Test p-value
log Revenue per Worker (1894 and 1900)	6.85 (.0072)	7.25 (.058)	0.0000	0.0000
log Power per Worker (1894)	-.39 (.015)	-1.11 (.14)	0.0000	0.0000

Panel B: Mean log Revenue per Worker and Power per Worker, "Switchers" vs "Non-Switchers," with Controls

	Pooled OLS	
Dependent Variable:	log (R/L) [1]	log (K/L) [2]
Factory Becomes Corporation	.37*** (.056)	-.12 (.17)
Intercept	7.57*** (.29)	-1.49*** (.12)
Ind., Year, Prov. Dummies	Yes	Yes
Years Included	1894, 1900	1894
N	26,384	10,069
N Switchers	261	133
R2	.2578	.3445

* $p < .05$, ** $p < .01$, *** $p < .001$. Source: Gregg Imperial Russian Manufacturing Database. In Panel A, standard errors are reported in parentheses. In Panel B, the regression compares factories that change form to become corporations to firms that are non-corporations and do not change form. Standard errors clustered by region, industry, year groups in parentheses. Statistics exclude 1908, because by definition there are no "switchers" in 1908. However, the inclusion of non-switchers from 1908 does not substantially change the results.

Table 2.12: Revenue per Worker and Power per Worker Increase for Factories That Change Form (F.E. Regressions)

	Panel Regression with Factory Fixed Effects	
Dependent Variable:	log (R/L)	log (K/L)
	[1]	[2]
Corporation	.13***	.18*
	(.039)	(.080)
	[.054]	[.098]
Intercept	6.93***	-.49***
	(.0037)	(.0050)
	[.0029]	[.0061]
Factory F.E.	Yes	Yes
1900 Included?	Yes	No
N	35,400	18,026
No. of Switchers	254	128
Overall R2	.0102	.0002

* $p < .05$, ** $p < .01$, *** $p < .001$. Source: Gregg Imperial Russian Manufacturing Database. L (Workers) denotes the total number of workers the factory, K (Power) denotes the total horsepower of machines in the factory, and R (Revenue) is the total value of output produced by the factory in that year, measured in Rubles. Robust standard errors in parentheses. Standard errors clustered by region-industry groups, where the group is fixed from the first year of observation, brackets.

Table 2.13: Median Regressions: Corporation-Owned Factories Grow Faster

	Median Regressions	
Dependent Variable:	% Change in Rev	% Change in Power
	[1]	[2]
Corporation	.16***	.48***
	(.034)	(.13)
Intercept	.16***	.50***
	(.013)	(.049)
Year Controls	Yes	No
N	11,008	2,331
Pseudo R2	.0016	.0026

* $p < .05$, ** $p < .01$, *** $p < .001$. Source: Gregg Imperial Russian Manufacturing Database. Standard errors in parentheses

Table 2.14: Instrumental Variables Estimates

Dependent Variable:	Two Stage Least Squares log (R/L) [1]	log (K/L) [2]
Corporation	.56	1.13*
	(.33)	(.52)
Intercept	7.31***	-2.02***
	(.20)	(.32)
1900 Included?	Yes	No
First Stage F-Stat	345.36	101.18
N	37,080	18,403
N Corps / Switchers	2,048	1,234
Ind., Prov., Year Controls	Yes	Yes

* $p < .05$, ** $p < .01$, *** $p < .001$. Source: Gregg Imperial Russian Manufacturing Database. Source: 1894, 1900, and 1908 factory lists. The first stage uses the predicted values of a logit regression. Standard errors clustered by region industry year groups.

Table 2.15: Descriptive Statistics for Corporations Only: A-Corps vs. Share Partnerships

		n	Mean	Std. Dev	Median	Min	Max	|t|
Revenue:	All Corporate	2,103	1,388,133	2,624,288	468,297	0	39,000,000	
	A-Corp.	910	1,123,597	2,059,014	406,401.5	0	21,000,000	
	Share Part.	1,193	1,589,916	2,969,397	549,100	0	39,000,000	4.05
Number of	All Corporate	2,137	753.82	1,398.04	288	0	13,498	
Workers:	A-Corp.	922	554.05	1,169.92	209	0	12,346	
	Share Part.	1,215	905.41	1,532.07	383	0	13,498	5.80
Revenue	All Corporate	2,097	2,946.90	9,093.84	1,532.43	0	340,000	
per	A-Corp.	908	3,052.26	5,267.04	1,839.36	0	95,090.91	
Worker	Share Part.	1,189	2,866.44	11,167.36	1,370.21	0	340,000	.4635
Total	All Corporate	1,315	603.16	1,241.09	163	0	12,772	
Machine	A-Corp.	524	558.25	1,256.03	120	0	12,772	
Power:	Share Part.	791	632.91	1,230.98	200	0	12,200	1.07
Machine	All Corporate	1,308	.98	1.58	.56	0	19.17	
Power per	A-Corp.	521	1.19	1.88	.67	0	19.17	
Worker	Share Part.	787	.85	1.33	.51	0	16.75	3.83
Capital	All Corporate	1,315	1,435.78	2,192.72	750	12	31,904	
Value*	A-Corp.	524	1,726.16	2,902.61	805	12	31,904	
(RUSCORP)	Share Part.	791	1,243.41	1,525.28	700	56	12,000	3.93
Factory	All Corporate	1,224	26.13	24.80	20	0	182	
Age (Years):	A-Corp.	513	21.41	23.62	16	0	179	
	Share Part.	711	29.54	25.09	24	0	182	5.73

*Authorized capital, as reported in corporate charters.

Source: Gregg Imperial Russian Manufacturing Database. Corporation-owned factories are identified by matching to the RUSCORP Database, which also classified corporations as A-Corporations or Share Partnerships. $|t|$ denotes the absolute value of t obtained from a two-group mean comparison test, where the groups are A-Corporations and Share Partnerships.

Table 2.16: Revenue per Worker and Power per Worker: Corporations Only

Comparing Two Types of Corporations

	Pooled OLS	
Dependent Variable:	log (R/L)	log (K/L)
	[1]	[2]
Dummy: Corporation is of	.14*	.047
the A-Corporation Type	(.061)	(.11)
Intercept	7.92***	-.73
	(.37)	(.57)
Ind., Year, Prov. Dummies	Yes	Yes
1900 Included?	Yes	No
N	2,053	1,238
N A-Corps	893	500
R2	.3341	.2067

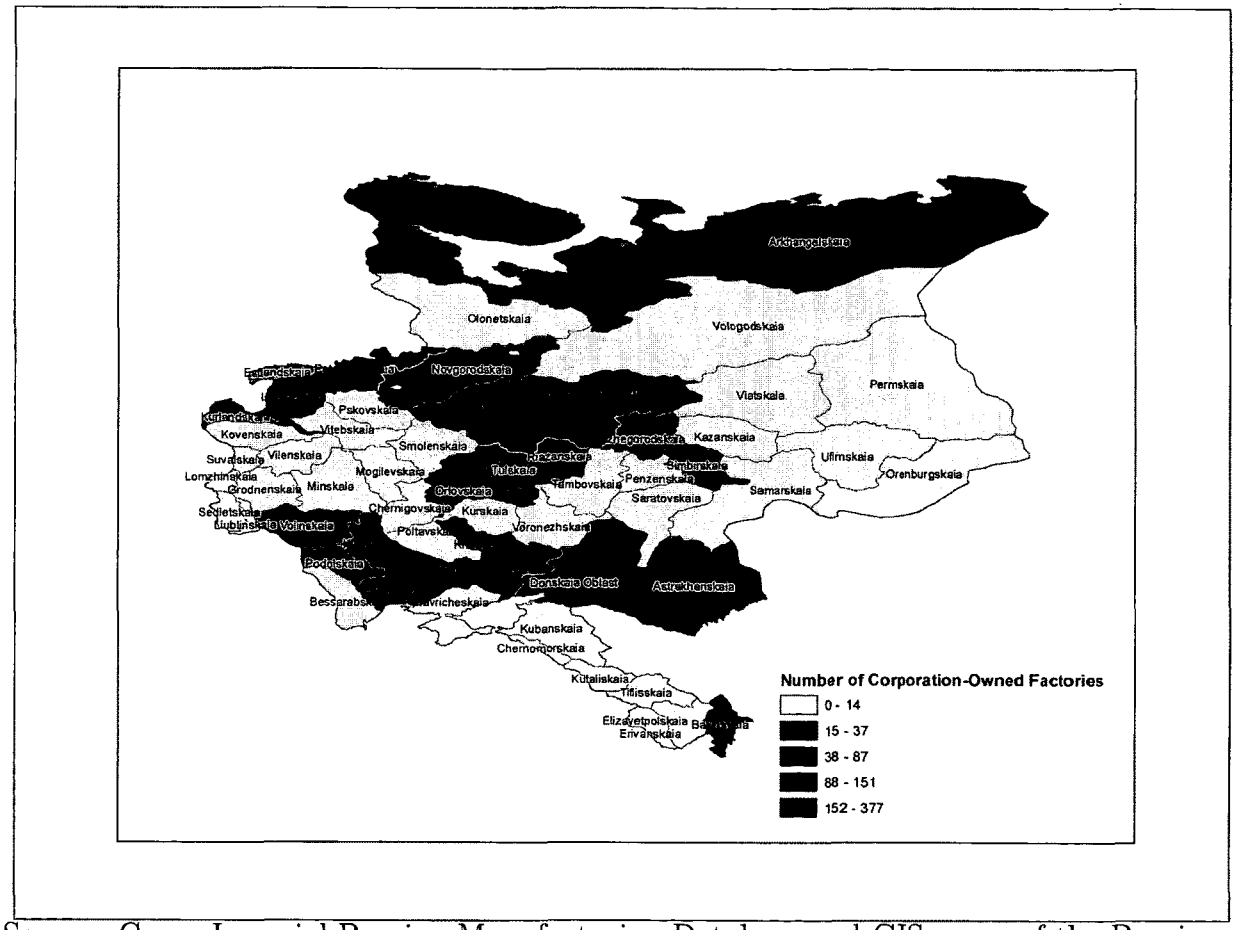
* $p < .05$, ** $p < .01$, *** $p < .001$. Source: Gregg Imperial Russian Manufacturing Database. Standard errors, clustered by Region-Industry-Year groups, in parentheses. L (Workers) denotes the total number of workers the factory, K (Power) denotes the total horsepower of machines in the factory, and R (Revenue) is the total value of output produced by the factory in that year, measured in Rubles. The omitted category is the Share Partnership type.

Figures

Figure 2.1: Cross Section: Corporations Were More Productive and More Capital Intensive

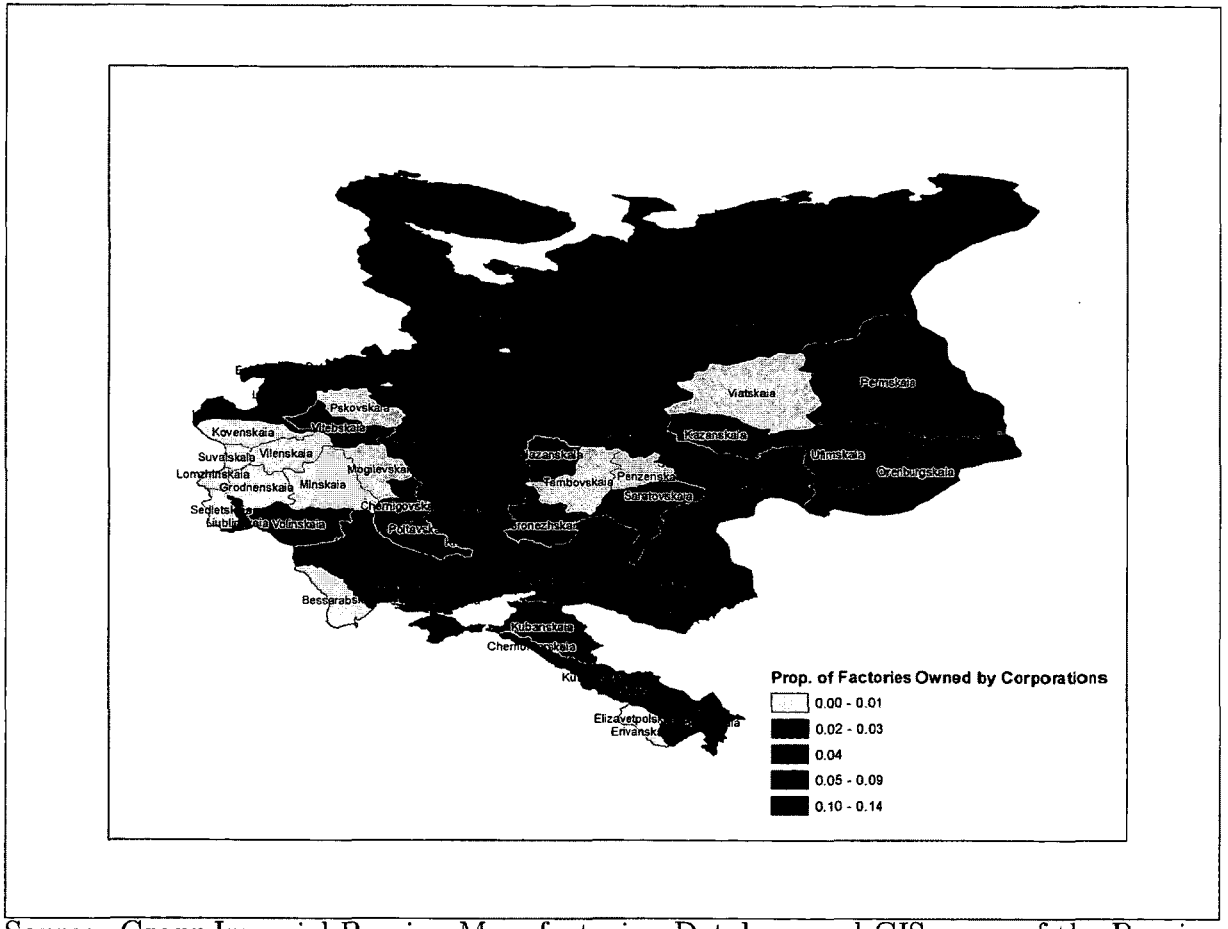
Source: Gregg Imperial Russian Manufacturing Database. Revenue per worker is a factory's total revenue (in rubles) divided by its total number of workers. Machine power is the total horsepower of machines in the factory.

Figure 2.2: Map of European Russia: Number of Corporation-Owned Factories, by Province



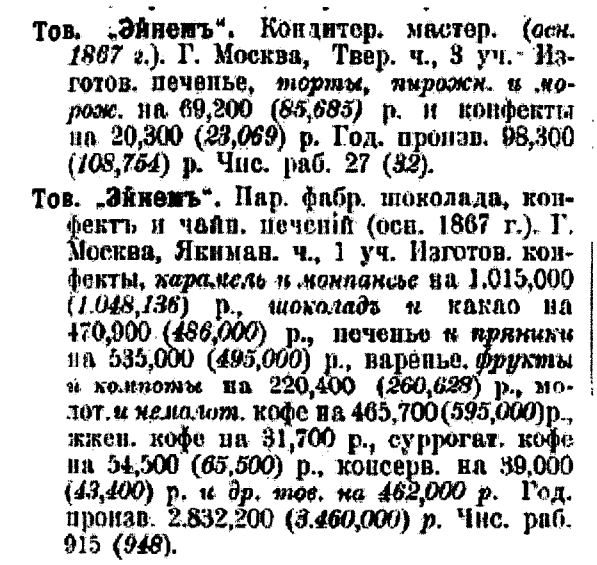
Source: Gregg Imperial Russian Manufacturing Database and GIS maps of the Russian Empire by Andre Zerger.

Figure 2.3: Map of European Russia: Proportion of Factories Owned by Corporations, by Province



Source: Gregg Imperial Russian Manufacturing Database and GIS maps of the Russian Empire by Andre Zerger.

Figure 2.4: Example of Entry for Two Factories from the 1900 Factory List

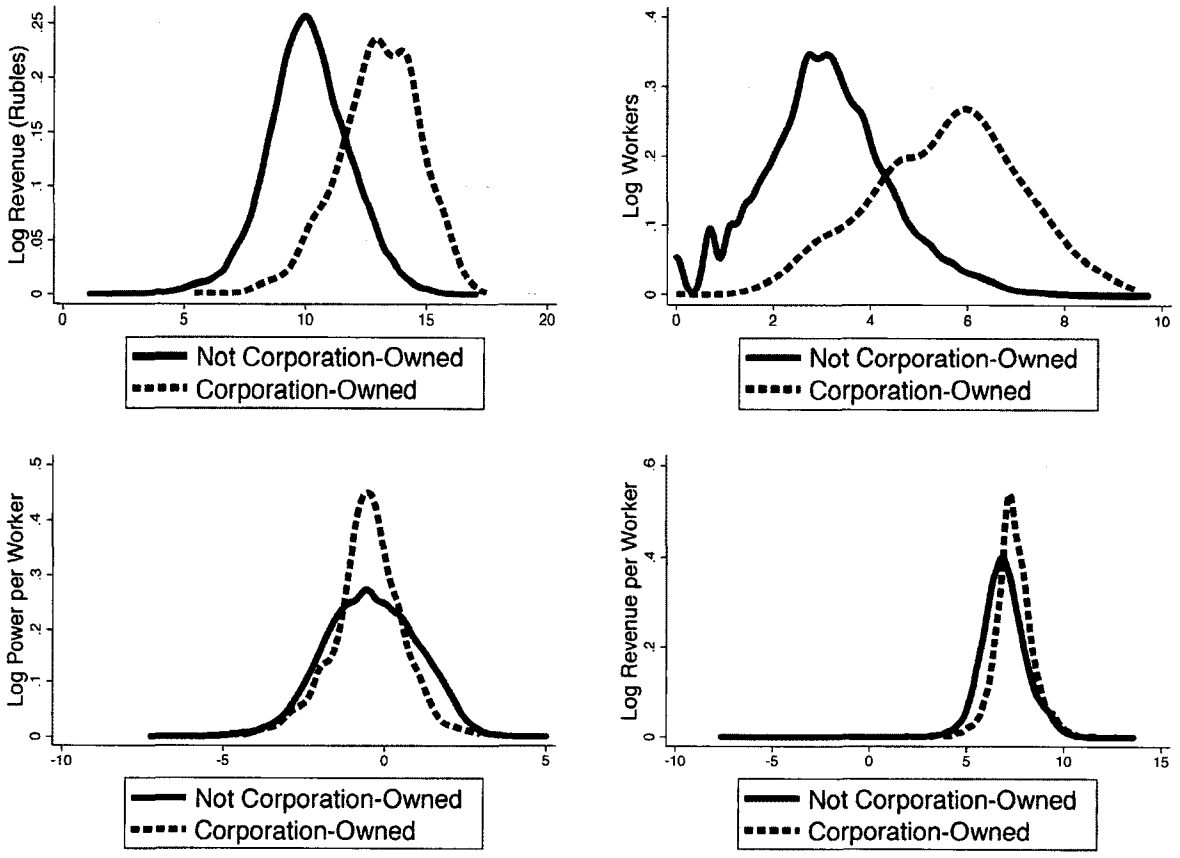


Тов. „Эйнемъ". Кондитер. мастер. (*осн. 1867 г.*). Г. Москва, Твер. ч., 3 уч. Изготов. печенье, *торты, пирожн. и морож.* на 69,200 (*85,685*) р. и конфекты на 20,300 (*23,069*) р. Год. произв. 98,300 (*108,754*) р. Чис. раб. 27 (*32*).

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 470,000 (*486,000*) р., печенье и *пряники* на 535,000 (*495,000*) р., варенье, *фрукты и компоты* на 220,400 (*260,628*) р., молот. *и мелалот.* 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*).

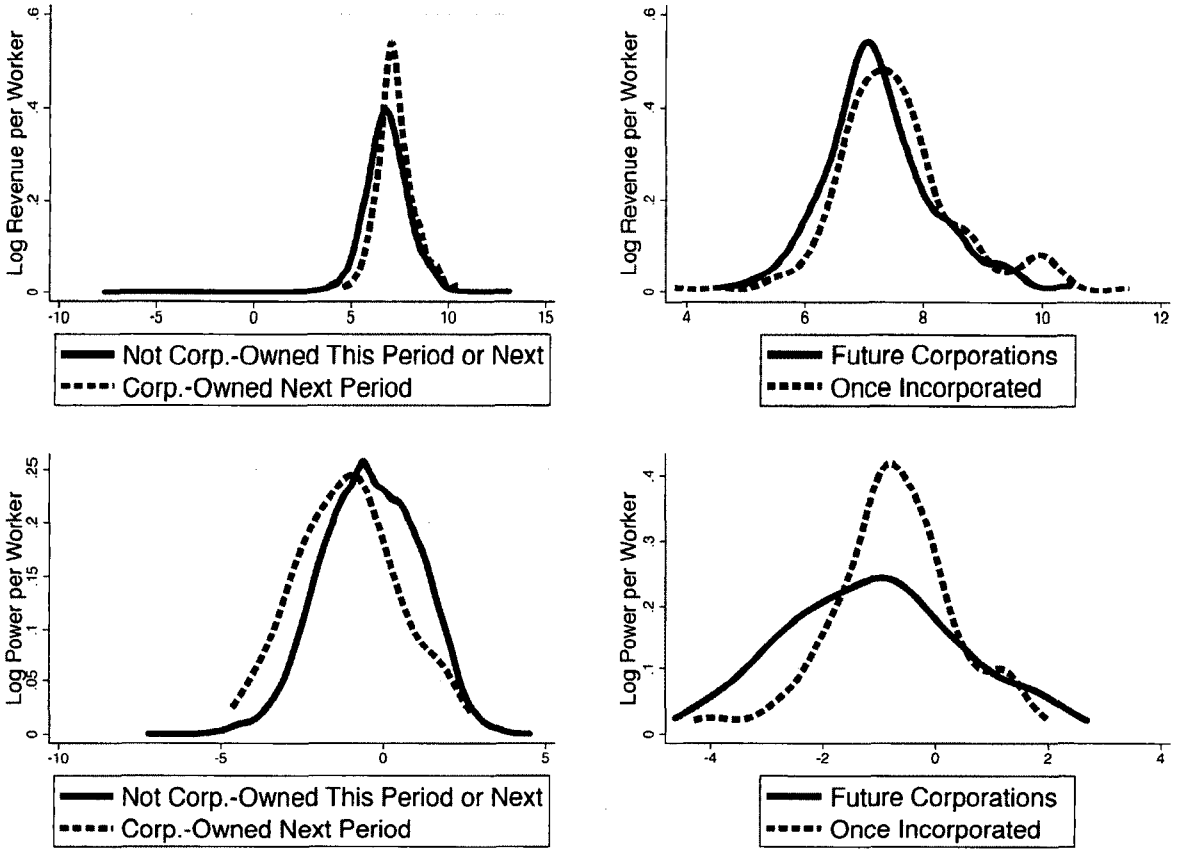
Source: List of Factories and Plants in European Russia (1903). Entries describe the "Einem" chocolate factory in Moscow, which is today the Red October Chocolate Factory.

Figure 2.5: Corporations and Non-Corporations: Comparisons of Revenue, Workers, Power per Worker, and Revenue per Worker (Densities)



Source: Gregg Imperial Russian Manufacturing Database. Gaussian kernels with optimal bandwidths.

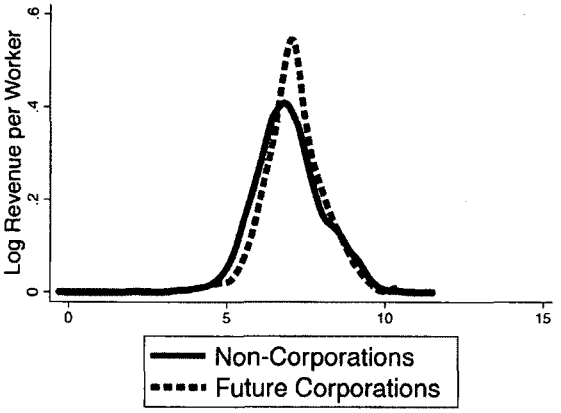
Figure 2.6: Revenue per Worker and Power per Worker for Firms Incorporating within the Sample (Densities)



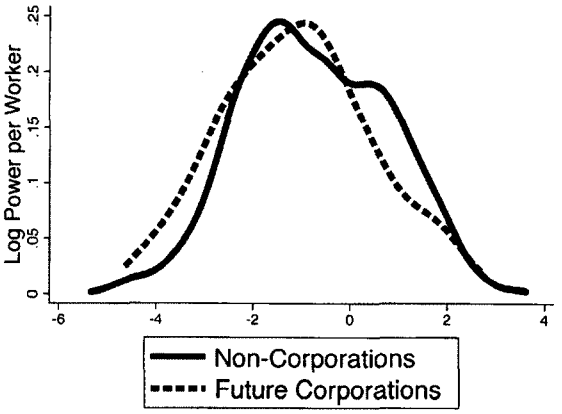
Source: Gregg Imperial Russian Manufacturing Database. Gaussian kernels with optimal bandwidths. All kernels showing information about machine power excluded 1900, since the 1900 volume has no information about machine power.

Figure 2.7: Comparisons: Future Corporations vs. Factories that Survive Two or More Periods (Densities)

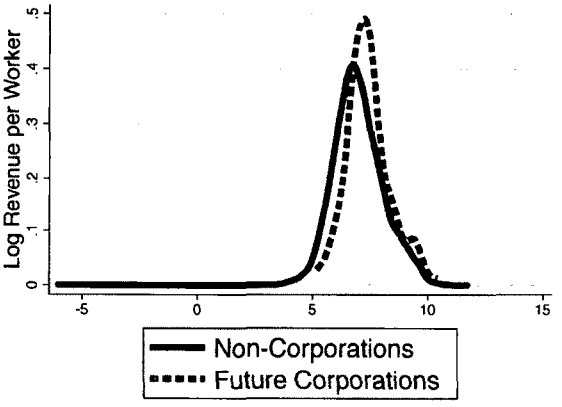
1894 log Revenue per Worker



1894 log Power per Worker

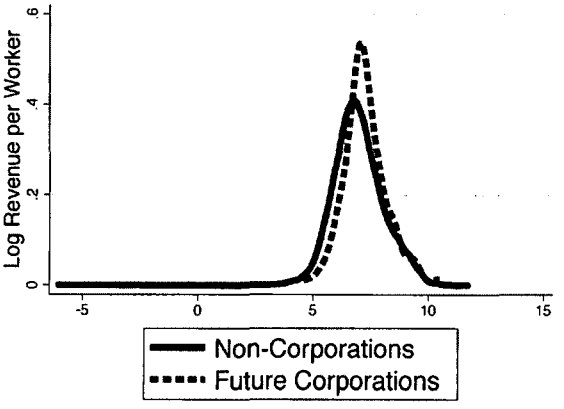


1900 log Revenue per Worker



(No Information on Power in 1900)

1894 and 1900: log Revenue per Worker



(No Information on Power in 1900)

Source: Gregg Imperial Russian Manufacturing Database. Gaussian kernels with optimal bandwidths. The 1900 volume has no information on power per worker, so any kernels describing machine power exclude 1900.

Appendix 1: Description of the Factory Database[54]

The database used in this paper includes information from the 1894, 1900, and 1908 Imperial Russian factory surveys.

Coverage

The 1894 census volume describes factories in every industry in the entire Russian Empire. The census included establishments that had factory tools or at least fifteen employees.[55] "Factory tools" did not necessarily mean large machines; there are many factories with fewer than fifteen employees and no listed machines in the census volume.The census only covered industrial factories; mines, farms, and oil refineries were excluded.[56]

Generally, the census's authors wanted the survey to include only true factories, not small workshops. The census's scope suits the purposes of this project, since only potential corporations are included. A small shoe repair booth, for example, would not be included in the census, nor would it consider becoming a corporation.

The 1900 census volumes describe factories in the sixty-eight provinces of European Russia and excludes farms, mines, oil refineries, and factories subject to the excise tax. The excise tax was levied on factories in certain industries, mostly alcoholic beverages.[57] Similarly to the 1894 census, factories with fewer than 15

[54]The following is an abbreviated version of a larger codebook and data description available upon request from the author.

[55]RGIA F. 20 O. 12 D. 164 L.90: "Ведомости должны быть составлены обо всех промышленных заведениях, имеющих не менее пятнадцать рабочих, а также и о тех, которые, при числе рабочих менее 15, имеют паровой котел, паровую машину или другие механические двигатели и машины или заводские и фабричные устройства."

[56]The 1850-1880 U.S. Census of Manufacturers used a cutoff based on output. The census excluded factories or workshops with less than $500 annual output, including the cost of materials (Atack and Bateman 1999). The 1900 U.S. Census of Manufacturers excluded hand trades similarly to the Russian censuses: "no hand trades were to be canvassed which were not carried on in a shop of some character" (Census of Manufactures, xxxix).

[57]Table 6 shows counts of the number of factories subject to the excise tax, and hence exempted from the 1900 census, by industry.

workers that did not use mechanical motors or had a general "handicraft character" ("ремесленный характер") were excluded.[58]

The 1908 census volumes describe factories from all manufacturing industries in the entire Russian Empire. Like the 1894 and 1900 volumes, however, the census excludes small handicraft and agricultural enterprises.[59]

Variables Listed in Each Volume

The Russian Ministry of Finance published a factory-level volume for 1894 that 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 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.

The 1900 and 1908 aggregate volumes list almost fifty variables for province-industry groups of factories. The volumes list total revenue, number of workers by age and gender, total value of fuels, number and power of machines, and expenditures

[58]1900 Statitischeskiie Svedeniia, Page I-II: "...не признанных фабриками, обыкновенно включались заведения: имещие менее 15 человек рабочих (ручные), не употреблявщие механических двигателей, носившие явно выраженный цеховой "ремесленный характер" (булочные, белошвенные, сапожные, портняжные, мастерские, и т.д.), или характер мелких сельскохозяйственных и кустарных заведений."

[59]This census included factories subject to the excise tax, oil refineries, and smelting as well as factories in Siberia and the Caucasus, but I excluded these categories from data collection for consistency.

such as the the total value of materials, total wage bill, taxes, insurance, and machine maintenance.

Definition of an Establishment

The enumerators listed two factories owned by the same firm separately if there was a significant difference between the establishments, for example they were located in different parts of the city or performed different parts of the production process in each establishment. The introductions to these census volumes do not indicate a systematic rule used by the enumerators to decide the boundaries of a factory.

Factories with similar names have different listings when two factories' owners share the same last name but not first names, often because they are descendants of the same entrepreneur. Two factories may share the same firm name is if they are located close to one another but have different activities. Since there are many listings for factories that have many activities, it is reasonable to assume that these factories that are listed separately are in distinct buildings, which is why they are listed separately.

Matching Factories Across Years

The database also contains identifiers that match factories across time. Every factory in the 1894 factory list is matched to factories in the 1900 factory list, and factories in the 1900 stratified sample are matched forward to the 1908 factory list.

A factory is a definite match to another factory if it has the same name, is located in the same place, has the same founding date, and produces the same product. When any of these matching criteria is not satisfied, I code the difference as a dummy variable in the data.

Appendix 2: Counterfactual Exercise, Additional Model Details, and Additional Results

Counterfactual Exercise

Here I perform a simple counterfactual exercise to estimate the size of the concession system's economic effects. I ask how much additional revenue the Russian industrial sector would have produced had the costs of incorporation been lower. In other words, I measure the change in output and machine power if more factories had been owned by corporation. The paper presented two estimates of incorporation's effects on firms' productivity and machine power. According to the fixed effects results, firms that switched form to become corporations added 13 percent more revenue per worker and 18 percent more power per worker. According to the instrumental variables estimation, incorporation gave firms 113 percent more revenue per worker. In this section I will calculate counterfactual output and machine power under a regime of easier incorporation. I will use the fixed effects estimates as a lower bound for the increase in output and machine power.

I calculate the counterfactual using the following procedure: I first rank all factories by revenue and impose that some percentage of the largest factories were corporation-owned. The maximum percentage I use matches United States incorporation rates. The comparison to the United States is appropriate because the United States had very high incorporation rates (Guinnane et. al. 2007) and because, similarly to Russia, the United States offered no private limited liability company alternative to the corporation. Furthermore, I will examine the metals and machines industry because incorporation was valuable to this industry's factories and because the industry offered room for growth in incorporation. Only 7.71 percent of metals and machines factories incorporated. Converting factories to corporations produces a new vector of factories' enterprise forms: I plug this new vector into the fixed effects

estimates with the original factory fixed effects to obtain new estimates of factories' predicted revenue per worker and power per worker. Then, I multiply these values by total workers to obtain total revenue and total power.

Table 2.17 presents results from the counterfactual exercise. If the top twenty percent of metals and machines factories incorporated, the Russian metals and machines industry would produce 8.3 percent more revenue and would use 24.3 percent more machine power. If Russia had matched U.S. incorporation rates, the metals and machines industry would have produced 11.2 percent more revenue using 30.7 percent more machine power, or an additional 120 million rubles using 74 thousand more horsepower in machines. Russia's high incorporation costs greatly reduced industrial output.

Additional Model Details

Recall from the paper that the expressions for corporations' and partnerships' profits are given by:

$$\pi_c = pQ(A, L_c, K_c) - wL_c - r_cK_c - T \text{ [1]}$$

$$\pi_p = pQ(A, L, K) - wL_p - r_pK_p \text{ [2]}$$

I assume a Cobb-Douglas production function of the form $F = L^{.7}K^{.2}$., so $Q = AL^{7/10}K^{2/10}$. Set $p = 1$. To find a firm's optimal use of labor and capital, take first order conditions, which yields two equations in two unknowns.

$$.7AL^{-.3}K^{.2} = w$$

$$.3AK^{-.8}L^{.7} = r$$

Solving for L and K, we obtain:

$$L = \left[A\left(\frac{\beta}{r}\right)^{1-\alpha}\left(\frac{\alpha}{w}\right)^{\alpha}\right]^{\frac{1}{1-\alpha-\beta}} = \left[A\left(\frac{2/10}{r}\right)^{3/10}\left(\frac{7/10}{w}\right)^{7/10}\right]^{10}$$

$$K = \left[A\left(\frac{\alpha}{w}\right)^{1-\beta}\left(\frac{\beta}{r}\right)^{\beta}\right]^{\frac{1}{1-\alpha-\beta}} = \left[A\left(\frac{7/10}{w}\right)^{8/10}\left(\frac{2/10}{r}\right)^{2/10}\right]^{10}$$

Thus we have $Q = A^{10}\left(\frac{7/10}{w}\right)^{7}\left(\frac{2/10}{r}\right)^{2}$. Notice that, since $r_c < r_p$, corporations tend to use more of both inputs and produce more output. Also, since $\frac{K}{L} = \frac{\beta w}{\alpha r}$, corporations will use relatively more capital per unit of labor than non-corporations.

Next, we solve the expression $\pi_C > \pi_P$ for the fixed cost T to determine the characteristics of firms that should obtain an Imperial concession. We have:$T \leq [Q_p(A, L_p, K_p) - Q_C(A, L_c, K_c)] - (wL_p - wL_c) - (r_cK_c - r_pK_p)$

Plugging in the expressions above, I find that:

$$Q_c - Q_p = A^{10}\left(\frac{7/10}{w}\right)^{7}\left[\left(\frac{2/10}{r_c}\right)^{2} - \left(\frac{2/10}{r_p}\right)^{2}\right] = A^{10}\left(\frac{7/10}{w}\right)^{7}(2/10)^{2}\left[\frac{r_p^2 - r_c^2}{r_p^2 r_c^2}\right]$$

$$L_c - L_p = A^{10}\left(\frac{7/10}{w}\right)^{8}\left[\left(\frac{2/10}{r_c}\right)^{2} - \left(\frac{2/10}{r_p}\right)^{2}\right] = A^{10}\left(\frac{7/10}{w}\right)^{8}(2/10)^{2}\left[\frac{r_p^2 - r_c^2}{r_p^2 r_c^2}\right]$$

$$r_cK_c - r_pK_p = A^{10}\left(\frac{7/10}{w}\right)^{7}\left(\frac{2}{10}\right)^{3}\left[\frac{r_p^2 - r_c^2}{r_p^2 r_c^2}\right]$$

Thus, putting all of the pieces together, we have:

$$T \leq A^{10}\left[\frac{r_p^2 - r_c^2}{r_p^2 r_c^2}\right]\left\{\left(\frac{7/10}{w}\right)^{7}\left(\frac{2}{10}\right)^{2} + w\left(\frac{7/10}{w}\right)^{8}\left(\frac{2}{10}\right)^{2} + \left(\frac{7/10}{w}\right)^{7}\left(\frac{2}{10}\right)^{3}\right\} = \left(\frac{19}{10}\right)\left(\frac{2}{10}\right)^{2}A^{10}\left(\frac{7/10}{w}\right)^{7}\left[\frac{r_p^2 - r_c^2}{r_p^2 r_c^2}\right]$$

The fixed costs that firms are wiling to pay to incorporate increase in productivity A and in corporations' capital cost advantage $r_p - r_c$. Finally, notice that 2/10 is β, the weight on capital. Elsewhere, β appears in the denominator of powers with a negative sign. Thus, the fixed cost firms are willing to pay in increasing in β.

Production Function

The paper shows that Russian corporations had more revenue per worker and more power per worker than unincorporated factories. Furthermore, while productivity in the form of revenue per worker motivated selection into incorporation, incorporation allowed corporation-owned factories to add more physical capital, which led to further gains in labor productivity.

The production functions shown in Table 2.18 present evidence that much of the gains in productivity that firms experience after incorporating comes through the addition of physical capital. OLS regressions include controls for each factory's location, industry, and year of observation and use standard errors clustered by region industry year groups. Columns 1 and 2 present estimates of the production function without including controls for a factory's enterprise form. Column 3 regresses a factory's total revenue on its number of workers, enterprise form, and controls. The coefficient on the Corporation dummy is large, positive, and statistically significant. However, the coefficient loses statistical significance in Column 4, which includes factories' total machine power. Thus, much of the difference between corporations and non-corporations in the production function operates through factories' differences in total machine power, a point reinforced by analysis of residuals from these regressions.

Columns 5 and 6 include instruments for factories' inputs and enterprise forms. In Column 5, I instrument for a factory's inputs using lagged inputs. In these regressions, labor share is much smaller and the capital share much larger than under OLS. When inputs are endogenous, we expect the capital share to be small under OLS, since factories adjust capital so much more slowly than they adjust labor. However, the difference in this case is larger than seems reasonable, perhaps because the instruments are weak: Shea's partial R-squared for log workers is .0043

and for log machine power is .0039, which are very low, even though the coefficients for the instruments in the first stage are statistically significant. Column 5 also features a negative coefficient on the dummy variable for whether a factory is owned by a corporation, which may also be the result of weak instruments. In Column 6, I also instrument for factories' enterprise forms using the instrument from the main text, the mean difference in revenue per worker between corporations and non-corporations in a given cell, excluding the factory in question. Again, the machine power coefficient is unexpectedly large, the corporation dummy variable coefficient is negative, and all instruments are relatively weak.

Table 2.21 and Figure 2.8 show residuals from Columns 1 and 2 of Table 2.18. Residuals of the production function measure each factory's total factor productivity. Table 2.21 shows that corporation-owned factories had higher average total factor productivity than their non-corporate peers (Row Group 1), unless the regression controls for factories' total machine power (Row Group 2). Figure 2.8 shows the same pattern. The residuals from Column 1 of Table 2.18 show great differences between corporations and non-corporations. The distribution of residuals for corporations is shifted to the right and does not include much of the long lower tail of unproductive factories that characterizes the non-corporate factories' distribution. The residuals from Column 2, however, show much smaller differences between corporations and non-corporations, though corporations' distribution still has a less pronounced lower tail. Thus, again, much of the difference in productivity between corporations and non-corporations is due to the fact that corporations have more total machine power.

Production Function Sensitivity to the Inclusion of Small Factories

Table 2.19 shows how the log Cobb-Douglas production function estimates change when the smallest factories are excluded from the regression. Estimates change because there are very few corporations that have a small number of employees. Recall from Table 2.18 that the coefficient on the Corporation dummy variable loses significance in a regression that includes all factories and controls for labor and capital inputs. However, as small factories as excluded, the coefficient becomes larger and regains statistical significance though is still smaller than in a regression excluding the machine power measure. As Table 2.19 reports, factories with fewer than 15 employees show considerable production function differences. The positive Corporation coefficient here is positive because firms with higher total factor productivity were more likely to choose to incorporate.

Translog Production Functions

Table 2.20 considers a more flexible production function form, the translog Cobb-Douglas production function, which allows for interactions among the labor and capital measures. The translog production function in this setting is given by:

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

$$+\beta_{KK} log(Power)^2 + \beta_{LK} log(Workers) log(Power)$$

Table 2.20 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.

Beginning in Column 3 of Table 2.20, 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 4 when I include an interaction term for whether a factory is corporation-owned and the number of workers and total machine power.

Figure 2.8 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 difference 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 2.21, row groups [3] and [4] show summary statistics for these residuals. Row group [3] shows the statistics for residuals from Column 1 of Table 2.20, and row group [4] shows the statistics for the residuals for Column 2 of Table 2.20. (Provided for comparison, ow groups [1] and [2] come from the residuals of Columns 1 and 2 of Table 11). A two-group mean comparison test for the first set of residuals (row group [3]) has a t-score with an absolute value of 15.18. The t-score of the second set of residuals (row group [4]) is much smaller, though the difference in means is still statistically significant (the t-score is 4.76). 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.

Quantile Regressions

Corporation-owned factories tended to be larger than other kinds of factories. Whether a factory was owned by a corporation, then, should be most relevant at higher quantiles of log Revenue. Quantile regressions presented in Table 2.22 largely confirm this prediction: the table shows how the coefficient on Corporation predicts several quantiles of log Revenue. The coefficient on the Corporation dummy is large, positive, and statistically significant at all quantiles but is largest at the seventy-fifth quantile.

Calculating Productivity by Imposing Shares

All production functions estimated so far in the paper have a rather large labor coefficient relative to the size of the capital coefficient. Log Cobb-Douglas production function estimates typically find labor coefficients of approximately .7 and capital coefficients of about .3. Here I calculate productivity by imposing these shares in a Cobb-Douglas production function and estimating total factor productivity as:

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

In Table 2.23, I show estimates in which I regress this measure of total factor productivity on similar variables as I did previously. Column 1 regresses total factor productivity on a dummy variable for corporation-owned factories alone. The coefficient is positive and 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.

Relationship of Value of Materials to Enterprise Form

This paper's production function estimates have used the form:

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

In terms of value-added, then, I have estimated:

$$r_{ijt} = m_{ijt} + va_{ijt} = \beta^L l_{ijt} + \beta^k k_{ijt} + \beta^c Corp_{ijt} + \epsilon_{ij}.$$

Here, 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 I find $m_{ijt}^C > m_{ijt}^{NC}$, then revenue is higher for corporations than for non-corporations with the same value-added. In this case estimation using revenue alone overstates the performance of factories owned by corporations relative to other kinds of factories in terms of value added. If, on the other hand, we have $m_{ijt}^C < m_{ijt}^{NC}$, I understate corporations' performance.

Data on total value of materials are known at the enterprise-level for a subset of the factories in the 1894 census. 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. Results using the 1894 manuscripts data suffer from some selection bias.

Aggregate volumes for the 1900 and 1908 census also describe factories' total value of materials at the province and industry level. I run regressions on the aggregate measures from the 1900 aggregate volume.

Table 2.24 shows regressions for the determinants of factories' total value of materials. Columns 1 through 4 use the 1894 manuscripts data, and Columns 5 through 9 use the aggregates. Column 1 suffers 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 there are other variables associated with incorporation that also may determine the total

value of materials. See, then, Columns 2 through 4: 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 5 through 9, 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 8 and 9, 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.

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 2.25, I present regressions for the 1894 factories with manuscripts and for the 1900 aggregate data. Because there are 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 aggre-

gate data. However, in Column 9, the coefficient on Corporation is significant in the cotton industry.

Factories per Firm

I the paper I consider each factory as an independent observation. However, factories belonged to firms; and some firms owned more than one factory. Corporations commonly owned more than one factory. Ignoring the correlation among the factories owned by the same corporation could introduce an upward bias in the coefficient on the corporation dummy variable. I find, however, that I understate differences between corporations and non-corporations by omitting controls for the number of factories each firm owns.

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. Controlling for the number of factories per firm in corporations, however, addresses the relevant bias.

Column 2 and 4 of Table 2.27 shows how controlling for firm size changes estimates of the determinants of revenue per worker and power per worker. The coefficient on the number of factories per firm is small and lacks statistical significance in the revenue per worker regression, and the coefficient is actually negative and statistically significant in the power per worker regression. Furthermore, introducing the control for the number of factories per firm increases the size of the Corporation coefficient.

Thus, not controlling for the number of factories per firm actually understates the differences between corporations and non-corporations.[60]

Survival

Incorporation allowed firms to avoid the problem of untimely dissolution, because corporations existed outside the identities of their founders, unlike partnerships, which died if any partners decided to leave the firm.[61] Thus, differences between corporation-owned factories and other factories may simply reflect that these factories are more likely to survive long enough to be counted in more than factory census.[62]

However, the data show that factories owned by corporations have very different characteristics from factories owned by similarly-lived non-corporation-owned factories. Figures 2.9 and 2.10 compare corporation-owned factories to non-corporation-owned factories. In Figure 2.9, 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 2.10, 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.

[60] Clustering standard errors by corporation also does not change any of the results (not reported).

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

[62] 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.

Table 2.17: Results from a Counterfactual Exercise Reducing Incorporation Costs in the Metals and Machines Industry

	Top 20%	Top 30%	Match US (62 %)
Increase in Revenue	8.3 %	9.6 %	11.2 %
Increase in Total Power	24.3 %	26.6%	30.7 %

Source: Gregg Imperial Russian Manufacturing Database (2015). I calculate counterfactual revenue and total power by converting some percentage of top producing metals and machines factories to corporations, plugging the new vector of enterprise forms into previously calculated fixed effects estimates, and then multiplying the resulting predicted values for revenue per worker and power per worker by total workers.

Table 2.18: Production Function Estimation

Pooled OLS	Dependent Variable: Log Revenue					
	[1]	[2]	[3]	[4]	(IV) [5]	(IV) [6]
Log (Workers)	1.09***	.89***	1.07***	.89***	.57***	.60***
	(.015)	(.026)	(.33)	(.026)	(.14)	(.14)
Log (Machine Power)		.26***		.26***	.68***	.69***
		(.024)		(.024)	(.13)	(.13)
Corporation			.33***	.026	-.22	-.84*
			(.046)	(.049)	(.11)	(.40)
Intercept	7.04***	7.45***	7.08***	7.45***	7.93***	7.82***
	(.22)	(.31)	(.21)	(.31)	(.39)	(.40)
Industry, Year, Prov. Dummies	Y	Y	Y	Y	Yes	Yes
1900 Included?	Y	N	N	N	N	N
N	38,048	17,786	38,048	17,786	12,991	12,942
R2	.7276	.7645	.7289	.7645	.7174	.7097

* $p < .05$, ** $p < .01$, *** $p < .001$. Standard errors, clustered by Region-Industry-Year groups, in parentheses for columns 1 through 4. In Column 5, inputs are instrumented with lagged inputs: the instrument for logWorkers is the factory's logWorkers measured in the previous year, and the instrument or logPower is the factory's logPower in 1894. In Column 6, I use lagged inputs as instruments for inputs and as the mean difference in revenue per worker between corporations and partnerships in a given cell excluding the factory in question as an instrument for enterprise form, as in the paper's main text. Robust standard errors in parentheses in columns 5 and 6.

Table 2.19: Production Function Sensitivity to Inclusion of Small Factories

Pooled OLS					
	L > 5	L > 10	L > 15	L > 20	L > 50
	[1]	[2]	[3]	[4]	[5]
Log (Workers)	.81***	.78***	.76***	.75***	.72***
	(.026)	(.28)	(.031)	(.034)	(.037)
Log (Machine Power)	.28***	.28***	.28***	.27***	.27***
	(.024)	(.024)	(.025)	(.025)	(.022)
Corporation	.11*	.16***	.19***	.20***	.25***
	(.044)	(.041)	(.039)	(.039)	(.036)
Intercept	7.79***	8.00***	8.15***	8.19***	8.46***
	(.27)	(.25)	(.25)	(.26)	(.24)
Industry, Year, Prov. Dummies	Y	Y	Y	Y	Y
1900 Included?	N	N	N	N	N
N	16,056	13,595	11,776	10,320	5,857
R2	.7471	.7328	.7247	.7229	.7057

* $p < .05$, ** $p < .01$, *** $p < .001$. Standard errors, clustered by Region-Industry-Year groups, in parentheses.

Table 2.20: Production Function Estimation (Translog)

Pooled OLS	Dependent Variable: Log Revenue			
	[1]	[2]	[3]	[4]
Log (Workers)	1.21***	1.39***	1.40***	1.41***
	(.066)	(.052)	(.052)	(.050)
Log (Machine Power)		.14**	.15**	.12**
		(.042)	(.042)	(.042)
Log (Workers)^2	-.016	-.043***	-.044***	-.048***
	(.0084)	(.0097)	(.0097)	(.0095)
Log (Machine Power)^2		.069***	.068***	.072***
		(.0083)	(.0084)	(.0084)
Log (Power) * Log (Workers)		-.069***	-.071***	-.068***
		(.016)	(.016)	(.016)
Corporation			.18***	.26
			(.036)	(.19)
Corp. * log (Workers)				.12*
				(.046)
Corp. * log (Power)				-.15***
				(.037)
Intercept	6.88***	6.74***	6.73***	6.75***
	(.24)	(.24)	(.23)	(.24)
Reg., Ind., Prov. Controls	Yes	Yes	Yes	Yes
1900 Included?	Yes	No	No	No
N	38,048	17,786	17,786	17,786
R2	.7282	.7765	.7769	.7774

* $p < .05$, ** $p < .01$, *** $p < .001$. Source: 1894, 1900, and 1908 factory lists. Standard errors clustered by Region-Industry-Year groups in parentheses.

Table 2.21: Summary Statistics for Residuals

		Corp.-Owned Factories		Non-Corp.-Owned Factories	Specification: Controls Included	Years Included
[1]	Mean	.26		-.015	Labor	1894
	Std. Dev	.86		.96		1900
	|t|		12.61			1908
	Median	.25		-.00064		
	Smallest	-5.52		-15.69		
	Largest	4.87		6.023		
	N	2,053		35,997		
[2]	Mean	.018		-.0013	Labor, Capital	1894
	Std. Dev	.83		.91		1908
	|t|		.73			
	Median	.0027		.033		
	Smallest	-5.044		-7.17		
	Largest	3.32		5.62		
	N	1,195		16,591		
[3]	Mean	.31		-.018	Labor, Labor^2	1894
	Std. Dev	.85		.95		1900
	|t|		15.18			1908
	Median	.31		-.0050		
	Smallest	-5.55		-15.17		
	Largest	4.84		6.09		
	N	2,053		35,997		
[4]	Mean	.12		-.0085	Labor, Capital	1894
	Std. Dev	.81		.89	Labor^2, Capital^2,	1908
	|t|		4.76		Labor*Capital	
	Median	.14		.040		
	Smallest	-5.52		-7.30		
	Largest	3.18		6.03		
	N	1,195		16,591		

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

Table 2.22: Quantile Regressions

	Dependent Variable: Log (Revenue)			
	Quantile: .25 [1]	Q: .25 [2]	Q:. 50 [3]	Q: .75 [4]
Corporation	.51***	.11**	.17***	.15**
	(.033)	(.041)	(.038)	(.048)
Log (Workers)	1.06***	.87***	.75***	.63***
	(.0052)	(.0081)	(.0076)	(.0097)
Log (Machine Power)		.25***	.31***	.39***
		(.0074)	(.0069)	(.0088)
Intercept	6.006***	6.25***	7.10***	7.91***
	(.018)	(.025)	(.023)	(.029)
Ind., Year, Prov. Dummies	Y	Y	Y	Y
1900 Included?	Y	N	N	N
N	38,056	17,786	17,786	17,786
Pseudo R2	.3921	.4522	.4721	.4795

* $p < .05$, ** $p < .01$, *** $p < .001$. Standard errors in parentheses.

Table 2.23: Determinants of TFP (Calculated by Imposing Shares)

Pooled OLS	Dependent Variable: Log (TFP)			
	[1]	[2]	[3]	[4]
Corporation	.29***	-.0024	.026	.97***
	(.042)	(.048)	(.049)	(.19)
Log (Workers)		.16***	.19***	.20***
		(.020)	(.026)	(.027)
Log (Machine Power)			-.038	-.032
			(.024)	(.25)
Corporation * log (Workers)				-.15***
				(.042)
Corporation * log (Power)				-.026
				(.038)
Intercept	8.19***	7.49***	7.46***	7.40***
	(.24)	(.30)	(.31)	(.30)
Ind., Year, Prov. Dummies	Y	Y	Y	Y
1900 Included?	N	N	N	N
N	17,786	17,786	17,786	17,786
R2	.2034	.2373	.2388	.2424

* $p < .05$, ** $p < .01$, *** $p < .001$. Source: 1894, 1900, and 1908 factory lists. Standard errors clustered by Region-Industry-Year groups in parentheses.

Table 2.24: Determinants of Total Value of Materials

OLS	1894 Micro [1]	1894 Micro [2]	1894 Micro [3]	1894 Micro: Cotton [4]	1900 Agg [5]	1900 Agg [6]	1900 Agg [7]	1900 Agg: Cotton [8]	1900 Agg: Cotton [9]
Corporation	4.15	.49	.012	.37	8.07	.28	.19	-34.32	-18.42
	(.38)	(.36)	(.34)	(.46)	(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	8.57	.90	1.92	1.71	3.24	1.38	.86	.73	.98
	(.77)	(.87)	(.83)	(.59)	(.17)	(.12)	(.15)	(.35)	(.51)
Industry Controls	Y	Y	Y	N	Y	Y	Y	N	N
N	245	219	72	72	686	669	667	24	18
R2	.3289	.6863	.8408	.8408	.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 2.25: 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 2.26: Survival by Enterprise Form

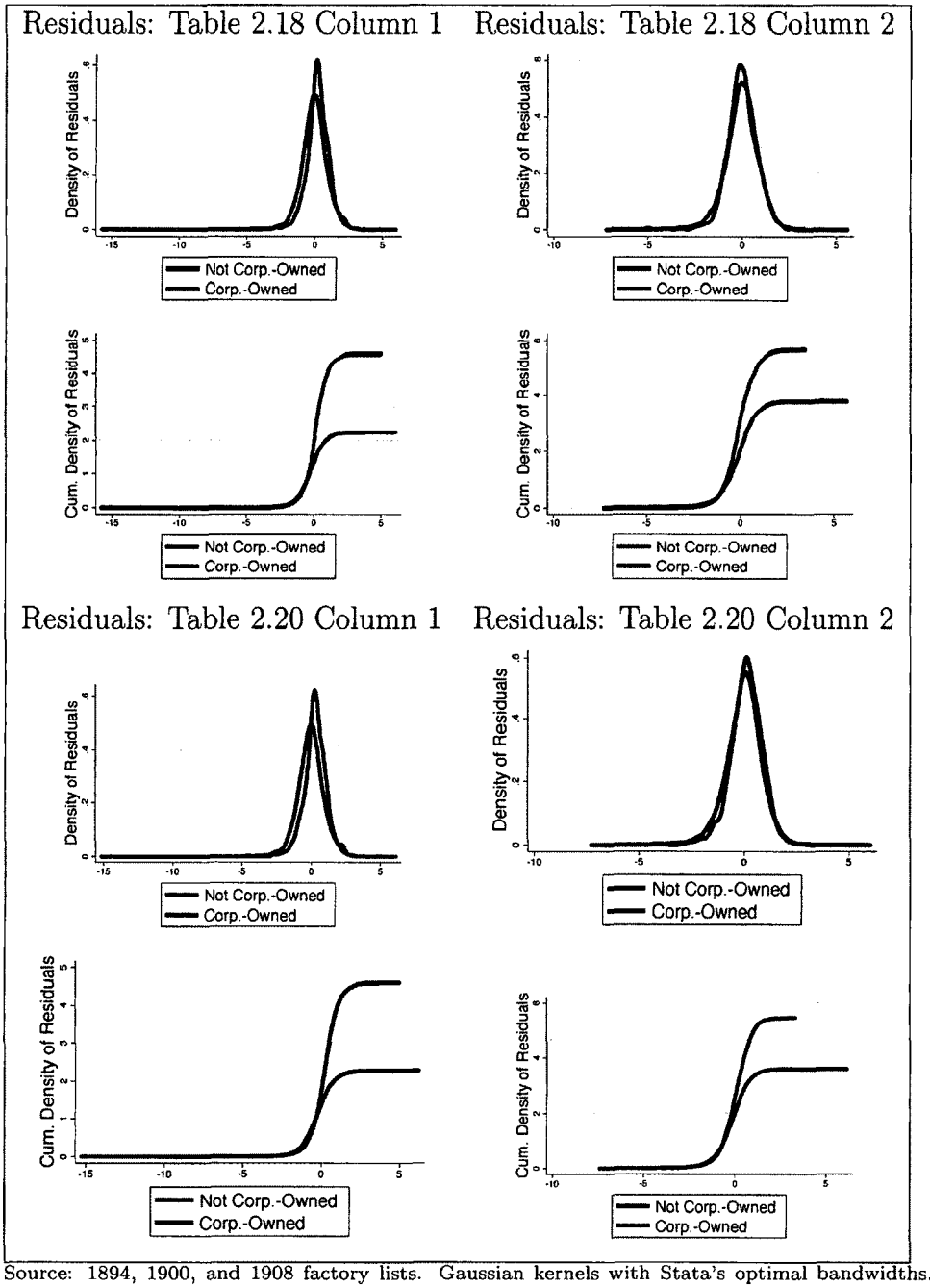
	1894	1900
Percentage of Corporation-Owned Factories that Survive Only One Year	40.35	43.60
Percentage of Non-Corporation Owned Factories that Survive Only One Year	68.13	55.62
Percentage of Corporation-Owned Factories that Survive Two or More Years	13.58	56.39
Percentage of Non-Corporation Owned Factories that Survive Two or More Years	12.76	44.38
Percentage of Corporation-Owned Factories that Survive Three Years	46.06	x
Percentage of Non-Corporation Owned Factories that Survive Three Years	19.11	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.

Table 2.27: Revenue per Worker and Power per Worker Controlling for Factories per Firm

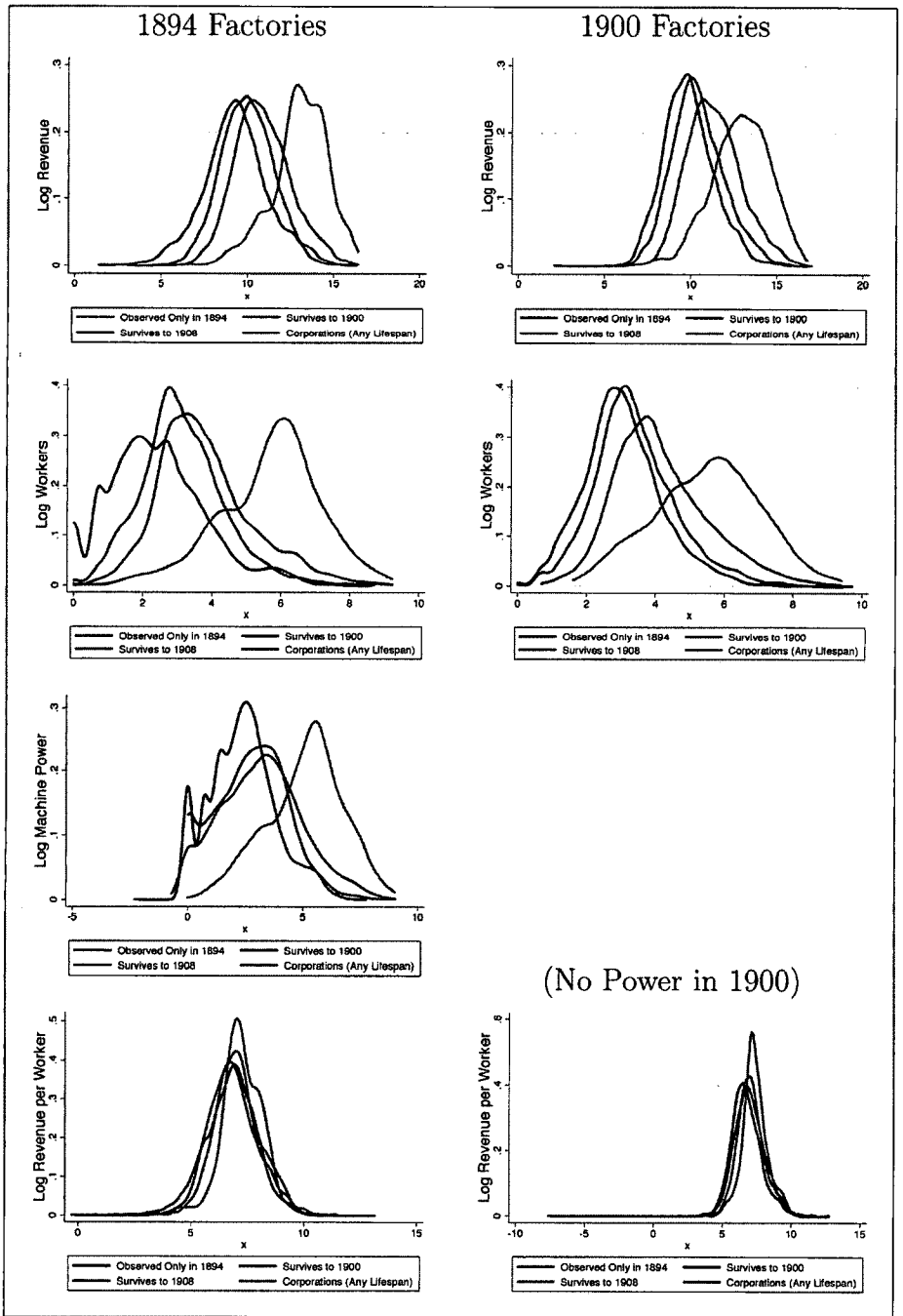
	Pooled OLS			
Dependent Variable:	log (R/L)		log (K/L)	
	[1]	[2]	[3]	[4]
Corporation	.46***	.48***	.18*	.23**
	(.044)	(.053)	(.071)	(.081)
Factories per Firm		-.017		-.055*
		(.021)		(.024)
Intercept	7.31***	7.33***	-1.97***	-1.92***
	(.20)	(.20)	(.37)	(.38)
Ind., Year, Prov. Dummies	Yes	Yes	Yes	Yes
1900 Included?	Yes	Yes	No	No
N	38,048	38,048	20,073	20,073
N Corps	2,053	2,053	1,238	1,238
R2	.2945	.2945	.3413	.3415

Figure 2.8: Kernel Density Estimates of Residuals



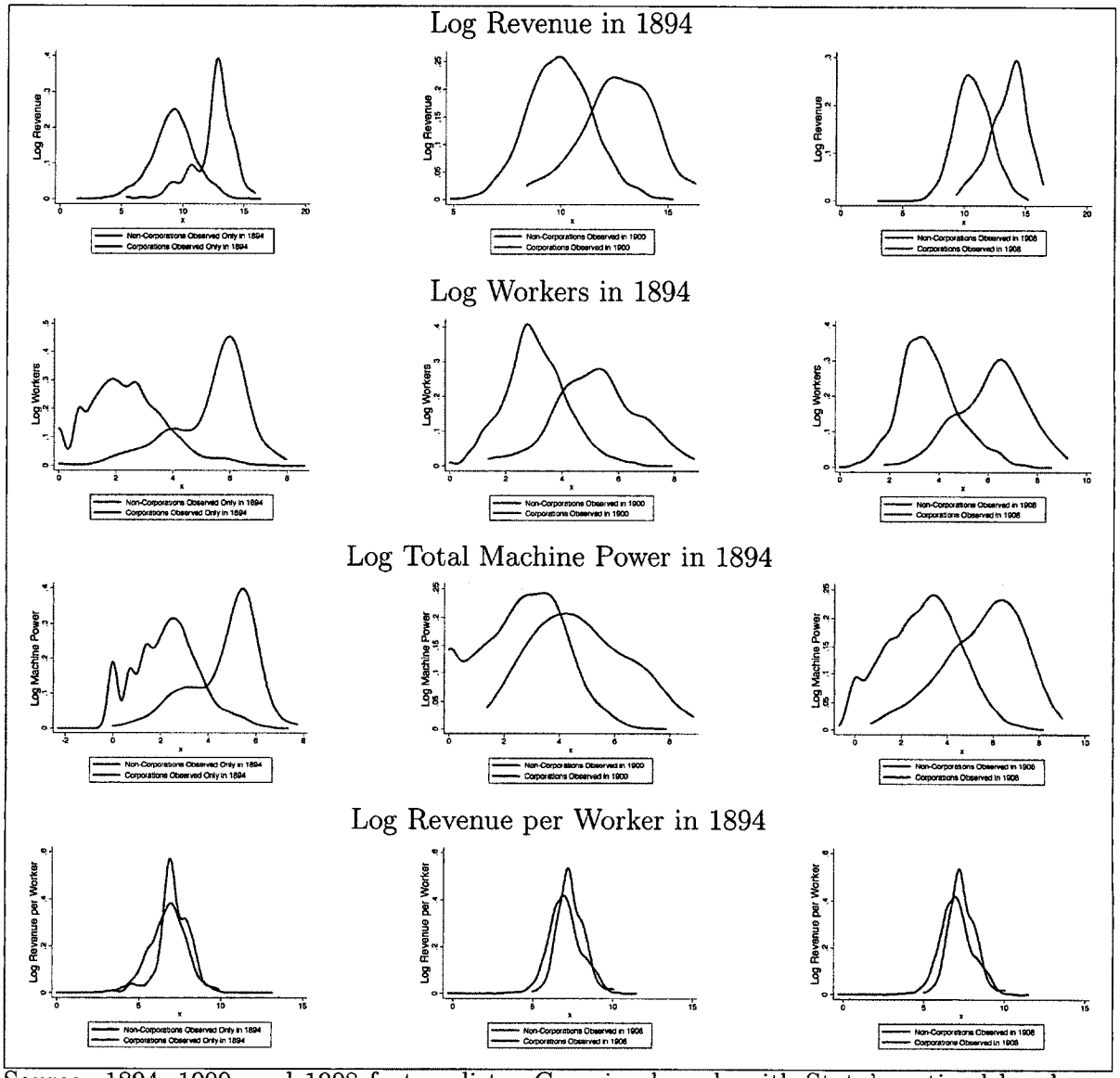
Source: 1894, 1900, and 1908 factory lists. Gaussian kernels with Stata's optimal bandwidths. The line labeled "Corps" is for corporation-owned factories only. The line labeled "NonCorps" is for factories owned by partnerships or single proprietorships.

Figure 2.9: 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 2.10: 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.

Chapter 3

Shareholder Rights and Share Capital: The Effect of the 1901 Russian Corporation Reform, 1890-1905

3.1 Introduction

In 1901, the Imperial Russian government introduced a corporation reform in response to widespread complaints of corporate abuse and corruption, especially in the form of concentration of power in the hands of a few large share block holders.[1] While Western European countries introduced general incorporation and private, limited liability enterprise forms after 1840, the Russian Empire left its concession system of incorporation in place and did not introduce any new enterprise forms.[2]

[1] Shepelev, *Corporations in Russia*, p. 201 and Owen, *Corporation under Russian law*, p. 150

[2] Guinnane et. al., "Putting the corporation," p. 692. For example, France introduced general incorporation in 1867, the German states did so between 1860 and 1870, and the United Kingdom did so in 1840 without limited liability and in 1855-6 with limited liability. The term "enterprise forms" can include both limited liability and unlimited liability forms, including simple and limited

Concession systems require firms to obtain special, government approved charters to incorporate, which stands in contrast to general incorporation systems, in which firms meeting standardized criteria are guaranteed access to incorporation. Russian firms incorporated only by the Tsar's special permission. Alexander Gerschenkron expected late industrializers like Russia to demonstrate "considerable differences...with regard to the productive and organization structures of industry" when compared to more advanced economies,[3] and the concession system certainly set Russia apart. In its entire history, the Russian Empire enacted only one major reform to its law on corporations, the 1901 reform. The bill strengthened minority shareholders' rights and removed bankers from corporations' boards of directors, which the bill's authors hoped would reign in corporations' excessive risk-taking. However, the reform did not affect all corporations equally.

Corporations affected by the reform (A-corporations[4] founded after the reform) had smaller total share capital, fewer shares, and higher par values for shares as observed in 1905.[5] The result for total share capital is especially strong. The new regulations disciplined corporations to be more conservative in raising capital by issuing stock, most likely by increasing the cost of having shareholders, since the provisions on removing bankers from boards could be avoided easily.

The effect of the 1901 Russian corporation reform speaks to a longstanding debate in economics that considers the relationships among agents in a corporation. In most contexts, corporations' structure can create principal-agent problems, since the

partnerships, single proprietorships, and corporations. Germany introduced a private limited liability form, the GmbH, in 1892, and France introduced its private limited liability form, the SARL, in 1925.

[3]Gerschenkron. *Economic Backwardness*, p. 7. Here Gerschenkron describes industrial production and organization in general, not legal institutions in particular.

[4]The Russian term is *Aktsionernye obshchestva*. The differences among types of corporations will be explained later in the paper. When transliterating words from Russian, I use the Library of Congress system without diacritical marks.

[5]Throughout the text, I use the term "share capital" to denote a corporation's total nominal capital, i.e. the par value of shares times the number of shares.

shareholders that own the company and directly benefit from corporate profits may not have the same incentives as the managers who make decisions. Bearle and Means (1932) termed this agency problem the "separation of ownership and control:" when ownership and control of a corporation are separated, the shareholders who own the corporation may not be able to discipline the managers running the company.[6]

The Russian 1901 corporation reform offers a rare opportunity to examine the financial effects of an attempt to improve corporations' principal-agent relationships through regulation. Unlike most corporate law changes in any context, Russia's 1901 did not affect all corporations equally. The 1901 reform seems to have made corporations affected by the reform more closely held: they decreased the amount of stock available to shareholders and made the fewer shares available more expensive. An analysis of corporate shareholder lists could confirm this explanation.

The 1901 reform's Russian authors expressed concerns over corporations' role in economic downturns, but clear shareholder rights could have also helped Russian companies to attract investments from far-away shareholders. The small size of Russia's domestic financial market amplified the importance of attracting foreign capital. Ol' (1983) estimated that foreign capital accounted for 37% of the total stock of trade industrial companies and credit institutions in 1901.[7] Corporations always present a tradeoff: limited liability corporations can successfully finance large ventures, but limited liability can prevent creditors from recovering debts, and managers can act

[6]Berle and Means (1932) document the separation of ownership and control in the United States, in which U.S. corporations' managers seized control of companies. The separation of ownership and control they described created a principal-agent problem in which U.S. corporations became dominated by small groups of large shareholders acting contrary to the interests of the large number of smaller shareholders in the company. Some empirical works (Hilt (2008), La Porta et al. (1999), Claessens, Djankov, Lang (2000)) quantify separation of ownership and control in modern and historical economies. In this paper, I find that Russian corporations responded to a change in the rights of small shareholders, which would be consistent with Russian corporations affected by the reform displaying some separation of ownership and control.

[7]The Russian financial sector represented 26.9 percent of national assets. The German and France financial sectors accounted for 39.5 and 42.9 percent of national income (Goldsmith, *Comparative balance sheets*). Information on foreign investment in Russia comes from Ol', *Foreign capital*, p. 255.

contrary to investors' interests. Sections II and III explain how Russia and other European countries balanced economic growth and corporate regulation.

Scholarship on Imperial Russian economic development has focused on state industrial policy and the persistence of labor market imperfections caused by serfdom. The role of law in Russian economic development remains poorly understood, and this paper highlights several features of Imperial Russian legal institutions. First, corporations changed how they structured capital in response to the 1901 reform, which shows that reforming the Russian commercial code altered corporate behavior, even though in theory the Russian Ministry of Finance could codify exceptions to the commercial code in corporate charters. Little is known about how Russian corporations performed or how they responded to written law.[8] Most of the largest industrial firms in the Russian Empire were organized as corporations, so a better understanding of Russian corporate behavior may shed light on the Russian industrial sector's rapid late nineteenth century growth.[9] Further research could determine how the Russian commercial code influenced corporate charters and explore the relationship of charter provisions to corporate performance.

[8]For example, Gerschenkron (1962) argued that state investment in manufacturing substituting for weak domestic capital markets, but Kahan (1989) pointed out that government policies often contradicted one another. Recent work by Nafziger (2010) and Dennison (2011) has described Russian agriculture, the largest sector of the economy, in new detail. Scholarship on Imperial Russian law remains limited. Wortman (1976) describes the development of the Russian law code and legal institutions in general, and Wagner (1994) explains Imperial Russian marriage and property law, but scholarship on Imperial Russian commercial law is scarce. Owen (1991) and Shepelev (1973) present comprehensive narratives of the development of Russian corporations. They do not stress empirical evaluations of corporate responses to particular legislative changes.

[9]The proliferation of a corporate form of business organization that guarantees limited liability to all investors in a company is commonly cited as a necessary precondition for modern economic growth, but some question this claim. Guinnane et al. (2007) argue that corporations' importance is overstated, since the small and medium-sized enterprises that comprise the bulk of businesses in an economy formed as private limited liability companies, not corporations, when that form was available. Guinnane et. al. cite Rosenberg and Birdzell (1986) and Freedeman (1979 and 1993) as examples of works arguing that the corporate form was a key technology for economic growth or that restriction of the form limits development. See also Kuran (2005) and Owen (1991), who argue that restrictions on incorporation limited growth in the Ottoman Empire and Russia.

Finally, the paper provides further evidence that the Russian commercial code treated two major types of Russian corporations (A-corporations and share partnerships) differently. Although the Russian commercial code makes no distinction between the two, the 1901 law affected corporations in each group differently, with share partnerships taking advantage of an exception in the law that allowed them to largely avoid its provisions. Similar to a private limited liability company (Guinnane et al 2007), Russian share partnerships were able to take advantage of full limited liability while avoiding some of the requirements placed on corporations in general.

In Section 2, I present a brief history of corporations in Russia, comparing the history of Russian enterprise form law to that in Western Europe and showing how Russian enterprise form law fell behind after the middle of the nineteenth century. Section 3 explains the 1901 corporation reform and its probable effects on Russian corporations. Next, I present results from a database of information from corporate charters and a 1905 business directory that argue that corporations affected by the reform decreased their total share capital, increased par share price, and decreased their total number of shares. An appendix, to be posted online, rules out several alternative explanations for the results.[10] The paper's conclusion suggests a future research agenda studying Russian corporate charters and firm performance.

3.2 Russian Corporation in a European Context

Until the middle of the nineteenth century, changes in Russian enterprise form law closely resembled Western European innovations. Before 1800, European corporations, or joint-stock companies, existed as organizations granted a special charter by the government to execute some specific task, for example conducting trade, or

[10]The appendix includes the following robustness checks: Heckman corrections for chartered firms that do not appear in the 1905 volume, pretrends analysis, analysis of results where the left hand side variable is in logs, and selection analysis.

to be granted privileges like monopoly rights in some territory.[11] The handful of corporations that existed in Russia before 1800 followed this model, and their charters usually did not even mention limited liability.[12] Early corporations, then, were created by means of a concession system of incorporation, in which all companies must obtain special permission to incorporate. The alternative, a registration system of incorporation or general incorporation, allows any company that satisfies a set of requirements to incorporate by registering at a government office.

However, Western European countries introduced significant reforms to their menus of enterprise forms throughout the nineteenth and early twentieth centuries. Gradually, Britain, France, and Germany eliminated their concession systems. After 1844, companies in Britain could incorporate without limited liability, and after 1856, they could do so with full limited liability. France introduced general incorporation in 1867, and Germany did so in the 1860s.[13] After adopting general incorporation laws, these Western European countries added additional flexible enterprise forms, which Guinnane et al (2007) term private limited liability companies (PLLCs). PLLCs granted limited liability to all of their members, but shares could not be traded. Russia's European neighbors introduced PLLC forms by the first quarter of the twentieth century: Germany introduced its PLLC, the Gesellschaft mit beschränker Haftung (GmbH) in 1892; the United Kingdom introduced the private limited company in 1907; and France introduced the société à responsabilité limitée (SARL) in 1925. After the introduction of the PLLC, small and medium sized enterprises began to prefer this form because it gave members limited liability

[11]Owen, *Corporation under Russian law*, pp. 6-10.

[12]For example, one of the most famous early corporations in Russia, the Russian-American company, did not grant its investors limited liability until many years after its founding. See Owen, *Corporation*, 9. Limited liability is also absent from Peter I's 1699 decree encouraging Russians to found "trading companies", "as there are in other states." (Polnoe sobranie zakonov rossiiskoi imperii (hereafter PSZ, Volumes 1 and 2). [Complete collection of laws of the Russian Empire], 1-1706. ["...как и в других Государствах, торговых компаний..."])

[13]Guinnane et. al., "Putting the corporation," p. 692.

but was also more flexible than the joint-stock (corporation) form (Guinnane et al 2007).

European governments recognized that corporations' limited liability could be risky, and they introduced regulations to strengthen shareholders' rights. The 1867 French law that introduced general incorporation also required companies to submit balance sheets every other year and to report the company's profit, loss, and inventory to its shareholders forty days before shareholder meetings.[14] The law also required that corporations make the profit and loss report available to shareholders for free at least fourteen days before the meeting and to establish a reserve fund. Stock exchange reforms in Germany and 1884 and 1896 increased underwriting requirements for German corporations and creating new governing bodies in the stock exchanges that were supposed to enforce existing regulations more tightly and to monitor new share issues.[15] The Russian 1901 law, described in Section 3, shares some of the features of these French and German regulations.

The Imperial Russian government issued regulations that established the Russian enterprise form menu at the beginning of the nineteenth century, though regulations for corporations remained vague. Tsar Alexander I formally codified limited liability for corporations in the Law of 1805, in which he decreed that "in the event of failure of a corporation, no investor may lose more than the capital he has invested in the enterprise."[16] The law of 1807, influenced by enterprise form innovations in Western Europe, introduced the simple and limited partnerships but stopped short of outlining the rights and responsibilities of corporations. The law used a mix of Russian and

[14]Foreman-Peck, "Accounting," p. 18.

[15]Fohlin. "Regulation," pp. 223-6.

[16]PSZ 2-21900: [" ...ни один из акционеров...при неудачах не теряет сыше положеннаго в компанию капитала."]

French words for "company" (*Aktsionernoe obshchestvo* and *aktsionernaia kompaniia* from *compagnie*) and "share" (*aktsiia* from *action*).[17]

The first set of detailed regulations for Russian corporations appeared in the Law of 1836, which described the procedure for obtaining a corporate charter through the Imperial concession system, a central feature of Russian business law until the 1917 Revolution. Russian firms submitted charters for review to a relevant ministry, usually the Ministry of Finance. The Ministry of Financed administered the concession system's bureaucratic procedure, which culminated in the Council of Ministers' approval and the Tsar's signature.[18] Although it represented a major fixed cost of incorporation, the concession system also presented some advantages. Because corporate charters carried the Tsar's signature at the end of the incorporation process, the charters themselves had the power of independent pieces of law.[19] The Imperial government could both place additional restrictions in a corporation's charter and grant special privileges, sometimes in direct violation of the commercial code. The flexibility of these charters and the degree to which the commercial code was binding, however, are poorly understood: this paper's results show that the changes to the commercial code set down in the law of 1901 had a real effect on the shape of Russian corporations.

The Ministry of Finance made several attempts to reform the Law of 1836 and introduce a registration system. Both reform attempts emerged from a desire to encourage Russian commercial development and improve corporate oversight, and both failed.[20] The Butovskii Bill effort began in the 1860s, a time of major reform

[17]Owen, *Corporation under Russian law*, p. 12. Owen argues that the law's terms for enterprise forms and their devices have French and Russian roots, though German terms are similar.

[18]RGIA f. 23 op. 12 and f. 22 op. 2. Any file from these collections reflects this procedure.

[19]Shepelev, *Corporations in Russia*, pp. 55-8. The chapter is titled, "The role of corporate charters as independent sources of law." ['Роль уставов акционерных компаний как сепаратных законодательных актов'].

[20]Owen, *Corporation under Russian law*, pp. 56-63 and pp. 138-42.

in Imperial Russia, but Finance Minister Reutern abandoned the project in 1874.[21] Further attempts, including the 1897 Tsitovich Commission and the 1911 Timashev Conference, also failed to produce new legislation.[22] In both cases, legislators expressed concern that allowing a broader pool of firms to incorporate, which might include smaller or less successful companies, was too risky, given corporations' limited liability.[23] A few laws did introduce some reforms to Russian corporations, though they fell short of introducing a registration system. The Imperial government allowed small savings and loan companies to incorporate by registration in 1872 and lifted the ban on the sale of futures in 1893.[24] The most significant legislative change, however, was the Law of 1901, which the next section describes in detail.

In the end, the Russian Empire introduced neither general incorporation nor the PLLC. However in practice the Russian share partnership, which was in fact a kind of corporation, resembled the German GmbH. By the end of the nineteenth century, in granting Imperial charters the Imperial government allowed major practical differences to emerge between two types of corporations: *aktsionernye obshchestva* ("A-corporations") and *tovarishchestva na paiakh* ("share partnerships").[25] The Nobel Company, for example, incorporated as an A-corporation in 1879 but amended its charter to become a share partnership in 1884.[26]

A Russian share partnership was a kind of corporation under the commercial code, but in other countries, the term "share partnership" denoted an entirely different enterprise form. The French and German codes, for example, included an enterprise form called the "limited partnership with tradable shares." Firms of this form had at least one partner with unlimited liability and shareholders with limited liability,

[21]Ibid., pp. 68-75.
[22]Ibid., pp. 190-192.
[23]Ibid., p. 76 and p. 148.
[24]See Shepelev, *Corporations in Russia,* p. 55 for details on incorporation for small savings and loan establishments.
[25]Owen, Corporation under Russian law, p. 152.
[26]Ibid., citing Shepelev, Corporations in Russia, p. 215.

and the shares could be bought and sold.[27] Russian share partnerships, by contrast, had no unlimitedly liable partners.

Similar to a GmbH, Russian share partnerships tended to be smaller than A-corporations and to issue shares of larger amounts to a small group of investors rather than trade shares on stock markets.[28] The differences arose at first because of a linguistic wrinkle: in Russian, the word "corporation" can be translated several ways, since there are two words for "share" (*aktsiia* and *pai*) and at least three words for "company" (*kompaniia*, *tovarishchestvo*, and *obshchestvo*). The Russian commercial code, however, makes no distinction between "corporations" that use any combination of these terms, in fact sometimes preferring yet another term, *tovarishchestvo pa uchastkam*.[29]

Consider some examples from the Ministry of Finance archives. Records from the chartering process suggest that companies decided whether to call themselves A-corporations or share partnerships and decided an initial share capital amount when they initially applied to be corporations. For example, when the company "Bunkovskaia Manufaktura Mironovykh" applied for a corporate charter in 1905, they noted that they wished to found a share partnership (*tovarishchestvo na paiakh*).[30] Furthermore, their initial charter draft specified a one million ruble share capital divided into 1000 shares of 1000 rubles each, which was approved.[31]

On the other hand, in 1901 the Sorevnovanie Manufacturing and Publishing Company applied to be an A-corporation (*aktsionernoe obshchestvo*) with a 500,000 ruble total share capital divided into 1000 shares of 500 rubles each.[32] Similarly, the

[27]Guinnane et al., "Putting," p. 692 (Table 1).

[28]Owen, Corporation under Russian law, p. 152.

[29]Ibid., p. 11.

[30]RGIA f. 23, op. 12, d. 21, l. 4 Article 1: 'Учреждается Товарищество на паях'.

[31]RGIA f. 23, op. 12, d. 21, l. 5 Article 7: 'Основной капитал Общества наначается в 1.000.000 рублей, разделенных на 1000 паев, по 1000 рублей каждый'.

[32]RGIA f. 22, op.2, d. 2585, l. 4: 'акционерное общество.: L. 4: 'Основной капитал Общества определяется в 500.000 рублей, разделенных на 1000 акций, по 500 рублей каждая'.

"Ramiba" Bentwood Furniture Company of Penza applied to found an A-corporation with a total share capital of 600,000 rubles, divided into 2,400 shares worth 250 rubles each in 1905.[33] The next section describes the provisions of the 1901 Russian corporation reform. The example of the Ramiba Company can serve as a preview of the effects of the reform on Russian corporations. In Section 6, I argue that A-corporations' total share capital decreased as a result of the reform. Thus, the Ramiba Company's total share capital may have been smaller than it would have been without the reform. Results presented in Section 6 and in the appendix indicate that companies like Ramiba, founded after the corporation reform, generally did not incorporate as share partnerships instead of A-corporations to avoid the provisions of the law.

3.3 The Law of 1901

The Law of December 21, 1901 was passed as an attempt to calm some of the previous years' "stock-exchange fever."[34] Stock exchange fluctuations followed two significant crop failures in 1897 and 1898 and a "severe industrial depression."[35] The Ministry of Finance believed that much of the stock exchange volatility came from bankers' tendency to serve on corporate boards, a possible source of conflicts of interest and oppression of minority shareholders by those who held larger blocks of shares.[36] The government also believed that holders of larger blocks of shares might use their voting power to insist on a course of action according to their personal

[33]RGIA f. 23, op. 12, d. 28, l. 2: 'Желая учредить акционерное общество под названием 'Общества первой Пензенской паровой фабрики гнутой венской мебели 'Рамиба"... L. 4: 'Основное капитал Общества ределяется в 600.000 рублей, разделенных на 2.400 акций, по 250 рублей каждая'

[34]Owen, Corporation under Russian law, p. 150.

[35]Von Laue. "Secret memorandum," pp. 61-2.

[36]Ibid.

interest rather than the interest of the corporation or its (minority) shareholders.[37] Thus, the law had two primary goals: first, to increase shareholder rights (especially for small shareholders), and second, to remove bankers from corporate boards of directors.[38]

3.3.1 The Law's Goals

The law's authors hoped to strengthen the rights of minority shareholders by adding several provisions to the commercial code.[39] Part I, Articles 1 through 5 require that shareholder meetings be well publicized in advance and that all stockholders who wish to attend a general assembly (shareholder meeting) must be allowed to do so as long as they give notice one week in advance.[40] According to Article 6,

[37]Ibid.

[38]I focus on the provisions altering shareholder rights in this paper because it is doubtful that the provisions removing bankers from corporations' boards of directors was enforceable. See the end of the next section.

[39]The Law of 1901 is number 3-20874 in the *Polnoe Sobranie Zakonov.* An excellent explanation of the law can be found in Owen, Corporation under Russian law, pp. 150-54.

[40]PSZ 3-20874 Part I Article 1 requires the corporation to publish an announcement of an upcoming shareholder meeting at least 21 days in advance, unless their charter allows a shorter time: "О созвыве Общих Собраний делаются публикация заблаговремено и во всяком случае не позднее двадцати одного дня, за исключением случаев, когда в Уставе Общества указан более короткий для сего срок." Also according to Article 1, this notice must contain the date and time, location, and agenda of the meeting: "В таковых публикациях означаются в точности: а) день и час, на который созывается Общее Собрание, б) помещение, в коем оно имеет происходить, и в) подробнее поименование вопросов, подлежащих обслуждению и решению Собрания." Article 2 requires the Board of Directors to draw up a list of shareholders wishing to attend the meeting four days in advance, which shareholders can request to see: "Изготовленный Правлением список акционеров, заявивших о желании участвовать в Собрании, выставляется в помещении Правления за четыре дня до Общего Собрания. В списке означаются нумера представленных владельцами акций. Копия означенного списка выдается каждому акционеру по его требованию." Article 3 requires that all named shareholders be permitted to participate in the shareholder meeting as long as they give seven days notice: "Владельцы именных акций пользуются правом голоса в Общем Собрании лишь в том случае, если они внесены в книги Правления, по крайней мере, за семь дей до дня Общего Собрания, причем для участия в Общем Собрании предьявления именных акций не требуется." Articles 4 details procedures for attendance to shareholder meetings by holders of unnamed shares (shares to the bearer), and Article 5 requires that a "advisory commission" representing at least 1/20 of the share capital of the firm review the list of shareholders in attendance: "До открытия Общего Собрания Ревизионная Комисия или Совет (в тех случае, когда нет Ревизионной Коммисии) проверяет составленный Правлением список (ст. 2) акционеров, причемв случае требования явившихся в Собрание акционеров, представляющих не менее 1/20 части основного капитала..."

the presiding officer of the shareholder meeting must be elected by shareholders at the meeting.[41] According to Articles 7 and 12, only one fifth of the company's capital stock must be present at the shareholder meeting to represent a quorum, and at least one half of the capital stock for major changes (changing the company's total share capital, revising the company's charter, issuing bonds, or dissolving the firm).[42] Previously, one half of the company's capital stock was required for a quorum and three-quarters to enact major changes.[43] Other articles require an open vote upon any request, the holding of a general assembly within one month of a request from one half of the company's capital stock, and the maintenance of an audit commission to verify a company's records and inventories.

The law also sought to eliminate bankers from corporate boards, though corporations could avoid this provision easily. Part Five of the law required that any executive director of a bank resign his corporate post within three years.[44] However, corporations could, for example, arrange an interlocking directorate, and since the law only required the executive directors of banks to resign from corporate boards, corporations could simply place one of the bank's other directors on the firm's board.[45]

The law did not apply to all corporations equally. While the law's provisions were meant to increase the influence of small shareholders in Russian corporations, Thomas Owen argues that the law's effectiveness was weakened by a major loophole:

[41]PSZ 3-20874: "По открытии Собрания, акционеры, имеющие право голоса, избирают из среды своей Председателя."

[42]PSZ 3-20874: "Для действительности Общих Собраний требуется, чтобы в них прибыли акционеры или их доверенные, представляющие в совокупности не менее одной пятой части основного капитала, а для решения вопросов: об увеличении или уменьшении основного капитала, о выпуске облигаций, об изменении Устава и ликвидации дел требуется прибытие владельцев акций, представляющих не менее полины основного капитала."

[43]Shepelev, *Russian Corporations*, p. 213.

[44]PSZ 3-20874 "Директоры-распорядители (или соответствующие им должностные лица) кредитных учреждений не могут одновременно состоят Директорами-распорядителями акционерных Компаний. Те из Директоров-распорядителей кредитных учреждений, кои во времени издания настоящего законоположения будут состоять в должностях Директоров-распорядителей акционерных Компаний, вправе оставаться в таковых должностях по сроке их избрания или назначения, но во всяком случае не долее трех лет."

[45]Owen, *Corporation under Russian law,* p. 152.

companies that incorporated as share partnerships and whose shares were not traded on a stock exchange were exempt from the law's provisions.[46] A-corporations were much more likely than share partnerships to issue shares on stock markets. Share Partnerships usually issued small numbers of large-denomination shares within small circles of shareholders, usually consisting primarily of family members.[47] The Law of 1901, then, should apply more to the A-corporations than to the share partnerships, which provides an opportunity to evaluate the law's effects by comparing changes in capital, share price, and number of shares for these two groups of corporations.

How did the law affect corporations founded before the reform? The 1901 law itself states that its provisions applied to all existing corporations.[48] However, as explained in Section 2, because the Russian commercial code recognized corporate charters as independent pieces of law, only corporations founded after the reform should be legally bound by the law's provisions.[49] Most likely, the government enforced the law through the process of granting corporate charters: corporations that submitted charters that did not conform to these new regulations would be required to revise their charters for approval. The law's pronounced effect on A-corporations founded after the reform demonstrates that corporations founded before the reform did not have to respond as definitively to the law's provisions.

[46]Owen, Corporation under Russian law, pp. 150-54. Also PSZ 3-20874, Part 1: "Относительно организации и созыва Общих Собраний и Ревизионных Комисий акционерных кредитных установлений, торгово-промышленных Обществ (за исключением железнодорожных) и Товариществ на паях (кроме тех, паи коих не котируются на бирже), а равно акционерных страховых Компаний, установливаются следующие привила:..."

[47]Owen, *Corporation under Russian law*, p. 152.

[48]PSZ 3-20874 Section 2: "Означенные правила распростроняются на все существующие поименованные в пункте I сего положения акционерные Компании в изменение и дополнение соответствующих постановлений действующих Уставов оных."

[49]Shepelev, *Russian Corporations*, pp. 55-8.

3.4 Measuring the Effect of the 1901 Reform

The paper's results are based on a database of information collected from every Russian corporate charter issued between 1700 and 1914 as well as data collected from a 1905 business directory, which serve as an information update to the charters.[50] The corporate charters provide a picture of a company at the time of its initial incorporation, including the company's founding date, and the business directory describes the condition of all corporations operating in 1905. The database contains variables such as the charter's law number; the company's total capital, number of shares, and share price both at the time of the company's founding and in as reported in the 1905 directory; the corporation type (A-corporation or share partnership); the firm's industry (four digit SIC code); and even demographic information on the company's founders. Many of the variables in ruble amounts are standardized according to a method outlined in Owen (1989).[51]

3.4.1 How Did the 1901 Reform Change Corporations' Share Capital?

My empirical approach compares the difference in differences between A-corporations and share partnerships founded before vs. after the reform, where the outcomes of interest are total nominal share capital, share price, and number of shares measured

[50]Source: The RUSCORP Database (Owen 1992). I use the database's main charter files and its 1905 update file, which is based on: Vasilii Aleksandrovich Dmitriev-Mamonov, Count, ed. *Ukazatel' Deistvuiushchikh v Imperii Aktsionernykh predpriiatii i torgovikh domov.* [Directory of Corporations and Partnerships in the Russian Empire]. 2nd ed., St Petersburg, 1905.

[51]Throughout its history, the Russian Empire recognized several kinds of rubles, including paper and silver rubles, all of which appear in corporations' charters and which had different values in the market. To place corporations' capital and share prices on an equal monetary footing, Owen converts the raw ruble amounts of total share capital and share price into several standard rubles, depending on the year. After 1852, the standard ruble of account is the credit ruble. The standardization does not account for geographic differences in price levels or inflation over time. In this study, share prices and total share capital amounts are presented in their standardized form whenever possible.

in the 1905 update file. Share capital (or nominal share capital) is the par value of shares times the corporation's number of shares. I calculate differences in nominal share capital, share price, and number of shares as observed in 1905 for corporations with founding dates before the reform to those variables observed in 1905 for corporations founded after the reform (but, of course, before 1905). Then, I evaluate whether A-corporations founded before vs. after the reform show a greater difference in 1905 nominal share capital, share price, and number of shares than share partnerships.

The Imperial government designed the law to have the greatest impact on the firms it assumed posed the greatest risks, primarily the A-corporations, which were more likely to have large circles of dispersed, anonymous shareholders. The reform was not randomly assigned to Russian corporations. Thus, with the caveat that the reform cannot be considered a natural experiment,[52] the results show how Russian A-corporations changed after the imposition of the reform.

I use the information on total share capital, share price, and number of shares from the 1905 file rather than the charter information for several reasons. First, measuring changes as observed in 1905 sheds light on how the reform worked in practice by showing the reform's effects on firms that already existed before 1901. While the law technically applied to all corporations, A-corporations founded before the reform may have experienced a smaller effect than firms that would have had to conform to the law's requirements while composing their charters. Second, measuring share capital, price, and number of shares for each firm at the same point in time acts as an additional control by putting firms on the same footing with respect to inflation and any events corporations may have experienced. Corporate charters issued fifteen

[52]This is a common problem that arises when studying the effects of policy changes. See, for example, Besley and Case (2000).

years apart would be different for reasons other than the effect of the 1901 reform.[53] However, this assumes that the 1905 file takes into account any share capital updates issued by corporations, which may soften the reform's effect and thus bias my results against finding an effect of the reform.

Not every firm for which the database has charter information appears in the 1905 update file. While it is possible that the Dmitriev-Mamonov 1905 corporate directory's authors simply missed some firms, it is most likely that the firms that do not appear in the 1905 file did not survive.[54] I consider specifications in which firms that do not appear in the 1905 directory (and hence probably did not survive to 1905) are dropped, in which firms that do not appear in 1905 are assumed to have zero market value, and in which firms that do not appear in 1905 are assumed to have some percentage of their market value at founding.[55]

The major characteristics of corporations in the years surrounding the reform should depend on whether the corporation is an A-corporation or a share partnership and when the corporation was founded. In Equation 1 below, a corporation i's total share capital, par share price, or number of shares in 1905 (y_i) depend on whether the corporation is an A-corporation (AC_i), whether the corporation was founded

[53]The 1905 Dmitriev-Mamonov directory lists updated par values, not market values. The only way to compare the share prices listed in the directory to real market values would be to match the stock prices listed in the Dmitriev-Mamonov directory to the stock prices listed in the St. Petersburg Stock Exchange Project data. Matching corporations between RUSCORP and the St. Petersburg Stock Exchange Project would be a difficult undertaking and is a goal for future research.

[54]To check whether a firm's absence is due to the firm's not surviving or to some omission by the authors of the 1905 volume, I compare results from the charter database to those from the 1894, 1900, and 1908 manufacturing censuses. 26.59 percent of the corporations that appear in the 1894 census volume do not appear in the 1900 volume, and about 50 percent of the corporations that appear in the 1900 volume do not appear in the 1908 volume. Of the 1699 corporations chartered between 1890 and 1905, 51.27 percent appear in the 1905 update file, which reflects a rate of survival similar to if not higher than that calculated from the manufacturing census volumes. (List of Factories and Plants 1897, 1903, and 1912).

[55]In the online appendix, I consider versions of the model that include a Heckman correction for firms that do not survive to be included in the 1905 data.

after the reform (t_i, a dummy variable), and whether the corporation satisfies both criteria ($AC_i * t_i$).[56]

$$y_i = \beta_0 + \beta_1 * t_i + \beta_2 * AC_i + \beta_3 * AC_i * t_i + \epsilon_i \qquad \text{Equation 1}$$

The key coefficient, β_3, shows the change in total capital, share price, or total number of shares (y) in 1905 for A-corporations founded after the reform minus the change experienced by share partnerships.[57] I assume that whatever trend may affect total share capital, share price, or number of shares as observed in 1905 would be the same for both kinds of corporations had the reform not taken place. This seems reasonable, since both kinds of corporations follow the same commercial code, operate in the same national economy, and trade shares on the same stock markets. Also, to my knowledge no other legislative change or event in this period of Russian history would have affected one type of corporation more than another. In the appendix I check this assumption by running the same analysis for years entirely before the reform.

Some of the variables in Equation 1 can be defined several ways. First, consider the size of the "before" and "after" windows (t). The number of observations in the dataset is relatively small for this analysis, and as the size of the window increases, the sample size increases, which increases the estimate's precision. However, as the size of the window increases, any results are less likely to be as a result of the actual reform and could possibly be the result of some other change that differentially affects A-corporations more than share partnerships. Therefore, I check a variety

[56] AC_i is a dummy variable that equals 1 if the corporation is an A-corporation and equals 0 otherwise. t_i, also a dummy variable, equals 1 if the corporation is founded after the reform and equals 0 if the corporation is founded before the reform.

[57] The coefficient β_3 is the "difference in differences," since

$$\beta_3 = (E[y_i|AC = 1, t = 1] - E[y_i|AC = 1, t = 0]) \\ -(E[y_i|AC = 0, t = 1] - E[y_i|AC = 0, t = 0])$$

The coefficient β_1 gives the difference $E[y_i|t = 1] - E[y_i|t = 0]$, and the coefficient β_2 gives $E[y_i|AC = 1] - E[y_i|AC = 0]$.

of window sizes. The standard window that will be used for most of the analysis is seven years before and five years after the reform, which the results suggest is a reasonable compromise. Finally, values for total capital, share price, and number of shares are presented in levels rather than logs to show the reform's raw effects and to allow for comparisons of the several effects, since share capital equals par value times number of shares; the online appendix includes results in logs.

3.4.2 Did Companies Change Form to Avoid the Law?

Owen argues that several flaws in the 1901 law's design limited its effect on Russian corporations.[58] For example, the government's exempting share partnerships from the provisions of the law represented a major weakness of this reform, since there were in fact several forms of managerial abuse "unique to share partnerships."[59] It follows that some firms might have incorporated as share partnerships instead of A-corporations and traded to small circles of acquaintances instead of listing shares on stock markets in order to avoid the restrictions of the newly updated commercial code.

Results presented below indicate that very few if any firms incorporated as share partnerships instead of A-corporations to avoid the law.[60] The characteristics of each type of corporation are generally stable for each group before and after the reform. For A-corporations, the benefits of choosing this kind of corporation outweighed the costs of introducing the new provisions required by the Law of 1901. Also,

[58]Owen, *Corporation under Russian law*, pp. 150-4.

[59]Ibid., 153. Owen gives two examples of forms of managerial abuse sometimes practiced within share partnerships. First, many share partnerships operated as family enterprises with female family members as shareholders; female shareholders 'could hardly have been expected to exercise their nominal rights against their fathers, brothers, and husbands' (153). Second, Owen argues that some companies that called themselves share partnerships in their charters actually traded shares on exchanges, yet more evidence that the differences between share partnerships and A-corporations could be subtle.

[60]See Section 5.

the appendix includes separate calculations demonstrating that changes in the A-corporations indeed drive the results. Finally, also in the appendix, I present results that explicitly control for selection into each kind of corporation.

3.5 An Overview of Russian Corporations

This section discusses the characteristics of Russian corporations as well as the differences A-corporations and share partnerships. The characteristics that predicted whether a corporation was an A-corporation or not did not substantially change after the reform.

Table 3.1 Panel A, which gives an overview of the characteristics of Russian corporate charters from 1890 to 1910, reveals that while many Russian corporations had small amounts of capital and shares and low share prices at the time of their founding, a few corporations were massive along these dimensions. For example, the mean total standardized share capital was about 1,200,000 rubles (about 85,200 pounds sterling in 1900), though the largest corporation's charter specified a total capital of ninety million rubles (about 6.4 million pounds sterling in 1900), almost seventy-five times the average.[61] The average Russian corporation was relatively small, even compared to British corporations: the average size of British corporation on the London stock exchange was about 1.1 million pounds sterling, or 15.75 million rubles.[62] In addition (though not shown on the table), 26.78 percent of corporations

[61]Owen, *Codebook*, p. 62 indicates that, after 1896, the ratio of the credit ruble to the gold ruble held to a stable three to two ratio. I use exchange rates from Denzel (2010) to convert Russian gold rubles to 1900 pounds sterling using the St. Petersburg to London rate.

[62]The average market value in United States dollars of a corporation on the London Stock Exchange was 5,492,000 (Hannah 2007 406). I used exchange rates from Denzel (2010) to convert to pounds sterling and then to Russian gold rubles, using the London and St. Petersburg rates. However, note that the London Stock Exchange number is a market price, which could be much larger than a nominal share price.

founded between 1890 and 1910 were headquartered in St. Petersburg, and 35.57 percent were founded after 1901.

Table 3.1 Panel B describes corporations' total share capital, share price, and number of shares as reported in the 1905 Dmitriev-Mamonov business directory. Similarly to Table 3.1 Panel A, most corporations had small amounts of total capital and shares and relatively low share prices, though the standard deviation was large, and a few corporations had very large total share capital, high share prices, and large numbers of shares. The mean standardized share capital was approximately 2.5 million rubles, almost double the mean share capital written in charters between 1890 and 1910. The final column in this table shows the "difference in differences" based on means. On average, A-corporations founded after the reform had lower total share capital, had higher share prices, and issued fewer shares.

Table 3.2 demonstrates that corporations in Russia comprised two major groups, both in the entire history of the Empire as well as in the period of interest: A-corporations and share partnerships. The proportion of corporations in each of the two major groups remained relatively constant over time, and there were generally about twice as many A-corporations as share partnerships. The breakdown of corporations by industry is presented in Table 3.3. Manufacturing firms made up more than half of the corporations in the database (2,884 out of 4,542), and there were also a large number of corporations in the transportation industry (mostly railroads). The other largest categories were mining (260 corporations), finance (345), and wholesale (260). Only 3 corporations had no classification, and no such corporations were founded in the period of interest for this paper (1890 to 1905).

In Table 3.4, I present the results of a probit regression for the determinants of corporation type. Column 1 shows that A-corporations had high total share capital, were more likely to be headquartered in St. Petersburg, were more likely to be new enterprises, and were more likely to be founded later. In Column 2, I

control for the element within total share capital (number of shares and share price): A-corporations were more likely to have a greater number of shares sold for lower prices and a higher total share capital as compared to other kinds of corporations. However, in this column, the coefficients for St. Petersburg and New Enterprise lose significance. I provide marginal effects (dF/dx) in brackets below the coefficients and standard errors. In general, the coefficients on the dummy variables for St. Petersburg and New Enterprise have the largest marginal effects.

Columns 3 and 4 include terms that interact a company's share capital, its number of shares, and whether the firm was a new enterprise with the corporation's founding year. Column 3 shows that, for corporations founded after 1890, the importance of total share capital for predicting whether a corporation is an A-corporation declined over time. When I control for the components of total share capital in Column 4, however, all interactions terms lose significance.

Columns 5 and 6 suggest that essentially the same kinds of firms became corporations before and after the reform. Column 5 presents the results from the regression above for firms incorporating between 1890 and 1900, and Column 6 shows the results for firms incorporating between 1901 and 1914. Share price, number of shares, and whether a firm was a new enterprise still predicted whether a corporation was an A-corporation, but some coefficients have changed size and significance. After the reform, the interaction term is still negative but has lost statistical significance. Similarly, the coefficient on total share capital is still positive but has lost significance.[63]

[63]That this coefficient would decrease in magnitude after the reform is not surprising: after all, the paper shows that the effect of the reform is to decrease total capital for A-corporations founded after 1901.

3.6 Main Results: Capital, Share Price, and Number of Shares

Corporations chartered after the reform had smaller total share capital in 1905. Since share capital equals the number of shares multiplied by the par value of each share, I also investigate changes in number of shares and par share price: par share price increased and the number of shares issued decreased, though these results are weaker.

3.6.1 Total Share Capital

Each of the columns in Table 3.5 shows that A-corporations had smaller total share capital after the reform, since the coefficient on $AC * t$ is negative and strongly statistically significant. First, I consider specifications that include all firms that survived to 1905, though with varying time windows (Columns 1 through 4).[64] A-corporations founded after the reform had total capital in 1905 that was smaller by 750,000 rubles on average (see Column 2), an economically significant amount since mean standardized capital for corporations chartered in the Russian Empire was approximately 1,200,000, as shown in Table 3.1.

A-corporations' total share capital decreased after the reform even after making an adjustment for firms that do not appear in the 1905 volume but were chartered within the time window (Column 5). When non-surviving firms are given a capital value in 1905 of zero, the coefficient on $AC * t$ is still negative and significant though it has decreased in magnitude. Now, standardized main capital for A-corporations founded after the reform is about 400,000 rubles smaller. This suggests a few things

[64]Column 1 considers a window of ten years before the reform and years 1901 to 1905 as the after window), Column 2 uses 7 years before, Column 3 uses 5 years before, and Column 4 uses firms founded 3 years before and 3 years after the reform.

about the effect of the treatment of the 1901 reform. If A-corporations were less likely to survive than share partnerships, one would expect that setting the capital value of non-surviving firms to zero would increase the absolute value of the coefficient, but instead the coefficient decreases. Thus, if anything, the reform more adversely affected the survival of share partnerships than A-corporations. A-corporations experienced a change in firm size, not just a decreased likelihood of survival.

Section 5 above showed that the population of Russian corporations consisted of many small corporations and a few very large corporations. I check that the results are not only true of the very large corporations by dropping from the analysis firms with greater than 22,000 shares, a standardized price above 4,000 rubles, and a standardized capital of over 30,000,000 rubles (Column 6). The effect on A-corporations founded after the reform is still negative and significant, though now the reform decreased total share capital by about 300,000 rubles, which suggests that at least some of the result of Column 1 was driven by very large firms.

The final Columns, 7 and 8, introduce controls for whether a firm is headquartered in St. Petersburg, the firm's industry, and the firm's standardized capital at the time of its founding. The industry dummies code each corporation's two-digit SIC code, where the possible categories are agriculture, mining, construction, manufacturing, transportation, wholesale, retail, finance, services, public administration, and unknown classification. Agricultural and nonclassified corporations do not appear in the data for this period, and I omit the mining industry to avoid multicollinearity.

These controls are introduced in case any of these features of corporations are not captured in the base specification. St. Petersburg was the financial and technical center of the Russian Empire, so firms that incorporated in St. Petersburg may haven taken advantage of finance networks and hence may have had larger capital. In both regressions 9 and 10, the coefficient on St. Petersburg is positive but not statistically significant. Recent work on chartering systems suggests that finance firms tend to

have more restrictive measures in their charters, since finance firms face greater temptations to be corrupt. Manufacturing firms, by contrast, tend to have fewer restrictions in their charters, since their activities are easier to observe.[65] Hence, finance and manufacturing firms may have responded differently to the reform. A full set of industry controls was used for these regressions, but for the sake of space only the coefficients on finance and manufacturing are displayed in the table. The coefficient on finance is negative in regressions 7 and 8, though it is not statistically significant. The coefficient on manufacturing switches signs between regressions 7 and 8 and is also not statistically significant. Finally, the coefficient on a firm's standardized capital at founding is positive and highly significant but is small relative to the size of an average firm's total capital.

Furthermore, the introduction of controls decreases the absolute value of the effect on A-corporations chartered after the reform. Now, these corporations had capital in 1905 that is only about 150,000 rubles smaller. When capital at founding is introduced as a control, the absolute value of the coefficient on $AC * t$ decreases. As we should expect, firms founded after the reform could have absorbed the effect of the reform by decreasing size at the time of the firm's founding, not just by the time of the 1905 update.

Throughout the table, A-corporations had larger total share capital than share partnerships (shown by the coefficient on AC), and the coefficients are significant. This agrees with the probit regression results presented in Table 3.4. The negative and sometimes statistically significant coefficient on the time window dummy variable t weakly suggests that there did exist a negative trend in total share capital for all corporations in the period of study.

[65]See, for example, Hilt (2008) or Bodenhorn (2006), which describe charters in the United States before general incorporation.

Finally, as a word of caution, the R^2 values in these regressions are quite small (most are less than .05); the model does not predict the total share capital of corporations in the Russian Empire very well. On the other hand, all of these regressions have large joint F-statistics, so the coefficients together are statistically significant predictors of corporations' total capital.

3.6.2 Share Price

Table 3.6 presents the estimation results for corporations' standardized par value share price in 1905. As in Table 3.5, the first four columns include large firms and make no adjustment for non-surviving firms. In each of these regressions, the coefficient on $AC * t$ is large and positive but not statistically significant. In Column 5, however, when the price of non-surviving firms is set to 0 in 1905 and I use a 7-year time window, the coefficient of interest is still large and positive but now becomes statistically significant. Corporations chartered as A-corporations after the reform had share prices 533 rubles larger in 1905, an economically significant effect since the average share price shown in Table 3.1 was about 740 rubles.

In Column 6, I drop outliers (as described in the previous section). As above, when a 7-year time window is used, the coefficient on $AC * t$ is large and statistically significant. A-corporations founded after the reform had share prices larger by 260 rubles in 1905. Though not shown on the table, significance disappears when I use a 5-year time window.

The final two columns, Columns 7 and 8, present results for regressions that include the controls explained in the previous section. The coefficient of interest in these regressions remains large, positive, and statistically significant. These regressions show that A-corporations chartered after the reform had share prices approximately 267 (Column 7) or 200 (Column 8) rubles higher in 1905. In general, the

coefficients on the controls are not statistically significant, though in Column 7, the coefficient on St. Petersburg is negative and significant, which runs contrary to my expectations.

Thus, although the result is not very robust, the standardized par share price for A-corporations increased as a result of the 1901 corporation reform. As with the last set of results, the regressions presented in Table 3.6 have somewhat small R^2 values, though they are larger than those in Table 3.4. All R^2 values in these regressions are above .13, and all joint F-statistics are large and significant.

3.6.3 Number of Shares

If standardized par value share price increases for treated firms, why does total share capital decrease? Total share capital is share price times number of shares divided by one thousand, so a decrease in capital could reflect a decrease in the number of shares issued. Table 3.7 presents regressions for number of shares as observed in 1905. The coefficient on AC*t is large, negative, and statistically significant in all eight regressions presented in Table 3.7, which confirms that the decrease in total capital reflects a decrease in number of shares issued. This also confirms that the largest corporations behaved differently than the average firm. For this set of companies, A-corporations chartered after the reform issued 1,500 fewer shares in 1905. Since the average firm issued approximately 3,800 shares (see Table 3.1), this effect has economic significance. A-corporations founded after the reform changed their capital structure by decreasing the total number of shares issued, resulting in a decrease in total share capital.[66]

[66]Similarly to the results presented in Tables 4 and 5, the regressions presented in Table 3.6 have small R2 values but large F-statistics.

3.7 Conclusion

The government of the Russian Empire enacted the 1901 corporation reform during a period of rapid industrial growth but high capital market volatility. The law introduced measures designed to increase the rights of minority shareholders, which the Imperial government believed would strengthen corporations by reducing the abuses committed by managers and large shareholders. The reform had three main effects on corporations: corporations affected by the reform issued less capital in stock, issued fewer shares, and issued shares at higher prices. A-corporations responded to the reform by beginning to more closely resemble the share partnerships that avoided the law's requirements. Perhaps, then, it is no surprise that the Ministry of Finance believed the law to be a failure since, despite its many new requirements, large shareholders continued to dominate corporations.[67]

More broadly, the reform's effects highlight the tradeoffs corporations face in governing and financing their operations. Corporations' founders and large block holders balance small shareholders' capital contributions against the cost of losing control over the firm's destiny. This paper's results suggest that the 1901 law's new shareholder rights presented significant costs to Russian A-corporations.

These findings highlight the need for further research on Russian corporations' owners and charters. Corporate shareholder lists, for example, could confirm that A-corporations after the reform tended to decrease their numbers of shareholders.[68] Furthermore, the direct effect of the law could be observed by reading corporate charters before and after 1901. Corporations may have written the new requirements for shareholder meetings directly into their charters. While the charter database does not have data on corporations' governance rules, collecting such data would be relatively

[67]Owen, *Corporation under Russian law*, p. 153, citing Shepelev, *Russian corporations*, p. 216.

[68]Turner (2009) discusses the characteristics of shareholders in English and Welsh joint stock banks; a similar exercise could be performed with Russian shareholder lists.

easy, since Russian corporate charters are available in several published sources.[69] Future research connecting this paper's results to the provisions of individual charters and shareholder lists could clarify the relationship between corporate governance and firm performance in the Russian Empire and other late-industrializing countries.

[69]The entire text of all Russian corporate charters founded before 1872 can be found in the Polnoe sobraniie zakonov Rossiiskoi Imperii (PSZ), which is available online at `http://www.nlr.ru/e-res/law_r/search.php`. After 1872, however, the Minister of Finance could approve the charters of pawn shops, warehouse and loan companies, and very small banks, so these charters did not have the Tsar's signature and hence their full text did not appear in the PSZ. The Third Series of the PSZ, which began in 1881, began to print only excerpts of very long charters. For complete charter information for firms founded after 1872, then, one must consult another, slightly rarer published source, the Sobraniie uzakonenii i rasporiazhenii pravitel'stva. See Owen, *RUSCORP Codebook*, 28-9. Combining shareholder lists and governance information from charters would permit an analysis or the relationship between corporate governance rules and the separation of ownership and control, as in Hilt (2008).

Tables

Table 3.1: Summary Statistics: Corporations at Founding (1890-1910) and in 1905

Panel A: Summary Statistics for Corporations at Founding 1890-1910

Variable	Mean	Std. Dev	Min	1st Quartile	Med	3rd Quartile	Max
Standardized Share Capital	1202.9	2739.1	3	300	600	1125	90000
Number of Shares	3802.5	8378.5	30	600	1250	3200	130000
Standardized Par Share Price	743.5	1231.7	0	250	250	1000	12500

Panel B: Summary Statistics for Corporations in the 1905 Update

Variable	Mean	Std. Dev	Min	1st Quartile	Med	3rd Quartile	Max	$\beta_3 = (E[y_i\|AO = 1, t = 1] - E[y_i\|AO = 1, t = 0]) - (E[y_i\|AO = 0, t = 1] - E[y_i\|AO = 0, t = 0])$
Standardized Share Capital	2583.6	12700.6	50	450	800	1800	265976	-751.7
Standardized Share Price	1131.6	1887.1	0	250	500	1000	25000	1106.7
Number of Shares	4482.0	10273.8	0	500	1200	4000	120875	-3121.1

Source: RUSCORP Database (Owen 1992), quoting the Dmitriev-Mamonov Directory (1905). Standardized total capital is in thousands of rubles. The final column, which lists the "difference in difference," is calculated from raw conditional means with no controls.

Table 3.2: Numbers of Corporations by Type

Type of Corporation (Word for "Company"/ Word for "Share")	(1) Entire Period (1700-1914)	(2) Before the Reform (1895-1900)	(3) After the Reform (1901-1905)
Obshchestvo/aktsiia	**2850**	**694**	**243**
Obshchestvo/pai	17	4	0
Tovarishchestvo/aktsiia	13	0	0
Tovarishchestvo/pai	**1525**	**197**	**101**
Kompaniia/aktsiia	87	0	0
Kompaniia/pai	9	0	0
Membership Org.	16	0	0
18th Century Form	5	0	0
N/A	20	0	0

Source: RUSCORP Database (Owen 1992). Under "Type of Corporation," the first word is the word used for "company:" obshchestvo (society), tovarishchestvo (partnership), company (kompaniia), etc. The second word is the word used for share, either "aktsiia" or "pai." The other kinds of corporations listed in the RUSCORP Database were so-called "Membership Organizations" (for example certain charitable organizations), a rare "eighteenth century type" of corporation, and a small number with no discernible form.

Table 3.3: Number of Corporations by Industry, 1700-1914

Industry	Number	Proportion
Agriculture	55	.0121
Mining	260	.0572
Construction	87	.00192
Manufacturing	2,884	.6350
Transportation	532	.1171
Retail	10	.0022
Finance	345	.0760
Services	106	.0233
Public Administration	0	0
Wholesale	260	.0572
Unknown Classification	3	.0007

Source: RUSCORP Database (Owen 1992).

Table 3.4: Determinants of Type of Corporation, 1890-1914

Probit:					1890-1900	1901-1914
$P(AC = 1)$	[1]	[2]	[3]	[4]	[5]	[6]
Share Capital	.00033***	.00016	.052*	.018	.29**	.025
(Standardized)	(.000048)	(.00012)	(.022)	(.024)	(.091)	(.04)
	[.00011]	[.000049]	[.015]	[.0051]	[.071]	[.0076]
Share Price		-.0015***	-.0015***	-.0014***	-.0012**	-.0015***
(Standardized)		(.00020)	(.00020)	(.00021)	(.00043)	(.00019)
		[-.00045]	[-.00045]	[-.00041]	[-.0030]	[-.00045]
Number of		.00012**	.000099**	.017	.00030*	.000083**
Shares		(.000039)	(.000034)	(.0097)	(.00015)	(.000029)
		[.000035]	[.000029]	[.0050]	[.000073]	[.000026]
Firm is Located in	.24***	-.12	-.12	-.13	-.00046	-.14
St. Petersburg	(.060)	(.066)	(.068)	(.069)	(.13)	(.082)
	[.075]	[-.037]	[-.036]	[-.037]	[-.00011]	[-.043]
Firm is a	.56***	.34***	.33***	-25.20	.18***	.44***
New Enterprise	(.055)	(.061)	(.062)	(18.34)	(.034)	(.081)
	[.17]	[.099]	[.094]	[-1]	[.042]	[.13]
Founding Date	.012**	-.0074	.0074	.0069	.19***	-.0051
	(.0040)	(.0045)	(.0080)	(.0093)	(.034)	(.015)
	[.0040]	[-.0022]	[.0022]	[.0020]	[.046]	[-.0016]
Share Capital *			-.000027*	-.0000092	-.00015**	-.000013
Founding Date			(.000012)	(.000012)	(.000048)	(.000022)
			[-.0000081]	[-.0000027]	[-.000037]	[-.0000040]
Number of Shares *				-.0000090		
Founding Date				(.0000051)		
				[-.0000026]		
New Enterprise *				.013		
Founding Date				(.0096)		
				[.0039]		
Intercept	-23.02**	14.86	-13.30	-12.48	-351.20***	10.50
	(8.56)	(8.61)	(15.23)	(17.67)	(65.21)	(28.33)
Number of Obs	2961	3001	2961	2961	1144	1817
Pseudo R^2	.0710	.2868	.2914	.2940	.3766	.2632
Wald χ^2	200.60	244.99	249.26	245.61	128.17	199.65

* p < .05, ** p < .01, *** p < .001 Source: RUSCORP Database (Owen 1992). Robust standard errors in parentheses. Marginal effects (dF/dx) in brackets. For dummies, the marginal effect is the change of moving the variable from 0 to 1. (There is no marginal effect reported for the intercept). Standardized main capital is in thousands of rubles. Biggest firms dropped according to the procedure outlined in later sections. Share price is the par value of shares.

Table 3.5: Total Capital Decreases as a Result of the Reform

OLS	Dep Variable: Total Basic (Osnovnoi) Capital in 1905 (Owen Standardized, Thousands of Rubles)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A-Corps.	1052.34***	1037.70 ***	877.72 ***	754.93 ***	399.03 ***	313.74 ***	269.83***	35.91
	(165.35)	(162.25)	(156.68)	(169.39)	(94.06)	(60.34)	(57.91)	(47.80)
t	-190.14	-156.64	-122.27	-31.47	-330.03 ***	-214.72 ***	-222.64***	-222.21***
	(118.11)	(116.03)	(123.71)	(136.39)	(60.44)	(45.64)	(47.01)	(41.62)
A-Corps.*t	-765.57 ***	-750.93 ***	-590.95 **	-431.36	-396.48 ***	-292.81***	-286.69***	-152.78*
	(241.85)	(239.77)	(236.08)	(268.9)	(107.64)	(78.39)	(76.44)	(67.51)
Firm is Located in St. Petersburg							295.66***	14.30
							(82.67)	(61.00)
Industry is Finance							-81.91	-117.81
							(215.43)	(202.90)
Industry is Manufacturing							-120.99	100.17
							(112.33)	(102.55)
St. Capital at Founding								.60***
								(.078)
Constant	915.88 ***	882.39 ***	848.01 ***	734.23 ***	553.99 ***	408.06 ***	483.06***	-22.59
	(70.72)	(67.16)	(79.01)	(82.03)	(48.61)	(30.98)	(112.14)	(118.68)
Time Window	10 Years	7 Years	5 Years	3 Years	7 Years	7 Years	7 Years	7 Years
Nonsurv. Firms	Dropped	Dropped	Dropped	Dropped	0'd	0'd	0'd	0'd
R^2 (Adj R^2)	.0483	.0496	.0432	.0315	.0402	.0468	.0643	.2862
No. of Obs.	871	797	703	489	1908	1757	1757	1757

* $p < .05$, ** $p < .01$, *** $p < .001$ Source: RUSCORP Database (Owen 1992). Parentheses contain robust standard errors. A 3 year time window means corporations incorporating before the reform includes corporations founded in the three years leading up to 1901, and after the reform includes corporations founded in the three years after the reform. Industry denotes 2-digit SIC codes; agriculture, mining, and nonclassified categories are omitted. I only report coefficients for finance and manufacturing. Columns 6, 7, and 8 drop outliers, and columns 7 and 8 include industry dummies.

Table 3.6: Par Value of Shares Increases as a Result of the Reform

OLS	Dep Variable: Share Price (Par Value) in 1905 (Owen Standardized)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A-Corps.	-1345.03***	-1328.18***	-1310.90***	-1233.27***	-884.90***	-449.62 ***	-429.37***	-126.17**
	(138.01)	(143.15)	(165.98)	(228.54)	(101.02)	(45.51)	(45.63)	(44.64)
t	-349.80	-264.98	-245.54	-192.64	-629.66***	-349.37***	-350.74***	-285.17***
	(208.61)	(215.00)	(230.54)	(295.90)	(119.29)	(56.49)	(56.36)	(47.64)
A-Corps.*t	325.28	308.43	291.1515	260.20	533.58***	259.06 ***	267.77***	196.05***
	(218.99)	(222.29)	(237.68)	(304.94)	(121.11)	(58.15)	(57.23)	(48.99)
Firm is Located in St. Petersburg							-62.59***	-13.53
							(17.97)	(16.27)
Firm's Industry is Finance							-36.31	-23.79
							(48.65)	(39.25)
Firm's Industry is Manufacturing							20.95	7.67
							(35.65)	(30.69)
St. Capital at Founding								.52***
								(.069)
Constant	1801.07***	1716.24***	1696.80***	1628.35***	1077.51***	631.69 ***	617.00***	124.45
	(130.13)	(140.11)	(162.89)	(224.79)	(99.73)	(44.51)	(59.13)	(67.27)
Time Window	10 Years	7 Years	5 Years	3 Years	7 Years	7 Years	7 Years	7 Years
Nonsurv. Firms	Dropped	Dropped	Dropped	Dropped	0'd	0	0'd	0'd
R^2	.1751	.2073	.2073	.1755	.1317	.1625	.1744	.4053
No. of Obs.	871	797	703	489	1908	1757	1757	1757
Joint F Stat	44.35	41.23	33.44	18.35	43.41	58.74	18.01	26.59

* $p < .05$, ** $p < .01$, *** $p < .001$ Source: RUSCORP Database (Owen 1992). Robust standard errors in parentheses. Time Window defines T in the regression: A time window of 3 years means that corporations incorporating before the reform includes corporations founded in the three years leading up to 1901, and after the reform includes corporations founded in the three years after the reform. For windows greater than 4 years, only corporations founded up to 1905 are included in the after window. Industry controls code for 2-digit SIC codes, where agriculture, mining, and nonclassified categories are omitted. For the sake of space only the coefficients for finance and manufacturing are reported. Columns 6, 7, and 8 drop outliers, and columns 7 and 8 include industry dummies.

Table 3.7: Number of Shares Decreases

OLS	Dependent Variable: Number of Shares in 1905							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A-Corps.	5295.47***	5447.97***	4860.97***	4026.62***	5447.97***	3561.74***	3079.07***	223.69
	(543.40)	(551.38)	(493.86)	(577.32)	(551.38)	(286.60)	(267.40)	(229.02)
t	-77.38	31.74	122.12	159.00	31.74	48.77	-114.52	-131.32
	(213.76)	(192.06)	(189.58)	(249.42)	(192.06)	(217.63)	(238.63)	(95.34)
A-Corps.*t	-2968.65***	-3121.142***	-2534.15***	-1914.07*	-3121.14***	-1491.17**	-1600.11**	-380.57
	(728.16)	(734.21)	(692.17)	(788.98)	(734.21)	(534.33)	(526.52)	(302.40)
Firm is Located in St. Petersburg							2978.14***	581.00*
							(549.04)	(269.45)
Firm's Industry is Finance							671.79	760.48
							(1740.44)	(1109.75)
Firm's Industry is Manufacturing							-1347.01	675.83
							(693.79)	(455.11)
St. Capital at Founding								1.09***
								(.09)
Constant	966.19***	857.07***	766.69***	804.27	857.07***	930.99***	1799.94*	-569.09
	(127.38)	(86.05)	(80.25)	(129.32)	(86.05)	(98.78)	(703.13)	(490.42)
Time Window	10 Years	7 Years	5 Years	3 Years	7 Years	7 Years	7 Years	7 Years
Nonsurv. Firms	Dropped	Dropped	Dropped	Dropped	0'd	0'd	0'd	0'd
R^2 (Adj R^2)	.0843	.0863	.0857	.0608	.0863	.1251	.2244	.7183
No. of Obs.	869	795	701	488	795	724	724	724
Joint F Stat	39.38	40.59	40.81	21.87	40.59	58.51	33.50	87.55

* $p < .05$, ** $p < .01$, *** $p < .001$ Source: RUSCORP Database (Owen 1992). Robust standard errors are reported in parentheses. Time Window defines T in the regression: A time window of 3 years means that corporations incorporating before the reform includes corporations founded in the three years leading up to 1901, and after the reform includes corporations founded in the three years after the reform. For windows greater than 4 years, only corporations founded up to 1905 are included in the after window. Industry controls code for 2-digit SIC codes, where agriculture, mining, and nonclassified categories are omitted. For the sake of space only the coefficients for finance and manufacturing are reported. Columns 6, 7, and 8 drop outliers, and columns 7 and 8 include industry dummies.

Appendix

This appendix presents additional estimation procedures to confirm that the changes in share capital, share price, and number of shares experienced by corporations after the 1901 reform are not merely the result of preexisting trends, the functional form of the regression equation, or selection. A Heckman two-step procedure accounts for the corporations not included in the 1905 directory. I confirm that the results observed in the paper are not merely the product of pre-existing trends. The result for total share capital remains when results are presented in logs, but the results for share price and number of shares are much weaker. Finally, I sort firms into corporation types based on observable characteristics from before the reform to address a concern that the reform changed how corporations self-selected into the groups of A-corporations or share partnerships.

Heckman Correction

Not every firm chartered between 1890 and 1905 survives long enough to be listed in the 1905 Dmitriev-Mamonov directory. We do not know, then, how the corporation reform affected these firms' share capital, share price, or number of shares in 1905.

In the previous sections, results for these firms were simulated by setting their share prices and total capital equal to some fraction of their share prices and capital at their founding dates. The Heckman two-step permits another sample selection bias correction for non-surviving firms (Heckman 1979). In Equation 1 in the body of the paper, y_i denotes the share capital, share price, or number of shares of firm i as measured in the 1905 directory. Now, suppose that D_i is an indicator that equals 1 if the firm appears in the 1905 directory. We only observe y_i if firm i is still in operation in 1905 (if $D_i = 1$). According to Equation A1, certain variables (Z) determine whether a firm is operational in 1905. The factors Z may include whether

the firm is an A-corporation, the firm's age, whether the firm is a new enterprise, and the firm's total capital at its founding date.

$D_i^* = Z_i\gamma + u_i$, where $D = 1$ if $D^* > 0$ and $D = 0$ otherwise. Equation A1

Older firms, new enterprises, and firms with smaller total basic capital at founding should be less likely to survive to 1905. Estimation takes place in two steps: the first stage estimates the selection equation, and the second stage estimates Equation 1 with an additional control for the Mills ratio from the selection equation.

The results are presented in Table 3.8. In Column 1, the coefficient on A-corporations is not statistically significant, which is reassuring for the sake of the previous results, since A-corporations are not more likely to survive than share partnerships. In the other regressions, this coefficient is omitted, since variables that directly affect the outcome should not be included in the selection equation. In each of the regressions, the strongest predictor of survival is whether the firm is a new enterprise at the time of incorporation: new enterprises are much less likely to survive, as we might expect.

The upper half of Table 3.8 presents the results of the second stage for total main capital and share price in 1905. In each regression, the coefficient on $AC*t$ when total capital is the outcome remain negative and statistically significant, although they are less significant than in the regressions presented in Table 3.6. The coefficients on $AC * t$ in the regressions using share price are positive but have no statistical significance until outliers are dropped. In Columns 6 and 7, which presents results for number of shares, the coefficients of interest are negative, large, and statistically significant, as they were in Table 3.7.

Pre-existing Trends

To confirm that the paper's results do not merely reflect pre-existing trends, I re-estimate Equation 1 using data from the decade preceding the reform, the results of which are presented in Table 3.9. Total capital decreases, but the coefficient is barely statistically significant in Column 2, and significance disappears when controls are introduced, a much weaker result than that presented in the Section 6. If any trend affected total capital for A-corporations more than share partnerships before the time of the reform, the effect is small. Similarly, the results for share price are also not statistically significant, and the coefficient has actually become negative. Any pre-existing trend, then, produces an effect easily distinguished from that of the 1901 law.

Results in Logs

All of the main results in this paper are presented in levels rather than logs. Tables 3.10 and 3.11 present regressions using log total capital, log standardized share price, and log total number of shares. In general, the results for log total capital remain (the coefficients are negative and statistically significant), but results for log standardized share price and number of shares are much weaker. In Table 3.11, the coefficient on $AC * t$ in Columns 1 through 6, which consider log standardized share price, only become significant once outliers are dropped, industry dummies are introduced, and an adjustment is made for nonsurviving firms. In Columns 7 and 8, which consider log total number of shares, the coefficient on $AC * t$ is negative and statistically significant as expected but loses significance once an adjustment is made for nonsurviving firms, a weaker result than was presented in Table 3.7.

Selection Induced by the Reform Does Not Drive the Results

The 1901 reform could have induced firms that would have been A-corporations to incorporate as share partnerships instead to avoid the provisions of the law. If this is the case, then results showing decreases in basic capital, increases in share price, and decreases in number of shares could simply reflect changes in the average characteristics of the two corporation types. In this section, I will address this concern by unpacking the basic difference-in-difference estimates and presenting results that use characteristics of corporations before the reform to determine firms' corporation type.

Table 3.12 presents regressions that isolate the effects of the reform for A-corporations and for share partnerships by running regressions for each group separately. Columns 1 and 2 present results for total capital Columns 3 and 4 present results for number of shares, and Columns 5 and 6 present results for share price. In the first two columns, we see that, after the reform, total capital has in fact decreased for both A-corporations and share partnerships but that the change is much larger for A-corporations (for share partnerships, the change is not statistically significant). Columns 3 and 4 show that A-corporations decreased the number of shares issued after the reform, and share partnerships left their number of shares essentially unchanged. In Column 3, the change is not significant for either group, though what change there is is larger for the share partnerships, which perhaps explains why the results for par share price are the weakest throughout the paper.

Tables 3.13 and 3.14 present results for a method that uses pre-reform characteristics of A-corporations and share partnerships to classify these corporations after the reform. Equation A2 shows which characteristics determine whether a corporation is an A-corporation before the reform.

$$P(AC = 1)_i = \Phi(\beta_0 + \beta_1 PETE_i + \beta_2 NE_i + \beta_3 YEAR_i) \qquad \text{Equation A2}$$

I designate a corporation as an A-corporation if the probability predicted by Equation A2 is above a certain threshold (the row above the column numbers on Table 3.13). The results of the probit regression are shown in Table 3.14. The results of the full procedure are shown in Table 3.13. In general, all results are the same as shown previously in the paper, perhaps even stronger in some cases: total capital decreases as a result of the reform (except for p>.7), number of shares decreases, and standardized par share price increases.

Table 3.8: Heckman Selection Model to Account for Nonsurviving Firms

Heckman Two-Step		Total Capital in 1905			Share Price in 1905		Shares in 1905	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Second Stage	A-Corps.	1018.33***	975.18***	740.73***	-1297.86***	-658.21***	5968.55	3401.59***
		(205.98)	(199.40)	(133.66)	(101.81)	(40.26)	(4410.30)	(390.64)
	t	-89.87	-88.12	10.53	-298.20	-112.63	-538.77	184.60
		(304.17)	(304.45)	(205.27)	(155.42)	(61.78)	(6721.85)	(600.62)
	A-Corps.*t	-829.44*	-829.94*	-553.41*	346.74	155.81*	14575.75	-1719.19*
		(386.23)	(386.35)	(256.41)	(197.25)	(77.22)	(8541.30)	(749.48)
	Constant	-1176.03	-1205.85	-1200.31	2728.72***	1541.00***	18243.43	-5430.00**
		(901.40)	(910.33)	(686.88)	(462.66)	(203.011)	(19310.45)	(2070.10)
Selection Model	A-Corps.	.037						
		(.050)						
	New Enterprise	-.37***	-.35***	-.33***	-.36***	-.33***	-.36***	-.33***
		(.049)	(.048)	(.051)	(.048)	(.051)	(.048)	(.051)
	Founding Year	.0021	.0023	-.000256	.0023	-.000255	.0023	-.000256
		(.0013)	(.0013)	(.0016)	(.0013)	(.0016)	(.0013)	(.0016)
	Constant	-4.65	-5.025*	-.21	-5.025*	-.21	-5.025*	-.21
		(2.51)	(2.46)	(3.09)	(2.46)	(3.086)	(2.46)	(3.09)
	No. of Obs.	3985	3985	3508	3985	3508	3985	3508
	Mills |t|	2.33	2.34	2.78	2.33	2.52	.92	3.14
	Chi2	36.87	36.31	41.29	190.31	320.09	12.95	91.74

* $p < .05$, ** $p < .01$, *** $p < .001$ Standard errors in parentheses. Source: RUSCORP Database (Owen 1992). Time Window defines T in the regression as elsewhere: A time window of 3 years means that corporations incorporating before the reform includes corporations founded in the three years leading up to 1901, and after the reform includes corporations founded in the three years after the reform. Share capital in thousands of Rubles. Capital and share price are Owen standardized. Industry controls code for 2-digit SIC codes, where agriculture, mining, and nonclassified categories are omitted. For the sake of space only the coefficients for finance and manufacturing are reported. Columns 3, 5, and 7 drop outliers. I use a 7-year time window in all columns.

Table 3.9: Pretrends Analysis

OLS	Dep Variable: Total Capital in 1905				Dep Variable: Share Price in 1905			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A-Corps.	727.17*	861.40**	607.53	336.14	-363.56***	-323.24***	-299.98***	56.07
	(346.65)	(270.24)	(315.10)	(254.68)	(79.49)	(77.75)	(79.14)	(65.37)
t	-277.11*	-30.69	-256.30	-218.80**	12.50	77.07	.94	109.37
	(134.23)	(61.42)	(134.81)	(85.08)	(84.74)	(86.57)	(84.69)	(62.34)
A-Corps.*t	-413.43	-571.75*	-354.90	-419.38	-86.06	-151.14	-113.69	-66.97
	(351.86)	(286.50)	(327.85)	(279.70)	(91.60)	(93.55)	(91.14)	(73.13)
St. Petersburg			385.06**	-101.93			-116.96***	-47.43*
			(134.69)	(96.98)			(25.55)	(19.93)
Finance			56.11	-93.78			-26.87	107.10
			(349.44)	(337.54)			(63.77)	(58.32)
Manufacturing			-9.48	180.69			87.60	118.49*
			(184.62)	(252.11)			(59.35)	(53.87)
St. Capital/Price at Founding				.91***				.69***
				(.09)				(.08)
Constant	685.17***	422.07***	627.56**	-215.03	619.19***	574.40***	560.36***	-254.77**
	(130.60	(52.29)	(213.56)	(201.04)	(72.09)	(69.81)	(84.42)	(86.66)
Time Window	7 Years	5 Years	7 Years	7 Years	7 Years	5 Years	7 Years	7 Years
Industry Dummies	No	No	Yes	Yes	No	No	Yes	Yes
R^2 (Adj R^2)	.0248	.0281	.0420	.3099	.1518	.1556	.1722	.4987
No. of Obs.	1263	1144	1263	1263	1263	1144	1263	1263

* $p < .05$, ** $p < .01$, *** $p < .001$ Source: RUSCORP (Owen 1992). Robust standard errors in parentheses. A 7 year time window, for example, defines before and after as 1886 to 1893 and 1893 to 1900. Total capital in thousands of rubles. Capital and share price are Owen standardized. Industry controls code for 2-digit SIC codes, where agriculture, mining, and nonclassified categories are omitted. For the sake of space only the coefficients for finance and manufacturing are reported. Outliers are dropped and non-surviving firms' outcome value is set to zero.

Table 3.10: Diff-in-Diff Regressions for Log Total Share Capital

OLS	Dependent Variable: Log Total Share Capital 1905 (Owen Standardized)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
A-Corps.	.49***	.50***	.49***	.38***	-.0022	.54***	.54***	.43***	.0082
	(.07)	(.07)	(.08)	(.07)	(.033)	(.08)	(.09)	(.081)	(.036)
t	-.27**	-.25*	-.21*	-.29**	-.12***	.03	-.12	-.012	-.12***
	(.10)	(.10)	(.11)	(.11)	(.03)	(.09)	(.14)	(.10)	(.032)
A-Corps.*t	-.31*	-.32*	-.31*	-.31*	-.029	-.27*	-.05	-.27*	-.043
	(.14)	(.14)	(.15)	(.14)	(.044)	(.12)	(.16)	(.12)	(.045)
St. Petersburg				.64***	.070*			.40***	.051
				(.084)	(.035)			(.074)	(.035)
Finance				.026	-.0094			.089	-.063
				(.25)	(.11)			(.15)	(.11)
Manufacturing				-.26	.13*			-.27**	.11
				(.14)	(.06)			(.098)	(.059)
Log St. Cap at Founding					.98***				.99***
					(.017)				(.018)
Constant	6.47***	6.45***	6.42***	6.60***	.12	5.46***	5.45***	5.64***	.077
	(.05)	(.05)	(.06)	(.14)	(.13)	(.07)	(.08)	(.12)	(.13)
Time Window	10 Years	7 Years	5 Years	7 Years	7 Years	7 Years	5 Years	7 Years	7 Years
Industry Dummies	No	No	No	Yes	Yes	No	No	Yes	Yes
Nonsurv. Firms' Pr.	Omitted	Omitted	Omitted	Omitted	Omitted	1/2 Founding	1/2 Fnd.	1/2 Fnd.	1/2 Fnd.
R^2	.0919	.0927	.0896	.1937	.8540	.0426	.0537	.1124	.8474
No. of Obs.	871	797	703	797	797	1111	703	1111	724

* $p < .05$, ** $p < .01$, *** $p < .001$ Source: RUSCORP (Owen 1992). Robust standard errors in parentheses. A time window of 3 years means that corporations incorporating before the reform includes corporations founded in the three years leading up to 1901, and after the reform includes corporations founded in the three years after the reform. Total capital is in thousands of rubles. Industry controls code for 2-digit SIC codes, where agriculture, mining, and nonclassified categories are omitted. Only the coefficients for finance and manufacturing are reported. Outliers dropped in column 9.

Table 3.11: Difference-in-Difference Regressions for Log Share Price (Par Value) and Share Number

OLS	Dependent Variable: Log 1905 Standardized Par Value						Log 1905 Shares		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
A-Corps.	-1.23 ***	-1.25***	-1.28 ***	-1.21***	-1.15***	-1.05***	1.72***	1.44***	.091
	(.07)	(.07)	(.08)	(.072)	(.22)	(.20)	(.083)	(.083)	(.23)
t	-.13	-.11	-.13	-.094	-1.97***	-2.40***	-.13	-.11	-1.87***
	(.112)	(.11)	(.12)	(.11)	(.27)	(.23)	(.13)	(.13)	(.26)
A-Corps.*t	.17	.18	.21	.19	.60*	.67**	-.38*	-.43**	-.23
	(.13)	(.13)	(.12)	(.13)	(.30)	(.26)	(.19)	(.167)	(.32)
St. Petersburg				-.17**					
				(.061)					
Finance				.0029	-.46	-.38		-.052	-.68
				(.14)	(.37)	(.31)		(.29)	(.51)
Manufacturing				.18	.067	.081		-.052	-.18
				(.08)	(.24)	(.21)		(.29)	(.32)
Constant	7.04 ***	7.01***	7.03 ***	6.86***	4.20***	4.10***	6.34***	6.88***	4.24***
	(.06)	(.06)	(.07)	(.10)	(.30)	(.27)	(.060)	(.17)	(.35)
Time Window	10 Years	7 Years	5 Years	7 Years	7 Years	10 Years	7 Years	7 Years	7 Years
Outliers Dropped?	No	No	No	No	Yes	Yes	No	Yes	Yes
Industry Dummies	No	No	No	Yes	Yes	Yes	No	Yes	Yes
Non-survivors	Omitted	Omitted	Omitted	Omitted	$y = 1.5$	$y = 1.5$	Omitted	Omitted	$y = 1.5$
R^2	.7388	.4134	.4302	.4345	.1011	.1451	.3515	.3825	.0864
No. of Obs.	858	785	692	785	1755	2139	787	722	1755
Joint F Stat	143.95	142.01	130.86	49.92	20.18	36.96	173.67	66.58	18.61

* $p < .05$, ** $p < .01$, *** $p < .001$ Robust standard errors in parentheses. In the final five columns, nonsurviving firms' stock prices are set equal to 1 (so that the log is zero). Source: RUSCORP Database (Owen 1992). Time Window defines T in the regressions: A time window of 3 years means that corporations incorporating before the reform includes corporations founded in the three years leading up to 1901, and after the reform includes corporations founded in the three years after the reform. For windows greater than 4 years, only corporations founded up to 1905 are included in the after window. Total main capital is in thousands of rubles. Industry controls code for 2-digit SIC codes, where agriculture, mining, and nonclassified categories are omitted. For the sake of space only the coefficients for finance and manufacturing are reported.

Table 3.12: Separated Differences for Changes in Dependent Variables by Corporation Type

OLS	Dependent Variable: Share Capital 1905		Dep. Var: Shares in 1905		Dep. Var: Share Price in 1905	
	A-Corporations	Share Partnerships	A-Corporations	Share Partnerships	A-Corporations	Share Partnerships
	(1)	(2)	(3)	(4)	(5)	(6)
t	-520.50**	-47.96	-1578.12**	13.72	38.28	-101.77
	(172.71)	(91.01)	(490.38)	(221.26)	(36.33)	(89.63)
Constant	1875.35***	857.98*	6313.05***	1458.43***	332.72***	978.24**
	(307.35)	(354.02)	(848.23)	(495.34)	(37.33)	(329.16)
Time Window	7 Years	7 Years	7 Years	7 Years	7 Years	7 Years
Outliers Dropped?	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Nonsurv. Firms	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted
R^2	.0362	.0254	.0472	.0467	.0299	.0421
No. of Obs.	489	235	489	235	489	235
Joint F Stat	10.14	.63	10.11	4.60	3.58	3.34

* $p < .05$, ** $p < .01$, *** $p < .001$ Robust standard errors in parentheses. Source: RUSCORP Database (Owen 1992). Time Window defines T in the regressions: A time window of 3 years means that corporations incorporating before the reform includes corporations founded in the three years leading up to 1901, and after the reform includes corporations founded in the three years after the reform. For windows greater than 4 years, only corporations founded up to 1905 are included in the after window. Total main capital is in thousands of rubles.

Table 3.13: Diff-in-Diff Regressions for Total Share Capital, Number of Shares, and Par Share Price with Adjustment for Post-Reform Selection

OLS	Dependent Variable: St. Share Capital 1905			Dep. Var: Shares in 1905			Dep. Var: St. Price in 1905		
	p (AKOB) > .5	p > .6	p > .7	p > .5	p > .6	p > .7	p > .5	p > .6	p > .7
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
A-Corps.	746.01***	741.99***	758.83***	3386.99***	3366.03***	3414.14***	-649.09***	-646.19***	-649.84***
	(101.86)	(101.76)	(101.76)	(296.30)	(295.93)	(295.65)	(56.52)	(56.63)	(56.29)
t	88.44	259.76	-96.08	152.97	1200.15	373.90*	-165.62	-332.44	-322.83***
	(138.26)	(157.03)	(64.02)	(303.39)	(631.98)	(174.90)	(169.02)	(181.35)	(76.07)
A-Corps.*t	-721.80***	-899.76***	-250.21	-2411.50***	-3492.75***	-1679.96***	393.62*	565.07**	439.48***
	(187.85)	(204.44)	(220.84)	(479.57)	(735.44)	(632.48)	(167.56)	(180.69)	(85.35)
Constant	1091.03***	1097.56***	1012.43***	2713.50***	2747.27***	2472.14***	956.37***	951.73***	981.55***
	(243.40)	(243.63)	(251.06)	(666.90)	(667.39)	(688.94)	(101.27)	(101.54)	(101.86)
Time Window	7 Years	7 Years	7 Years	7 Years	7 Years	7 Years	7 Years	7 Years	7 Years
Outliers Dropped?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Nonsurv. Firms	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted
R^2	.0752	.0753	.0816	.1424	.1420	.1502	.2907	.2889	.2975
No. of Obs.	724	724	724	724	724	724	724	724	724
Joint F Stat	8.74	8.61	10.11	26.76	18.98	22.17	22.85	21.88	21.94

* p < .05, ** p < .01, *** p < .001 Robust standard errors in parentheses Source: RUSCORP Database. Time Window defines T in the regressions: A time window of 3 years means that corporations incorporating before the reform includes corporations founded in the three years leading up to 1901, and after the reform includes corporations founded in the three years after the reform. For windows greater than 4 years, only corporations founded up to 1905 are included in the after window. Total main capital is in thousands of rubles.

Table 3.14: Determinants of A-corporations Used for Table 3.15 (Year < 1901)

Probit: $P(AC = 1)$	[1]
Firm is Located	.35***
in St. Petersburg	(.069)
Firm is a	.45***
New Enterprise	(.069)
Founding Date	.036***
	(.0023)
Intercept	-67.27***
	(4.43)
Number of Obs	2127
Industry Dummies?	Yes
Pseudo R^2	.1585
Wald χ^2	318.75

* p < .05, ** p < .01, *** p < .001 Source: RUSCORP Database (Owen 1992). Coefficients, not marginal effects, are reported above. Robust standard errors for the coefficients appear in parentheses.

Chapter 4

Vertical and Horizontal Integration in Imperial Russian Cotton Textiles, 1894-1900

4.1 Introduction

Vertical integration can reduce transaction costs and alleviate uncertainty, but its effects are not always positive: integration requires additional coordination within the firm, which may be costly, and it may reduce competition. In the Russian Empire, large vertically integrated factories and firms coexisted with many highly specialized, atomistic factories. The paper seeks to explain patterns of factory organization in the Russian Empire.

I document the characteristics of horizontally and vertically integrated cotton textile factories and firms using a newly collected database of manufacturing establishments. I find that vertically integrated factories and firms were older, had more workers and more machine power, and tended to be located outside of European Russia. Vertically integrated firms and factories produced more revenue given the

same workers and machine power, and the variance of the distribution of productivity for vertically integrated factories and firms was smaller than for non-integrated factories or firms. The paper also links factories to the firms that owned them; I find that factories owned by multi-factory firms had more workers and were more likely to be located outside of European Russia.

Theories explaining vertical integration emphasize transaction costs, for example contracting costs, and financial market development. According to Coase (1937), firms engage in vertical integration to save the cost of transacting on the market, and they expand until the point where the savings in terms of transaction costs equals the cost of managing a larger firm. Williamson's (1985) explanation is similar: greater transactions costs, or less perfect markets, encourage vertical integration. Brown's (1992) study of German cotton textile firms largely confirms the Coase hypothesis. Brown argues that German firms before World War I tended to be highly vertically integrated since a protective tariff wall kept German markets thin, exposing firms to price risk for inputs and outputs. The Russian Empire also had protective tariffs, and markets within the Empire may not have been well integrated: indeed, I find that factories and firms located on the Empire's periphery, where markets were thinner, tended to be more vertically and horitzontally integrated.

Much recent literature argues that vertical integration is related to credit markets imperfections, but the effect of better credit markets could be positive or negative.[1] Flawed credit markets may encourage integration if one result of little credit if few firms, which means that markets are thin. On the other hand, if firms are unable to obtain credit, firms cannot acquire down- or up-stream firms, so there may be

[1]Acemoglu et al (2009) argue in a cross-country regression framework that countries with both greater contracting costs and great financial development have more vertical integration. Macchiavello (2012) takes into account that the size distribution of firms varies by industry. In this theory, entry leads to more competition, which reduces vertical integration in the largest firms but also forces smaller, dis-integrated firms to exit. The author predicts that "higher financial development reduces vertical integration in industries where a high share of output is produced by small firms" (Page 1).

less integration. If credit markets were less developed outside of European Russian, the result that factories and firms outside of European Russia were more horizontally and vertically integrated supports the first hypothesis. I find little evidence that corporations were more vertically or horizontally integrated, despite their access to additional capital markets, which further emphasizes the importance of thin markets.[2]

Furthermore, I cannot argue that certain features of the Russian economy or certain factory characteristics caused vertical or horizontal integration, nor can I argue that integration produced certain characteristics, because I observe these factories and firms at two cross-sections. The goal of this paper, rather, is to document the characteristics of the largest and most integrated factories and firms, which will suggest paths for future research.

This paper proceeds as follows: Section 4.2 provides background on the Russian industrial sector and the cotton textile industry in particular. Section 4.3 outlines predictions about the shape of vertical and horizontal integration in the Russian textile industry based on theories of integration. The next section, Section 4.4, describes the Imperial Russian factory database. Sections 4.5, 4.6, and 4.7 present results and additional estimates, and Section 4.8 concludes.

4.2 The Russian Cotton Textile Industry

Cotton textile production was perhaps the most developed industry in the Russian Empire. The industry emerged in the eighteenth century and grew rapidly throughout the nineteenth century, and unlike many Russian industries, the Im-

[2]Detailed information on the development of Russian credit and capital markets could shed light on the debate.

perial government interfered with the cotton industry relatively little.[3] Table 4.1 compares the cotton industry to other industries in the Russian Empire based on the population of factories from the 1894 and 1900 manufacturing censuses. Although the cotton industry represented only 4.21 percent of factories in the data, these factories accounted for more more twenty percent of the total revenue. The industry's factories were some of the most productive as measured by revenue per worker, and only the paper, foods, and wood industries had more machine power per worker.

This study focuses on Russian cotton factories, because the industry was more vertically and horizontally integrated on average and displayed a great deal of variation in integration as well. Table 4.1 shows the cotton industry's remarkable level of vertical integration. The cotton industry possessed the highest average number of activities per factory in the 1894 census.[4] Cotton factories also displayed great variation in integration: the cotton industry had the highest standard deviation in the number of activities per factory.

The major branches of the Russian cotton textile industry were weaving, spinning, and chintz printing. According to Tugan-Baranovsky, the most final stages of cloth production, fabric printing, developed first, and the earlier stages such as the production of yarn developed only much later.[5] The Empire's center of cotton weaving was located in the village of Ivanovo in Vladimir province, part of the Central Industrial region. Cloth printing and other branches of the cotton industry also tended to be located in the Central Industrial Region.[6] Finally, the development of the Russian railroad network made possible the movement of raw cotton from

[3]Tugan-Baranovsky, "Russian Factory," 49-50. Tugan-Baranovsky also documents how, even in the eighteenth century, the cotton industry used relatively little serf labor and argues that use of free labor contributed to its high level of development (64).

[4]In a Tobit regression left-censored at zero of log number of activities on log number of workers and a dummy variable for the cotton industry, the cotton coefficient is large and statistically significant (.20 with a .05 standard error.)

[5]Tugan-Baranovsky, "Russian Factory," 48.

[6]Ibid., 173.

Turkestan to the central provinces.[7] Thus, the production of raw cotton was located primarily outside of European Russia.

Given the data available, the paper cannot assess the Russian cotton textiles industry's competitiveness. While the data might have been able to detect monopolies or large formal combinations in the cotton industry, cotton firms seemed to have formed cartels rather than combinations to restrain trade and I cannot observe cartels in the data (described below in Section 4.4).[8]

4.3 Model and Predictions

This section outlines predictions concerning the relationship between factory or firm characteristics and vertical or horizontal integration. First, consider vertical integration. Older firms should be more vertically integrated, since age is a proxy for projects and for survivorship. Second, corporations should be more vertically integrated, since corporations had access to extra sources of capital. Finally, since vertical integration requires larger factories, there should be a positive relationship between vertical integration and a measure of scale such as number of workers or total revenue. Some of what determines horizontal integration should be similar: more horizontally integrated firms should be older and more likely to be incorporated.

Furthermore, since access to credit varied by geography across the Empire, we should observe different patterns of vertical and horizontal integration in the different regions of the Empire. I divide the Russian Empire into two groups of regions. European Russia included most regions of the Empire, including Congress Poland and most of the Caucasus; Non-European Russia denotes the Eastern Siberia, Western

[7]Ibid., 292.

[8]See Owen (1991), 132-137, and Bovykin (1984), 226-227, which describe cartels and monopolies in the cotton textile industry in particular: the dominant scheme in cotton tended to be price-fixing arrangements among the large cotton weavers in Ivanovo.

Siberia, and Turkestan regions.[9] Regions outside of European Russia likely had thinner markets and weaker credit and capital markets. If factories or firms were more vertically integrated outside of European Russia, I would find support for Brown's (1992) hypothesis that thin markets stimulate integration. I can test the importance of credit and capital markets by examining corporations, since corporations had additional access to long-term capital.[10] If corporations were more vertically or horizontally integrated, capital market development must have been a crucial determinant of integration. Gerschenkron (1962) argued that the Russian industrial sector had been so held back by weak capital markets and by serfdom that the state had to substitute for private capital to stimulate industrial growth.[11] The state of Russian capital and credit markets, then, may have been important determinants of vertical and horizontal integration.

For the sake of this paper, I define vertical integration as follows: factories or firms are vertically integrated if they posses more than one specialization, or activity. For example, a cotton factory that had weaving as well as spinning operations was vertically integrated with two activities. In the case of firms, the definition is more broad: if a firm owned two factories, one of which spins and the other of which weaves, the firm would be considered vertically integrated with a total number of activities of two. In the first part of the paper, I consider vertical integration within

[9]See Gregg (2015b) for a more precise definition of European Russia as defined by the statistical volumes. Provinces with number codes greater than 68 are considered members of Non-European Russia.

[10]My dissertation's first chapter explains corporations' capital advantages. In short, corporations offered investors full limited liability, access to formal stock markets, lock-in of capital, and the ability to exist as an entity. Each of these advantages allowed corporations to raise more equity capital than their non-corporate peers.

[11]Gerschenkron, p. 20: "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." Kahan (1989) was less sanguine about the role of the state: some policies like industrial excise taxes contradicted the state's industrialization efforts (see Chapter 2: Government Policies and the Industrialization of Russia).

factory establishments alone. I define horizontal integration as the grouping together of factories into firms; the measure of horizontal integration is the number of factories per firm. I study horizontal integration in the second half of the paper, beginning in Section 4.6.3.

I estimate the following regressions equations to study the relationship between vertical integration and factory characteristics:

$$\begin{aligned} log(na_{ij}) = \quad & \alpha + \beta_l log(Workers_{ij}) + \beta_a log(Age_{ij}) + \beta_{ER} 1[Prov = ER]_{ij} \\ & + \beta_C 1[E.Form = Corp]_{ij} + \beta_k log(Power_{ij}) + \epsilon_{ijt} \end{aligned} \quad [1]$$

$$\begin{aligned} log(na_{ijt}) = \quad & \alpha + \gamma_l log(Workers_{ijt}) + \gamma_a log(Age_{ijt}) \\ & + \gamma_C 1[E.Form = Corp]_{ij} + \eta_t + \mu_{ijt} \end{aligned} \quad [2]$$

Equation 1 is estimated using 1894 data alone, and Equation 2 is estimated with both years of data. Here, $log(na_{ijt})$ is the natural log of the number of activities in factory i in province j in year t. The term $log(Workers_{ijt})$ is the natural log of the factory's number of workers, $1[Prov = ER]$ is a dummy variable that equal one of the factory was located in European Russia, $1[E.Form = Corp]$ is a dummy variable that equals one if the factory was owned by a corporation, and $log(Power)_{ij}$ is the factory's log total machine power (measured in horsepower), a measure of physical capital. The term η_t controls for the year of the observation. Notice that the European Russia dummy only appears in Equation 1, because only the 1894 volume includes factories outside of European Russia, and that the year control only appears in Equation 2, since this equation includes more than one year.

I predict that $\beta_l > 0$ and $\gamma_l > 0$, since larger factories had more workers; $\beta_a > 0$ and $\gamma_a > 0$, since older factories had more opportunities to take on additional operations; and $\beta_C > 0$ and $\gamma_C > 0$, since corporations had additional capital to purchase additional operations. The sign of β_{ER} more difficult to predict: if capital

markets inside European Russia were better integrated, factories in European Russia could have been more vertically integrated since developed capital markets would have allowed them to purchase additional functions, or, it could mean that factories were less vertically integrated, since the market was thicker and price risk lower (following Brown 1992).

Finally, if vertical integration allowed factories or firms to save on transaction costs, it should be possible to measure a performance advantage to vertical integration. Factories that had more activities should be more productive. I measure this in two ways. First, I measure productivity as the residual of a log Cobb-Douglas production functions of the form:

$$\begin{aligned} log(Revenue/Worker_{ij}) = \quad & \alpha + \delta_l log(Workers_{ij}) + \delta_k log(Power_{ij}) \\ & + \delta_C 1[E.Form = Corp]_{ij} + \delta_{ER} 1[Prov = ER] \\ & + \delta_{na} log(na_{ij}) + e_{ij} \end{aligned} \quad [3]$$

$$\begin{aligned} log(Revenue/Worker_{ijt}) = \quad & \alpha + \phi_l log(Workers_{ijt}) + \phi_C 1[E.Form = Corp]_{ijt} \\ & + \phi_{ER} 1[Prov = ER]_{ij} v_{ijt} + \phi_{na} log(na_{ijt}) + \eta_t + v_{ijt} \end{aligned} \quad [4]$$

Similarly to Equations 1 and 2, Equation 3 is estimated using only 1894 data, and Equation 4 is estimated using both years of data. In these equations, $log(Revenue/Worker_{ij})$ or $log(Revenue/Worker_{ijt})$ is the log revenue per worker of factory i in province j in year t as measured in rubles; $log(Workers_{ijt})$ is a factory's log number of workers plus; $log(Power_{ij})$; $1[E.Form = Corp]$ is a dummy variable that equals one if the factory was owned by a corporation; $1[Prov = ER]_{ij}$is a dummy variable that equals one if the factory was located in European Russia; η_t controls for the year of the observation in Equation 4; na_{ijt} is the log number of activities that take place within the factory.

Factories with more machine power should be more productive in terms of revenue per worker, so we should find $\delta_k > 0$. If factories have significant economies of scale, we should also find $\delta_l > 0$ and $\phi_l > 0$. My dissertation's first chapter finds that corporation-owned factories in the Russian Empire were more productive on average, so I should find that $\delta_C > 0$ and $\phi_C > 0$. If vertical integration increases productivity, we should find that $\delta_{na} > 0$ and $\phi_{na} > 0$.

4.4 Data

Data for this paper comes from the cotton industry chapters from surveys of manufacturing establishments conducted by the Russian Empire in 1894 and 1900.[12] For every factory in the Russian Empire, the 1894 factory-level volume lists the factory's name; street address; number, type, and power of all machines; number of workers by age and gender; ruble value of mineral and plant-based fuel sources; and total value of output in rubles. Also, most significantly for this paper, the volume lists every production activity that took place place within the factory. Figure 4.1 shows an example from the 1894 factory list for the Nikolskaia Manufaktura Partnership of Savva Morozov Son and Company, a particularly complex factory.[13] This example shows the impressive amount of detail the 1894 volume gives for each individual factory.

Similarly, the Empire published a factory-level volume for the 1900 factory survey, though this volume lists much less detail than that for 1894. The volume lists each factory's name and street address, number of workers, total value of output, and a

[12]I choose cotton because the factories within this industry have the most interesting variation in horizontal and vertical integration. Including other industries and matching factories and firms across those industry categories would provide another dimension of integration. However, such linking across industries is very rare in the 1894, 1900, and 1908 factory database, and separating and classifying factory activities for all factories in the Empire would be costly.

[13]Savva Morozov was a serf who, because of his success in silk textiles, purchased his family's freedom from the Sheremetev estate in 1820. (Tugan-Baranovsky, page 77).

description of the factory's products. For this census, the authors devised a standard classification system for the subindustries within the cotton industry (See Table 4.4). From these, we can break down which factories had which activities to approximate the information given in the 1894 factory-level volume. For example, if a factory is classified as belonging to the Cotton Spinning and Weaving subindustry, the factory would be listed as having the activities "spinning" and "weaving." Figure 4.2 shows two entries from the 1900 factory list as an example. The two entries are for two factories owned by Aleksei Vasilievich Smirnov. Unlike the entries in the 1894 factory list, the entries in 1900 are short paragraphs that describe each factory, and much less detail is provided about the factory's activities.

Furthermore, for both years, I am able to match factories to the firms that own them. The RUSCORP Database (Owen 1992), a list of all corporations founded in the Russian Empire, makes it possible me me to match corporation-owned factories to the corporations that owned them using the factory's name, location, and industry. When factories were not owned by corporations, they were listed under the personal names of the partners or single proprietors that own them. In this case, I match factories to firms if the first, middle, and last names are the same for the single owner or for all partners and if the factories were located in the same province.

The dataset for this paper consists of every cotton factory from the 1894 and 1900 factory lists.[14] Table 4.2 shows the breakdown of the number of factories and firms in the dataset by region for both years. There are 666 factories in the 1894 cotton data and 731 factories in the 1900 cotton data.

[14]The Database of Imperial Russian Manufacturing Establishments (Gregg 2013) contains only a sample of cotton factories from 1894 and 1900, while this paper uses data from the population of cotton factories from these years.

4.5 Overview of Vertical and Horizontal Integration in the Cotton Industry

This section presents counts of factories and firms and descriptive statistics to show how much vertical and horizontal integration there was in the Russian cotton industry in 1894 and 1900 and how integrated factories and firms differed from non-integrated factories and firms. Integrated factories were not evenly distributed about the Empire, and integrated factories and firms had higher revenue, more workers, were older, had more machine power, and had higher revenue per worker.

Table 4.2 breaks down factories and firms in 1894 and 1900 by the regions of the Russian Empire. The region Turkestan does not appear in the 1900 data, because Turkestan was not part of European Russia. The regions which contained the most cotton firms and factories are the Central Industrial, Previslitskii (Poland), Turkestan, and Central Blacksoil regions. The Prebaltic regions, which contains St. Petersburg, also had a lot of cotton factories.

Tables 4.3 and 4.4 show the number of factories in 1894 and 1900 by activity and by the subindustry classification system used in the 1900 factory-level volume. The categories in Table 4.4 are broken down into their components to form the column titled "Number of Factories (1900)" shown in Table 4.3. As shown in both tables, the 1894 data provide much more detail on fatories' activities. Still, both years of data describe some of the major categories of cotton activities: cotton wool production, thread-making, spinning, weaving, dyeing, and finishing. The data for 1894, however, include not only additional activities in the cotton industry but also activities outside of the cotton industry. 145 factories, for example, included a repair shop: this would normally be classified in the metals and machines industry. Many

factories also produced their own gas, peat, or electric fuel, and 9 factories made bricks.

Different activities were concentrated in different regions of the Russian Empire. Table 4.5 shows how the activities weaving, spinning, and cotton cleaning were distributed about the Empire in 1894 and 1900. Weaving and Spinning were concentrated in the industrial regions of the Empire: Central Industrial, Previslitskii, Central Blacksoil, and Prebaltic. Cotton cleaning, an early stage in raw cotton processing, takes place in Turkestan, a region that largely overlaps with modern-day Uzbekistan and which was a major cotton producer in the Russian Empire.[15]

Table 4.6 shows how the characteristics of factories varied by the number of activities contained within the factory. I have broken down the number of factories into three categories: factories with one activity (non-integrated factories), factories with between 2 and 4 activities (moderately integrated factories), and factories with 5 or greater activities (highly integrated factories). As the number of activities in factories increased, revenue, number of workers, machine power, age, and revenue per worker increased (though revenue per worker decreased slightly in 1894 between moderately integrated and very integrated factories). These results are consistent with predictions: integrated factories were larger, older, and more productive.

The numbers of revenue, number of workers, machine power, age, and revenue per worker are all larger in 1900 in Table 4.6 for several reasons. First, it is reasonable to assume that factories grew over time, and many of the factories survived more than one period. Second, and probably more significantly, the 1900 volume reports much less detail about the activities taking place without factories than the 1894 volume. Thus, a factory with 5 activities as listed in 1900 was probably a larger factory than a factory with 5 activities in 1894.

[15]Tugan-Baranovsky, "Russian Factory," 292.

4.6 Determinants of Vertical Integration, Horizontal Integration, and Revenue per Worker

Taking the number of activities in a factory or firm as a measure of vertical integration, how does vertical integration vary with factory or firm size, geography, enterprise form, and factory age? The regressions shown in Tables 4.7, 4.8, and 4.12 address these issues. Table 4.9 shows that more vertically integrated firms were more productive, and Figure 4.3 shows that the distributions of TFP become tighter about the mean as the number of activities within the factory increases.

4.6.1 Which factories were vertically integrated?

Factories within European Russia, where credit markets are likely more developed and markets are thicker, were less integrated. Thin markets encouraged vertical integration. The first regression results are presented in Table 4.7. Columns 1 through 5 of Table 4.7 show how the log number of activities in cotton factories varied with log number of workers, log factory age, whether the factory was located in European Russia, whether the factory was owned by a corporation, and the machine power in the factory. In Column 1, the coefficient on log number of workers is positive and statistically significant at the .001 level: bigger factories, as measured by number of workers, had more activities within the factory. The coefficient on log factory age is small relative to its standard error in Column 2, but it becomes much larger once I control for whether the factory was located in European Russia. In Column 3, the coefficient on log factory age is large and positive, and the coefficient on the European Russia dummy is large and negative.

Column 4 adds a dummy variable for whether the factory was owned by a corporation, and the coefficient is positive but small relative to its standard error. When I

add a control for the machine power in the factory in Column 6, the coefficient on the corporation dummy becomes even smaller; my first dissertation chapter argues that incorporation allows factories to purchase large machines, controlling for machine power absorbs much of the difference between corporations and non-corporations.

The results are a bit different for non-cotton activities, however. As with the log total number of activities, the number of log non-cotton activities increases with number of workers and is smaller if a factory was located in European Russia. The coefficient on log factory age, however, is now negative and small. Factories with more machine power had more non-cotton activities (Column 6). Also, the coefficient on the corporation-owned dummy variable is positive, a bit larger, but still statistically insignificant in Column 7. Factories that had more powerful machines were more likely to participate in industries outside of cotton.

Table 4.7 Columns 8 and 9 show similar regressions including factories from both the 1894 and 1900 volumes. The relationships shown in the previous regressions are similar here: older factories with more workers performed more functions. In this table, I introduce a control for the year of observation. The coefficient for a 1900 factory is negative and large, as could be predicted: the 1900 volume provides a much less detailed description of factory activities.

The 1894 factory-level volume provides information not only on the activities taking place within the factory but also the factory's final products. Table 4.8 shows similar regressions to those presented in Table 4.7. The number of products, whether defined as total number of products, cotton products only, or cotton with bricks and chemicals, increases with the number of workers and decreases if the factory was located in European Russia. The coefficient on log factory age is small and changes sign when I control for whether a factory was located in European Russia.

4.6.2 Are vertically integrated factories more productive?

Table 4.9 presents estimates of production functions for the 1894 data separately and the 1894 and 1900 combined. The dependent variable in these regressions is the log of the total value of output in rubles divided by the factory's number of workers. Column 1 shows a correlation between a factory's productivity as measured as revenue per worker and the factory's level of vertical integration (number of activities). Column 2 controls for factory's inputs: even controlling for a factory's size in terms of number of workers and machine power, factories with more activities produced more revenue per worker. Columns 3 and 4 introduce controls for the factory's age and whether the factory was owned by a corporation. Factories owned corporations produced more revenue per worker given the same number of workers, amount of machine power, and number of activities. This is consistent with my previous work: my dissertation's first chapter showed that corporations were more productive.

Columns 5 through 8 present similar regressions over both years of data, though a control is introduced for the year. Factories in 1900 had substantially less revenue per worker than factories in the 1894 data: perhaps the 1900 factory-level volume captured more small factories than did the 1894 volume. Also, the coefficient on log factory age is now much smaller but remains statistically insignificant. The coefficients for log number of activities and whether the factory is owned by a corporation are both positive and statistically significant at the .001 level.

Productivity can also be measured as the residual of a log Cobb-Douglas production function. Kernel density estimates of residuals by number of activities are presented in Figure 4.3. The first figure shows a density plot of residuals from a regression of log Revenue on log Workers using data from both 1894 and 1900. The second figure plots the density of residuals from a regression of log Revenue on log Workers using data from 1894 only (since machine power is only measured in 1894).

As the number of activities increases, the density of residuals becomes tighter about the median. More specifically, while there were highly unproductive factories with fewer activities, factories that had more activities do not appear on the lower tail of the distribution. However, the difference is smaller when I control for machine power: much of the productivity difference between vertically integrated and non-integrated factories can be explained by differences in physical capital.

4.6.3 Determinants of Firm Activities and Firm-Level Production Functions

This section repeats much of the analysis presented above at the level of the firm instead of the factory. A more common vertical integration model considers division of activities across establishments owned by the same firm. For example, a vertically integrated firm can own three factories, each of which perform a distinct stage in their production process. In the case of Russian textiles, many processes occurred in single factory buildings. Firm-level analysis will confirm that integration patterns in Russia are similar when the unit of analysis is the factory or firm

4.6.4 Matching Factories to Firms and Determinants of Firm Size

I first match factories in the 1894 and 1900 data to the firms that owned them. If a factory was owned by a partnership or single proprietorship, I match factories whose owners had the same first, middle (patronymic), and last names. If a factory was owned by a corporation, I match all factories that had the same corporation name. Table 4.10 Panel A shows how many factories can be matched to firms. Here, "firm size" means the number of factories that belonged to a firm. Thus, in 1894 there were 580 firms that owned one factory. Also in 1894, there were 64 factories

that belonged to two-factory firms, and hence there were 32 two-factory firms, and so on. In both 1894 and 1900, there was only one firm that had seven members, the Karl Sheibler Corporation in Petrokovskaia Province (part of modern-day Poland, named after Piotrków). There were slightly more many-member firms in 1900 than there were in 1894.

Table 4.10 Panel B shows the number of corporations and non-corporations by firm size. The largest firms tended to be corporations, especially in 1900, though there were not very many large firms in either year.

What were the characteristics of factories that belonged to large, horitzontally integrated firms? Table 4.11 presents Tobit regressions in which the dependent variable is the size of the firm. This tobit is left-censored at zero, because each firm must own at least one factory (and the log of one is zero). The unit of analysis in this regression is the factory: thus, the dependent variable is the size of the firm to which each factory belongs. The most important determinants of whether a factory belonged to a large firm are the number of workers and whether the factory was located in European Russia. Factories that had more workers and that were located outside of European Russia were more likely to belong to multi-member firms.

4.6.5 Firm-Level Vertical Integration and Production Functions

In this section I aggregate factories into the firms that owned them to perform analysis at the firm level rather than the factory level. The value of revenue, number of workers, and machine power for the firm are taken to be the sum of those for each factory. The age of the firm is the age of the oldest factory that belongs to the firm. In all regressions, I control for the number of factories that belong to the firm (firm size).

Results for a tobit regression showing the determinants of number of activities for firms is shown in Table 4.12. The results are similar to those shown in factory-level analysis. Column 1 controls for the number of establishments (factories) within the firm (the firm size), the firm's number of workers, and the firm's age. As expected, the number of activities in the firm increased in the number of establishments owned by the firm. The number of activities increased in the log number of workers and firm's age, though the coefficient on the log of firm age is small and not statistically significant. Column 2 shows that firms located in European Russia tended to have fewer activities. Though corporate firms had more activities, the difference is not statistically significant.

Columns 2 and 3 present the same regressions presented in Columns 1 and 2, though now the dependent variable is the number of non-cotton activities taking place within the firm. Neither the number of establishments within the firm nor the firms's age are significant determinants of the number of non-cotton activities within the firm. Log firm size has a similarly-sized coefficient as it did for the regressions using overall number of activities. Firms outside European Russia tended to have more non-cotton activities. Also, corporations tended to have more non-cotton activities within firms than non-corporations, though the difference is not statistically significant.

Table 4.12 Columns 5 through 7 shows similar tobit regressions for both years combined. As in Section 4.6.1, firms outside European Russia are excluded from these regressions, since the 1900 volume lists only factories in European Russia. Columns 5 and 6 show regressions for all activities that can take place within the firm, while Column 7 shows only cotton activities, which places both 1894 and 1900 on the same basis since the 1900 volume only includes cotton activities. The number of total activities or cotton activities increases in firm size, log number of workers,

and factory age; and the number of activities or cotton activities is smaller for firms in 1900.

The previous section presented results that suggested that vertically integrated Russian factories produced more revenue per worker. Table 4.13 shows similar patterns at the firm level. Column 1 through 4, which use only the 1894 data, show that firms with more overall activities, more machine power, and fewer workers tended to produce more revenue per worker. Corporations were also more productive. Columns 5 through 8 use both the 1894 and 1900 data: in these regressions, firms with more factories produce more revenue per worker, though the result is fragile: when I control for whether the firm is a corporation, the coefficient on firm size loses statistical significance. Vertical integration and corporate ownership are strongly related to firms' revenue per worker.

4.7 Additional Functional Forms and Alternative Definitions of Integration

Table 4.14 presents several additional functional forms and specifications. I present results that use OLS instead of Tobit, robust or clustered standard errors, and nonlinear terms. Regressions using OLS decrease the size of the estimates, all standard error forms give similar results, and regressions using nonlinear terms perform somewhat worse than regressions without nonlinear terms. I also present results that use alternative definitions of integration.

Table 4.14 shows results using 1894 data alone and 1894 and 1900 combined, estimating the main regression equations using Tobit, OLS, and robust and clustered standard errors. In general, the results are the same as observed in Table 4.7: older factories with more workers and more machine power outside of Euro-

pean Russia had more activities. Regressions estimated with OLS have coefficients that are smaller in absolute value, and clustering standard errors reduces statistical significance somewhat. Overall, however, the results are unchanged.

So far in the paper, I have only examined regressions using linear terms. Table 4.14Columns 2 and 6 displays the results of regressions that include some squared terms. Column 2 introduces log workers squared and log factory age squared: the coefficient on log workers squared is now statistically significant, though smaller than the log workers coefficient in Column 1, and log workers has lost statistical significance. The regression in Column 6 is similarly difficult to interpret: now the only statistically significant coefficient is the year dummy.

Finally, I examine an alternative definition of integration. In the paper so far, I have used the number of activities within the factory or firm as the dependent variable in a Tobit regression. There are at least two other ways to define vertical integration using the variables available in the 1894 and 1900 volumes. The first way is to define a vertically integrated factory or firm as one that had more than one activity. Table 4.10 Panel C shows a breakdown of factories and firms in both years using these two definitions of integration. About half of factories and firms in 1894 and a slightly smaller proportion of firms and factories in 1900 had more than one activity.

In Table 4.15, I present estimates from a probit regression in which the dependent variable is whether the factory or firm had more than one activity. The probit regressions presented in 4.15 show similar patterns as observed previously in the paper: factories or firms that were older, had more workers, and were located outside of European Russia were more likely to be integrated. In these regressions, corporate ownership does not strongly predict integration, nor does having more machine power. Additional capital, then, may be helpful for acquiring more activities overall but not for becoming integrated in the first place.

4.8 Conclusion

This paper has documented the characteristics of horizontally and vertically integrated factories and firms in the Imperial Russia cotton industry, one of the Empire's most technologically advanced and productive industries. I find that older factories with more workers located that were outside of European Russia tended to be the most vertically integrated. Factories that had more workers and that were located outside of European Russia were more likely to belong to horizontally integrated firms. And there is evidence that more vertically integrated factories and firms were also more productive.

The results of this paper emphasize some of the main characteristics of the Russian industrial sector in general. The various branches of the Russian cotton industry were distributed about the geography of the Empire, where market thickness and access to credit and capital varied greatly. There were some very large, highly vertically integrated firms and many single-factory, single-proprietor-owned firms as well. Further research is needed to pinpoint the sources of firm and factory growth, to explore how the Russian governments disparate industrial policies contributed to the size distribution of firms in the industrial sector, and to evaluate the competitiveness of Russian industry at the turn of the twentieth century.

Tables

Table 4.1: Revenue, Labor, and Degree of Vertical Integration by Industry (1894 and 1900)

	Total Factories	%	Total Revenue	%	Total Rev./ Workers	Total Power/ Workers (1894)	Avg. Num. of Activities (1894)
Cotton	**1,397**	**4.21**	**931,654,477**	**21.85**	**1,377.70**	**.27**	**2.31 (Std. Dev. 2.05)**
Animal Products	3,042	9.17	203,952,736	4.78	2,233.09	.11	1.48 (0.81)
Chemicals	1,263	3.81	253,318,493	5.94	2,729.14	.22	1.46 (0.92)
Flax, Hemp, and Jute	780	2.35	115,024,057	2.70	896.57	.19	1.90 (1.36)
Foods	12,853	38.74	1,404,825,064	32.94	2,124.98	.29	1.50 (0.88)
Metals and Machines	3,318	10.00	542,674,191	12.73	1,477.45	.10	1.36 (0.67)
Mineral Products	2,864	8.63	120,441,589	2.82	580.27	.07	1.33 (0.73)
Mixed Materials	762	2.30	54,442,893	1.28	1,064.81	.06	1.44 (0.94)
Paper	1,923	5.80	130,893,215	3.07	1,104.40	.31	1.90 (1.08)
Silk	577	1.74	45,336,931	1.06	935.19	.05	1.35 (0.76)
Wood	2,434	7.34	145,715,856	3.42	1,301.03	.30	1.39 (0.77)
Wool	1,962	5.91	315,875,978	7.41	1,269.69	.22	1.93 (1.59)
Total	33,175	100	4,264,155,462	100			

Source: Gregg Imperial Russian Manufacturing Database (2015). The "Foods" category includes both factories subject to the excise tax and factories not subject to the excise tax. Percentages are in the Revenue category are rounded and may not add up to 100. The final column reports standard deviations in parentheses.

Table 4.2: Number of 1894 Cotton Factories by Region

	1894		1900	
	Number of Factories	Number of Firms	Number of Factories	Number of Firms
Caucasus	1	1	2	2
Central Blacksoil	40	39	89	88
Central Industrial	427	404	431	401
Eastern	5	5	4	4
Northwestern	2	2	2	2
Prebaltic	39	35	37	31
Previslitskii	75	68	154	143
Southern	17	17	12	12
Turkestan	60	58	(N/A)	(N/A)
Total	666	618	731	683

Source: Gregg Imperial Russian Manufacturing Database (2015). Factories are matched to firms by first and last names and by province, unless the factory is owned by a corporation, in which case they are matched by the corporation name.

Table 4.3: Number of Cotton Factories by Activity (1894 and 1900)

Activity (Cotton)	Number of Factories (1894)	Number of Factories (1900)	Activity (Other Ind.)	Number of Factories (1894)
Cotton Wool	78	49	Electricity	**3**
Bleaching	77		Repair Shop	**145**
Spinning	92	117	Gas	**70**
Weaving	366	426	Peat	**6**
Dyeing	219	120	Looms and Shafts	**5**
Finishing	145	282	Bricks	9
Printed Fabric	87		Book Binding	1
Velvet	2	6	Bread Baking	**4**
Engraving	28	2	Butchery	3
Mech. Spinning	9		Chemicals	4
Printed Skirts	1		Mechanical	1
Wicks	4		Looms	3
Twine	2		Soap	1
Bands	2		Artificial Wool	1
Machine Belts	1		Boxes	1
Heald	1		Brushes	1
Cordage	1		Foundry	1
Belts	1		Rubber Weaving	1
Rugs	1		Machine Building	1
Spinning (Fallen)	8	21	Lime	1
Knitted Fabric	1		Flour	3
Waste Yarn	1		Flax Spinning	1
Lacework	1		Hemp Scutching	1
Spun Yarn	1		Wool Cleaning	1
Brocade	1		Worsted	1
Talc Padding	1		Fire Hoses	1
Chintz	1		Butter	3
Cordage2	1		Mineral Paints	1
Cotton Cleaning	59		Carpentry	1
Worsted Vicuna	1		Alizarine	2
Cotton Baling	40		Wood	4
Thread	13	21		
Hydrocyanic Dyeing	4			

Source: Gregg Imperial Russian Manufacturing Database (2015). Activities are indicated in the entry for each factory in 1894 (See Figure 4.1). For 1900, the categories are compiled by decomposing the categories listed in Table 4.4.

Table 4.4: Number of Factories in Each 1900 Cotton Subindustry

Subindustry Classification	Number of Factories
Cotton Quilting	49
Cotton Spinning	42
Vicuna	24
Cotton Thread	21
Cotton Weaving	152
Cotton Weaving Distribution Offices	116
Velvet	6
Cotton Spinning and Weaving	37
Cotton Weaving with Dyeing and Finishing	67
Cotton with Weaving, Dyeing, and Distribution	53
Cotton Dyeing and Finishing	124
Cotton Weaving, Dyeing, and Finishing	38
Cotton Engraving	2
Total	731

Source: Gregg Imperial Russian Manufacturing Database (2015)

Table 4.5: Number of Cotton Factories by Activities and Region

	Weaving		Spinning		Cleaning	
	1894	1900	1894	1900	1894	1900
Caucasus	1	0	1	1	0	n/a
Central Blacksoil	17	62	1	2	0	n/a
Central Industrial	298	285	42	58	0	n/a
Eastern	0	0	1	0	0	n/a
Northwestern	1	0	0	0	0	n/a
Prebaltic	15	8	21	21	0	n/a
Previslitskii	34	71	24	33	0	n/a
Southern	0	12	1	2	0	n/a
Turkestan	1	n/a	1	n/a	59	n/a
Total	367	426	92	117	59	

Source: Gregg Imperial Russian Manufacturing Database (2015). The categories for 1900 come from decomposing the categories listed in the 1900 volume (See Table 4.4). The last column says "n/a" because the 1900 volume gives no information on cotton cleaning.

Table 4.6: Descriptive Statistics for Cotton Factories by Number of Activities, 1894 and 1900

Number of Activities	**Revenue** 1894	1900	**Workers** 1894	1900	**Machine Power** 1894	1900
1	89,370.84	328,866.3	70.28	283.74	41.31	n/a
	(297,779.8)	(936,864.4)	(180.54)	(653.40)	(197.92)	
$1 < x < 5$	561,634.8	1,228,719	393.08	882.25	254.95	n/a
	(1,154,009)	(2,362,472)	(716.69)	(1678.57)	(676.78)	
$x > 4$	2,970,454		1,981.90		1372.82	n/a
	(2,896,532)		(2120.30)		(1670.88)	

Number of Activities	**Age** 1894	1900	**Revenue per Worker** 1894	1900
1	19.33	18.99	1277.22	876.31
	(18.43)	(18.56)	(1926.88)	(1138.05)
$1 < x < 5$	26.70	29.95	2157.94	1231.96
	(23.08)	(24.83)	(3238.71)	(1873.44)
$x > 4$	42.55		2055.27	
	(28.73)		(1753.23)	

Source: Gregg Imperial Russian Manufacturing Database (2015)

Table 4.7: Determinants of Number of Cotton Factory Activities (1894 and 1900)

Years:	1894 Only							1894 and 1900	
Tobit	Dep. Var: Log Number of Activities					Log Number of Non-Cotton Activities		Log Number of Activities	
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
Log Num. of Workers	.35***	.34***	.36***	.42***	.41***	.48***	.22***	.26***	.26***
	(.020)	(.022)	(.022)	(.051)	(.051)	(.036)	(.059)	(.018)	(.023)
Log Factory Age		.064	.16***	.098*	.099*	-.014	-.0064	.18***	.18***
		(.036)	(.037)	(.039)	(.039)	(.046)	(.043)	(.030)	(.030)
European Russia			-.97***	-.74***	-.72***	-.69***	-.63**		
			(.14)	(.16)	(.17)	(.19)	(.19)		
Log Machine Power				-.045	-.050		.18***		
				(.16)	(.043)		(.051)		
Owned by Corporation					.082		.14		.054
					(.11)		(.11)		(.090)
Year = 1900								-.36***	-.36***
								(.062)	(.062)
Intercept	-1.25***	-1.36***	-.87***	-.93***	-.91***	-2.06***	-1.45***	-1.48***	-1.46***
	(.10)	(.13)	(.13)	(.16)	(.16)	(.21)	(.20)	(.12)	(.13)
Chi2	288.37	259.16	312.20	223.02	223.76	292.99	220.53	335.47	335.26
R2	.1942	.1909	.2300	.2323	.2335	.3229	.3008	.1274	.1275
N	626	571	571	380	379	571	379	1201	1200

*** $p < .001$, ** $p < .01$, * $p < .05$. Source: Gregg Imperial Russian Manufacturing Database (2015). Tobit is left-censored at zero, since a firm has one or more activities. Standard errors in parentheses. Regressions in columns 8 and 9 include only European Russia.

Table 4.8: Determinants of Number of Cotton Factory Products (1894)

Tobit	Dep. Var: Log Number of Products			Log Number of Products, Cotton Only			Log Number of Cotton Products with Bricks and Chemicals		
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
Log Num. of Workers	.30***	.30***	.36***	.30***	.31***	.38***	.29***	.30***	.36***
	(.036)	(.041)	(.045)	(.036)	(.041)	(.047)	(.035)	(.040)	(.044)
Log Factory Age		-.047	.069		-.070	.045		-.057	.054
		(.059)	(.062)		(.058)	(.060)		(.057)	(.060)
European Russia			-1.36***			-1.40***			-1.32***
			(.23)			(.226)			(.220)
Intercept	-2.26***	-2.17***	-1.57***	-2.28	-2.15	-1.57	-2.21	-2.10	-1.52
	(.24)	(.27)	(.24)	(.24)	(.27)	(.24)	(.24)	(.26)	(.24)
Chi2	94.70	81.64	123.44	97.74	85.49	131.43	95.20	82.48	124.37
R2	.1226	.1156	.1748	.1304	.1251	.1922	.1249	.1185	.1787
N	625	570	570	625	570	570	625	570	570

Source: Gregg Imperial Russian Manufacturing Database (2015). Tobit is left-censored at zero, since a firm has one or more activities. Standard errors in parentheses. Chemicals includes Alizarine.

Table 4.9: Determinants of Cotton Factory Productivity (Revenue per Worker), 1894 and 1900

OLS	Dependent Variable: Log Revenue per Worker							
	1894 Only				1894 and 1900			
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Log (Number of Activities)	.30***	.22**	.18*	.16*	.33***	.36***	.33***	.23***
	(.063)	(.076)	(.075)	(.079)	(.051)	(.062)	(.059)	(.066)
Log (Machine Power)		.20***	.16***	.16**				
		(.044)	(.046)	(.048)				
Log (Number of Workers)		-.31***	-.33***	-.34***		-.026	-.13***	-.087**
		(.054)	(.054)	(.055)		(.022)	(.026)	(.028)
Form = Corporation			.42***	.41**			.75***	.68***
			(.11)	(.12)			(.090)	(.094)
Log (Factory Age)				.078				-.0028
				(.43)				(.032)
YEAR = 1900								-.34***
								(.078)
Intercept	6.94***	7.85***	7.98***	7.85***	6.67***	6.78***	7.10***	7.16***
	(.076)	(.15)	(.16)	(.18)	(.049)	(.11)	(.12)	(.13)
F-Stat	22.67	11.26	11.30	9.75	40.67	20.51	34.04	23.94
R2	.0347	.1098	.1448	.1507	.0327	.0342	.0856	.0972
N	504	344	343	320	1012	1012	1011	939

*** $p < .001$, ** $p < .01$, * $p < .05$. Source: Gregg Imperial Russian Manufacturing Database (2015). Regressions with 1894 and 1900 data include European Russia only. Robust standard errors in parentheses.

Table 4.10: Number of Cotton Factories, Firms, and Corporations

Panel A: Number of Factories and Firms by Firm Size

	1894		1900	
Firm Size	Number of Factories	Number of Firms	Number of Factories	Number of Firms
1	580	580	653	580
2	64	32	42	21
3	15	5	15	5
4	0	0	8	2
6	0	0	6	1
7	7	1	7	1

Panel B: Number of Firms by Enterprise Form (Corporations vs. Non-Corporations)

	1894		1900	
Firm Size	Number of Non-Corporations	Number of Corporations	Number of Non-Corporations	Number of Corporations
1	498	82	554	99
2	18	13	11	10
3	0	5	2	3
4	0	0	0	2
6	0	0	0	1
7	0	1	0	1

Panel C: Number of Integrated and Non-Integrated Cotton Factories and Firms

	1894		1900	
	Factories	Firms	Factories	Firms
Number of Activities = 1	333	315	412	524
Number of Activities > 1	333	304	319	159
Total	666	619	731	683

Source: Gregg Imperial Russian Manufacturing Database (2015). The author matched factories to firms, as described in the text: factories that do belong to corporations belong to the same firm if the first, middle, and last names match and if they are located in the same province in the same industry. Factories that belong to corporations are matched by corporation name. Factories are matched to corporations using the RUSCORP Database (Owen 1992).

Table 4.11: Factory Characteristics Determining Cotton Firm Size, 1894 and 1900

Tobit	Dependent Variable: Log Firm Size						
	1894 Only				1894 and 1900		
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Log (Total Workers)	.44***	.42***	.45***	.32*	.62***	.61***	.68***
	(.084)	(.085)	(.089)	(.16)	(.086)	(.089)	(.11)
Log (Factory Age)		.090	.20	.20		.030	.00071
		(.12)	(.13)	(.14)		(.10)	(.10)
European Russia			-1.46**	-1.59***			
			(.43)	(.45)			
YEAR = 1900							-.37
							(.19)
Form = Corporation				-.11			-.25
				(.28)			(.24)
Log (Machine Power)				.12			
				(.14)			
Intercept	-4.25***	-4.31***	-3.46***	-3.01***	-5.77***	-5.74***	-5.73***
	(.72)	(.77)	(.66)	(.65)	(.74)	(.76)	(.79)
F-Stat	61.71	59.28	72.91	52.25	145.32	144.90	149.78
R2	.1900	.1863	.2291	.1872	.2526	.2559	.2646
N	579	532	532	348	1208	1125	1124

*** $p < .001$, ** $p < .01$, * $p < .05$. Source: Gregg Imperial Russian Manufacturing Database (2015). The unit of observation is the factory. Thus the dependent variable is the size of the firm to which the factory belongs. Tobit is left-censored at zero, since a firm has one or more factories. Standard errors in parentheses. Regressions that include 1900 exclude factories outside European Russia.

Table 4.12: Determinants of Cotton Firm Activities, 1894 and 1900

Years:	1894				1894 and 1900		
Tobit	Dep. Var: Log Number of Activities		Dep. Var: Log Num. of Non-Cotton Activities		Dep. Var: Log Number of Activities		Dep. Var: Log Num. of Cotton Activities
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
No. Firm Establishments	.24**	.13	.015	-.019	.20*	.20*	.28**
	(.094)	(.092)	(.095)	(.092)	(.081)	(.082)	(.084)
Log Num. of Workers	.34***	.34***	.36***	.39***	.33***	.35***	.30***
	(.023)	(.027)	(.062)	(.070)	(.024)	(.030)	(.031)
Log Factory Age	.067	.15***	.052	.083	.19***	.19***	.20***
	(.037)	(.039)	(.076)	(.076)	(.039)	(.039)	(.041)
European Russia		-.86***		-.93*			
		(.14)		(.36)			
Corporation		.12		.077		-.082	-.13
		(.12)		(.15)		(.12)	(.12)
Year = 1900					-.98***	-.99***	-.77***
					(.081)	(.082)	(.085)
Intercept	-1.62***	-1.00***	-2.43***	-1.85***	-2.09***	-2.14***	-2.26***
	(.15)	(.17)	(.42)	(.41)	(.17)	(.18)	(.19)
Chi2	287.78	330.09	53.95	60.31	449.62	449.07	341.59
R2	.2227	.2559	.1910	.2135	.1998	.1998	.1613
N	532	531	141	141	1123	1122	1125

*** $p < .001$, ** $p < .01$, * $p < .05$. Source: Gregg Imperial Russian Manufacturing Database (2015). Tobit is left-censored at zero, since a firm has one or more activities. Standard errors in parentheses.

Table 4.13: Cotton Industry Firm-Level Production Functions (1894 and 1900)

OLS	Dependent Variable: Log Revenue per Worker							
	1894 Only				1894 and 1900			
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
No. Factories in the Firm	-.059	.028	.019	.028	.082**	.094**	.058	.067
	(.076)	(.064)	(.063)	(.062)	(.031)	(.033)	(.035)	(.037)
Log (Number of Activities)	.30***	.20*	.18*	.17	.27***	.29***	.26***	.15*
	(.067)	(.082)	(.082)	(.085)	(.051)	(.058)	(.056)	(.066)
Log (Machine Power)		.19***	.16**	.17**				
		(.046)	(.047)	(.049)				
Log (Number of Workers)		-.31***	-.32***	-.34***		-.014	-.11***	-.069*
		(.057)	(.057)	(.058)		(.022)	(.026)	(.029)
Form = Corporation			.35**	.33**			.81***	.74***
			(.12)	(.13)			(.088)	(.092)
Log (Firm Age)				.072				-.019
				(.045)				(.034)
YEAR = 1900								-.34***
								(.082)
Intercept	6.97***	7.82***	7.93***	7.82***	6.61***	6.66***	7.02***	7.09***
	(.10)	(.15)	(.16)	(.19)	(.059)	(.11)	(.12)	(.13)
F-Stat	10.32	7.17	7.35	6.87	29.36	19.93	34.66	23.44
R2	.0354	.1112	.1344	.1425	.0281	.0286	.0848	.0986
N	463	312	311	295	936	936	935	873

*** $p < .001$, ** $p < .01$, * $p < .05$. Source: Gregg Imperial Russian Manufacturing Database (2015). Regressions using data from 1894 and 1900 (Column 5 through 8) include European Russia only.

Table 4.14: Determinants of Number of Cotton Factory Activities (1894 and 1900): Alternative Specifications

	Dep. Var: Log Number of Activities							
	1894				1894 and 1900			
	Tobit [1]	Tobit [2]	OLS [3]	OLS [4]	Tobit [5]	Tobit [6]	OLS [7]	OLS [8]
Log Num. of Workers	.41***	.091	.23***	.23***	.24***	.24**	.14***	.14***
	(.085)	(.095)	(.030)	(.057)	(.031)	(.076)	(.011)	(.017)
Log Num. of Workers^2		.028**				.00094		
		(.0091)				(.0073)		
Log Factory Age	.099*	-.0080	.068*	.068*	.14**	.058	.062***	.062**
	(.043)	(.13)	(.027)	(.028)	(.048)	(.10)	(.013)	(.017)
Log Factory Age^2		.030				.016		
		(.025)				(.019)		
Year = 1900					-.44**	-.44***	-.27***	-.27***
					(.14)	(.058)	(.030)	(.063)
European Russia	-.72*	-.92***	-.33***	-.33*				
	(.30)	(.11)	(.083)	(.16)				
Corporation	.082		.11	.11	.079		.072	.072
	(.11)		(.084)	(.10)	(.15)		(.047)	(.093)
Log (Machine Power)	-.050		.0053	.0053				
	(.073)		(.029)	(.047)				
Intercept	-.91**	-.16	-.30***	-.30	-1.15***	-1.08***	-.16***	-.16*
	(.30)	(.26)	(.084)	(.16)	(.024)	(.21)	(.044)	(.072)
Std. Errors	C	R	R	C	C	R	R	C
Chi2 / F	26.27	104.53	78.91	43.12	26.70	82.98	106.08	50.88
R2	.2335	.2379	.4600	.4600	.1157	.1157	.2714	.2714
N	379	571	379	379	1256	1257	1256	1256

*** $p < .001$, ** $p < .01$, * $p < .05$. Source: Gregg Imperial Russian Manufacturing Database (2015). Tobit is left-censored at zero, since a firm has one or more activities. Standard errors in parentheses: "C" means clustered by Province, "R" means robust. Regressions for that include both 1894 and 1900 use observations only from European Russia. Chi2 statistics are reported for Tobit regressions; F-statistics are reported for OLS.

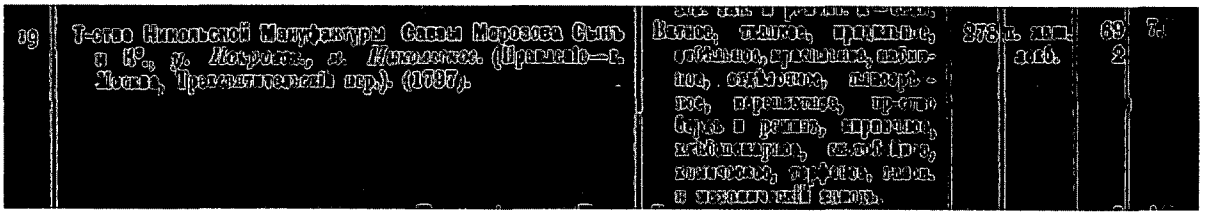
Table 4.15: Determinants of Cotton Factory Integration: 1894 and 1900

Probit	Definition of Integration: $na_{ijt} > 1$			
	Dep. Variable: Factory is Integrated		Dep. Variable: Firm is Integrated	
	1894	1894 and 1900	1894	1894 and 1900
	[1]	[2]	[3]	[4]
Log Num. of Workers	.66***	.25***	.66***	.34***
	(.11)	(.028)	(.12)	(.032)
Log Age	.12	.15***	.15*	.14**
	(.069)	(.034)	(.074)	(.040)
Year = 1900		-.43***		-1.14***
		(.076)		(.087)
European Russia	-1.16***		-1.26***	
	(.28)		(.30)	
Corporation	.12	.13	.16	-.067
	(.23)	(.12)	(.28)	(.13)
Log (Machine Power)	-.20*		-.15	
	(.089)		(.091)	
Intercept	-1.30***	-1.38***	-1.42***	-1.68***
	(.29)	(.13)	(.32)	(.15)
Wald Chi2	96.42	216.93	99.67	325.60
Pseudo R2	.2799	.1235	.3329	.2334
N	379	1256	348	1172

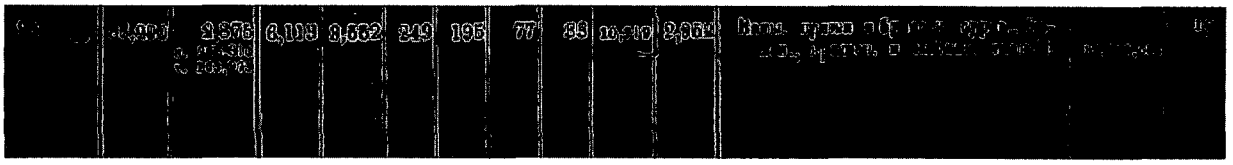
*** $p < .001$, ** $p < .01$, * $p < .05$. Source: Gregg Imperial Russian Manufacturing Database (2015). Tobit is left-censored at zero, since a firm has one or more activities. Robust standard errors in parentheses. Regressions for that include both 1894 and 1900 use observations only from European Russia.

Figures

Figure 4.1: 1894 Factory List Example



Source: Perechen' fabrik i zavodov (1896), Page 2. Translation: Nikolskaia Manufaktura Partnership of Savva Morozov Son and Co. Located in Pokrovsk. uezd, (m) Nikol'skoe (Board of Directors: Moscow, Trekhsiatitel'skii Lane. Founded: 1797. Activities: cotton wool, weaving, spinning, bleaching, dyeing, printed fabric, finishing, velvet, book binding, looms and shafts, bricks, bread baking, butchery, chemicals, peat, gas, mechanical. The factory operates 278 days per year. It has 69 steam engines with a total power of 7,010 horsepower and 2 locomotives with a total horsepower of 45.



Source: Perechen' fabrik i zavodov (1896), Page 3. The factory has 93 steam boilers with a total square footage of 97,233. It used 86,290 rubles in plant-based fuels, 2,875 rubles in general mineral fuels, 268,310 rubles in oil, 163,973 rubles in peat. They employ 6,113 adult men, 3,552 adult women, 249 adolescent men, 195 adolescent women, 77 boys, and 33 girls, for a total number of workers of 10,219. They also employ 2,952 workers outside of the factory. They produce cotton wool, yarn, and woven and dyed fabrics. Their total annual output is 13,753,694 rubles.

Figure 4.2: 1900 Factory List Example

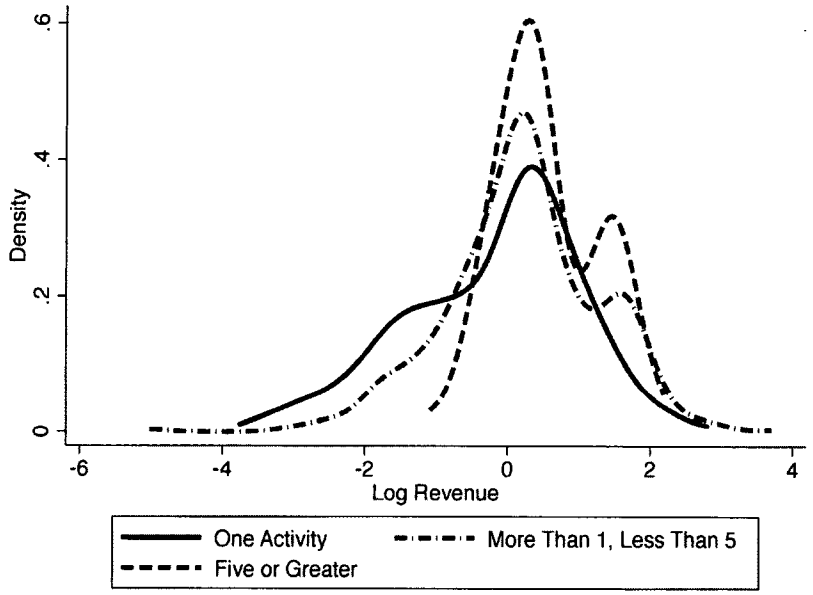
Смирновъ, Ал. Вас., пот. поч. гр. Бумагопрядильн. фабр. (осн. 1899 г.). Покров. у., Кудыкин. вол., д. Ликино. *Ближ. ст. Ликино, Орѣховск. подъѣздн. пути, ½ в., ст. Дрезна, М.-Н. ж. д., 7 в., грунт. д. Почт. и тел. адресъ конт.: Москва, Юшкова пер., Шуйское подворье, №№ 29—30.* Год. произв. 61,300 (*1.216,843*) р. *Перераб. хлоп. ок. 91,700 п.* Чис. раб. 494 (*458*).

Смирновъ, Ал. Вас., пот. поч. гр. Бумаготкац. завд. (осн. 1881 г.). Покров у., Кудыкин. вол., д. Ликино. *Ближ. ст. Ликино, Орѣховск. подъѣздн. пути М.-Н. ж. д., проселоч. д. Адресъ для прост. корр: ст. Ликино, для заказной: Дулевское почт. отд.; конт.: Москва, Шуйское подворье, №№ 29—30.* Вырабт. тк. пестротканн. Год. произв. 120,500 р. (*91.425 п. на 1.988,700 р.*). *Перераб. бумаж. и вигонев. бум. пряж. и мал. ч. льнян. пряжи.* Чис.. раб. 1,031.

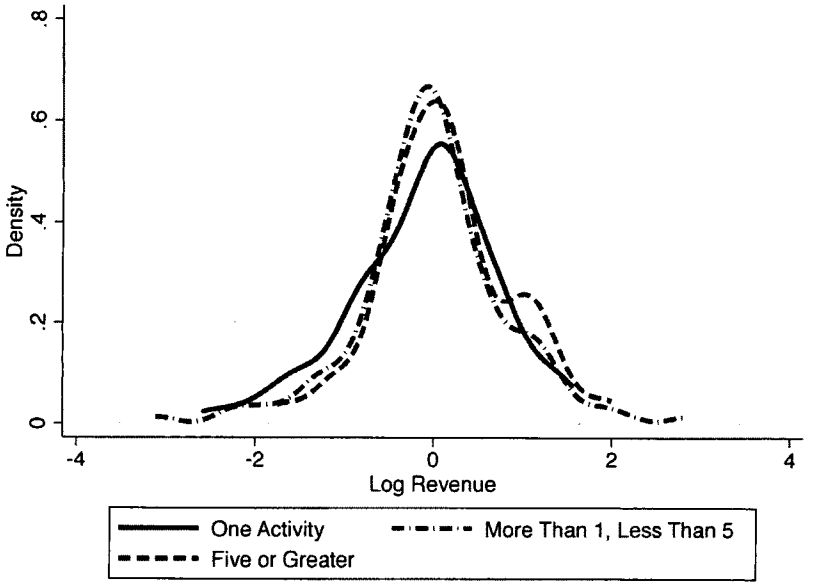
Source: 1900 Factory List, Page 7 (Vladimirskaia Guberniia). Translation: First entry: "Smirnov, Al. Vac. Hereditary citizen. Cotton spinning factory. (Founded 1899). Pokrov. uezd, Kudykin volost, Likino road. Close to Likino station, Orelkhovsk. route, 1/2 verst, st. Dresna, M-N Railroad, 7 versts. Mail and telephone address: Moscow, Iushkov Lane, Shiuskoe Compound, Numbers 29-30. Yearly output 61,300 (1,216,843) rubles. Processing of about 91,700 puds of cotton. Number of workers: 494 (458)." Second entry: "Smirnov, Al. Vac. Hereditary citizen. Cotton spinning factory. (Founded 1881). Pokrov. uezd, Kudykin volost, Likino road. Close to Likino station, Orelkhovsk. route, M-N Railroad. Address for correspondence: Likino Station, for orders: Dulevskoe mail department. Distribution: Moscow, Shuiskoe Compound, Numbers 29-30. Yearly output: 120,500 rubles (91,425 pounds and 1,988,700 rubles). Processing of cotton and vicuna yarn and (small gauge?) linen yarn. Number of workers: 1,031."

Figure 4.3: Production Function Residuals

Residuals from Regressing Revenue on Labor (1894 and 1900)



Residuals from Regressing Revenue on Labor and Capital (1894)



Source: Gregg Imperial Russian Manufacturing Database (2015).

Chapter 5

Data Appendix: Imperial Russian Manufacturing Establishments Database: 1894, 1900, and 1908

5.1 Introduction and Data Sources

This document describes the construction of a new database of Russian manufacturing establishments based on Imperial Russian factory censuses. The original sources for the database are published factory-level and aggregate census volumes from 1894, 1900, and 1908. The database consists of the census population of factories from 1894, 1900, and 1900 and a complete digitization of the 1900 and 1908 aggregate volumes. The database also includes a built-in stratified sample from the 1894, 1900, and 1908 data with post-stratification weights for any researcher that would prefer to use a sample rather than the whole population.

This database will be useful to scholars in many fields, including general Russian history, Russian economic history, development economics, and industrial organization. For example, new information on Russian factories can shed light on the sources

of high performance and the remaining obstacles to growth in the Russian industrial sector around the turn of the twentieth century.[1] The Russian Empire at this time was mostly agricultural,[2] like many developing economies today; researchers in development economics could compare Imperial Russian factory performance to that in developing economies today.[3]

Around the turn of the twentieth century, the Imperial Ministry of Finance and Ministry of Trade and Industry conducted several manufacturing censuses. This database includes information from the 1894, 1900, and 1908 factory surveys. For the 1894 census, the database includes information from a published factory-level volume. For the 1900 and 1908 censuses, the Ministries published two volumes: one with factory micro data and a limited number of variables and the other with data at the level of regions and finely-defined industries but with many more variables.[4]

This data appendix and codebook serves as a general introduction to the database. I will describe the data sources in Section 2, noting their coverage, available variables, and population sizes. Section 3 describes the construction of the stratified sample

[1]According to Gregory (1974), Russian per capita income in 1912 was less than a third of that in Germany in 1905. But the Russian economy was growing rapidly, the industrial sector in particular. By Maddison's estimates, Russian GNP almost doubled between 1890 and 1914 and grew at an average annual rate of 2.1 percent while French GNP grew at an average annual rate of 1.37 percent, German at 1.05 percent, and U.S. at 1.62 percent. Russian pig iron output more than quadrupled between 1890 and 1910 (Kahan 1989).

[2]As late as 1913 about two thirds of Russia's population was engaged in agriculture, and agriculture accounted for almost half of national income (Goldsmith 1961).

[3]See Bloom and Van Reenen (2007 and 2010); Hsieh and Klenow (2009); Johnson, MacMillan, and Woodruff (2002); MacMillan and Woodruff (2002); and Paulson, Townsend, and Karaivanov (2006) for recent examples on factories and firms in developing and transition economies.

[4]There was also a factory census conducted for the years 1910, 1911, and 1912, but these census volumes only describe goods which could be traded on international markets, since the purpose of the census was to evaluate the possible effects of a change in the protective tariff regime. Also, there are no micro volumes for this census. For these reasons, this data has been excluded from this round of data collection. 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.

from the 1894, 1900, and 1908 factory-level volumes and verifies the validity of stratification. Section 4 describes the organization of the data files and the fields in each field. Section 5 presents some summary statistics from the factory-level and aggregate data (with matched moments), factories matched across years and unmatched factories, and factory-level and aggregate production functions.

5.2 Description of the Data

This section will describe the population of firms covered by each census and the variables published in their factory-level and aggregate volumes. Each census covered slightly different populations of factories, and the variables published also differed slightly.

5.2.1 Coverage

The 1894 census volume describes factories in every industry in the entire Russian Empire. The data provide each factory's province location, and Table 5.1 shows how the Empire grouped provinces into regions. The instructions to factory managers and enumerators stated that, for the purpose of this census, a "factory" was to be included if the establishment had fifteen or more employees or, if the establishment did not have at least fifteen employees, if the establishment had factory tools.[5] "Factory tools" did not necessarily mean large machines; there are many factories with fewer than fifteen employees and no listed machines in the census volume. Because the census only covered industrial factories, mines, farms, and oil refineries were excluded.

[5]RGIA F. 20 O. 12 D. 164 L.90: "Ведомости должны быть составлены обо всех промышленных заведениях, имеющих не менее пятнадцать рабочих, а также и о тех, которые, при числе рабочих менее 15, имеют паровой котел, паровую машину или другие механические двигатели и машины или заводские и фабричные устройства."

The 1900 census volumes describe factories in the sixty-eight provinces of European Russia (See Table 5.2) and only covers factories which fell under the administration of the Ministry of Finance's Department of Trade and Industry, the predecessor of the Ministry of Trade and Industry, which excludes farms, mines, oil refineries, and factories subject to the excise tax. The excise tax was levied on factories in certain industries, mostly alcoholic beverages.[6] The definition of a "factory" employed by the enumerators of the 1900 census was similar to that from the 1894 census: factories with fewer than 15 workers that did not use mechanical motors or had a general "handicraft character" ("ремесленный характер") were excluded.[7]

Like the 1894 census, the 1908 census volumes describe factories from all manufacturing industries in the entire Russian Empire (See Table 5.3). Thus, unlike the 1900 census, the 1908 census describes factories subject to the excise tax, oil refineries, and smelting as well as factories in Siberia and the Caucasus. In fact, the census volumes include data on factories collected by the Ministry of Trade and Industry, the Mining Department, and the Revenue Department. Like the 1894 and 1900 volumes, however, the census excludes small handicraft and agricultural enterprises.

Because of the limits in the coverage of each of these census years, the database should not be thought of as a snapshot of all non-agricultural activity in the Russian Empire around the turn of the century. Rather, the database describes industrial factories, which ranged in size from very small enterprises to large complexes. Certainly, however, a large amount of production of the same kinds of goods produced by these factories were produced by very small artisan shops that were excluded from the data. It would be inappropriate, for example, to use this data to quantify the

[6]Table 6 shows counts of the number of factories subject to the excise tax, and hence exempted from the 1900 census, by industry.

[7]1900 Statitischeskiie Svedeniia, Page I-II: "...не признанных фабриками, обыкновенно включались заведения: имещие менее 15 человек рабочих (ручные), не употреблявщие механических двигателей, носившие явно выраженный цеховой "ремесленный характер" (булочные, белошвенные, сапожные, портняжные, мастерские, и т.д.), или характер мелких сельскохозяйственных и кустарных заведений."

absolute magnitude of all production of some good or the number of factory workers in the Russian Empire.

5.2.2 Size

The 1894, 1900, and 1908 Russian factory censuses, while differing in coverage, all describe an impressive number of manufacturing establishments. The 1894 census describes about 17,000 factories, the 1900 factory census describes approximately thirteen thousand factories, and the 1908 census describes about twenty thousand factories. Table 5.4 summarizes this information and also points out that the workers described by these censuses represent a very small percentage of the population of the Russian Empire. This is both because the coverage of the censuses was limited and because the industrial sector represented a small portion of the overall Russian economy.

Table 5.5 compares the overlapping areas of coverage for all three years, an "apples to apples" comparison, which shows more clearly how the number of factories captured by the census changed over time. The table includes only those regions in the 1894 census which also appeared in the 1900 census, and it includes only those regions and industries in the 1908 census which also appeared in the 1900 census.[8] In these regions and industries, the 1908 census describes 13,321 factories; the number of factories in European Russia captured by the census increased between 1900 and 1908, though only slightly.

The 1900 factory census excluded factories subject to the Imperial excise tax. Table 5.6 shows the industry and number of those factories subject to the excise tax. The largest categories are those involving the production of alcoholic beverages.

[8]It is not possible to exclude factories subject to the excise tax for the 1894 volume, because that would require entering data for every factory in the 1894 volume.

5.2.3 Variables Listed in Each Volume

In this section, I explain the variables provided by the published and archival material for each year of the factory census. A summary of the variables available by year appears in Table 5.7.

The 1894 factory census questionnaire asked factories thirty-five questions that covered factory revenue, expenses, and practices. Factories reported their name and location, a complete list of products in physical and ruble units, a complete list of materials in physical and ruble units, a complete list of fuels in physical and ruble units, detailed information on all machines, a table of the number of workers by age and gender employed each month of the year (Easter 1894 to Easter 1895), working hours and wages for workers by position,[9] the nationality and education of factory foremen, and many other variables. The Russian State Historical Archive holds about 1,500 original completed factory questionnaires; it appears that the archivists chose to keep the questionnaires from all factories within only certain provinces and industries.[10]

The Russian Ministry of Finance also published a factory-level volume for 1894 that includes much of the information contained in the original questionnaires. 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.

[9]It does not list the number of workers by profession, unfortunately.

[10]These questionnaires for 1894 are located in RGIA F. 20 O. 12. I have collected the total value of materials and daily working hours for almost all of these factories, and this information is available upon request. 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 since there were official publications of factory-level information, though the original surveys would have provided much more detailed information about each factory.

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.

The 1900 and 1908 aggregate volumes list almost fifty variables for province-industry groups of factories. The volumes list total revenue, number of workers by age and gender, total value of fuels, number and power of machines, and expenditures such as the the total value of materials, total wage bill, taxes, insurance, and machine maintenance.

5.2.4 Definition of an Establishment

One important issue to consider is the definition of an establishment in the 1894, 1900, and 1908 data. This is especially relevant for projects that study the boundaries of the factory and firm. From studying examples of firms with multiple listed factories, I conclude that the enumerators listed two factories owned by the same firm separately if there was a significant difference between the establishments, for example they were located in different parts of the city or performed different parts of the production process in each establishment. Unfortunately, the introductions to these census volumes do not provide any clues about a systematic rule used by the enumerators to decide the boundaries of a factory. In this section I will discuss examples from the 1894 and 1900 volumes (the 1908 volume is very similar to the 1900 volume). I will show mostly examples from the cotton, an industry in which vertical and horizontal integration were common.

First, factories with similar names have different listings when two factories' owners share the same last name but not first names, often because they are descendants of the same entrepreneur. Figures 5.2 and 5.3 show examples of such cases. In 1894, Petr Pavlovich Il'in and Mikhail Pavlovich Il'in both owned cotton weaving factories in Vladimir province (Figure 5.2). The locations of the factories are similar (the city of Kovrov on Ivanovskaia Street), but the factories have district and different entries in the volume: they have different number of workers, revenue, etc. Figure 5.6 shows the entries in the 1900 volume for the Egor Ivanovich Sirotkin and Ivan Ivanovich Sirotkin cotton textile-dyeing factories in Kaluzhskaia province. These factories have similar locations and activities but different founding dates and distinct numbers of workers and amounts of revenue.

Another reason for two factories to have the same firm name is if they are located close to one another but have different activities. Since there are many listings for factories that have many activities, it is reasonable to assume that these factories that are listed separately are in distinct buildings, which is why they are listed separately. Figures 5.4, 5.5 and 5.6 show examples of such factories. Alexandra Karetnikova owned two factories in very similar locations in Vladimir Province in 1894 (Figure 5.4). The two factories engaged in different activities: the first engaged in spinning, weaving, and general cloth-production activities while the second mainly dyed and bleached fabric. Figures 5.5 and 5.6 show a similar examples from the 1900 volume: the Zimini company in Moskovskaia province owned two factories, one of which weaved and the other of which dyed; and the Smirnov company in Vladimirskaia province owned a spinning factory and a weaving factory, located close to one another.

Figure 5.7 shows a more common case. The Einem candy company owned two factories, which had two distinct activities and were located in slightly different places within the city of Moscow. The first factory, a bakery, was located in the Tver section of Moscow while the second factory, a chocolate maker, was located in the Yakiman

section of Moscow. It seems clear in this case that these are two distinct factories located in different places, though owned by the same firm.

5.3 Construction of the Factory-Level Data: Collection, Matching, and Optional Stratified Sample

The previous sections described the population of factories in each year of the factory census and the variables available in each volume. The database includes information on all individual factories described by the data, and I have matched factories across sample years to form an unbalanced panel. Though the database includes information on all factories described by the censuses, I also composed a large, stratified sample of factories in each year for researchers who would rather use a random subset of the population. This section describes the construction of the factory-level data, the procedures for matching factories across years, and the construction of the stratified sub-sample.

5.3.1 Collecting the Factory-Level Data

The database contains an entry for every factory listed in each of the factory-level volumes. I first entered the names of all factories listed in each volume, coding their Province location and their industry as listed in the volume. Then, I composed column headings for all possible variables (and their variations) provided by the census volumes. Finally, I coded all information listed for each factory.

Certain factories' entries are missing information for one or more variables. In these cases, I had to decide whether to code the missing information as a blank entry or as a zero. In the 1894 data, almost all variables are coded as missing if information was not provided, except for variables describing machines, fuels, and

types of workers, since we can reasonably assume that those factories simply had none. When factories had no revenue or no workers at all, the census volume literally writes zero, so when such information is not reported, it is truly missing. I apply similar reasoning to the 1900 and 1908 volumes.

Figure 5.1 shows a map of the Russian Empire with darker shader for provinces that contained more factories. Moscow Province, Petersburg Province, and several Polish provinces contain many factories, while the northeast regions of the Empire were less industrialized.

5.3.2 Matching Factories Across Years

The database contains identifiers that match factories across time. Every factory in the 1894 factory list is matched to factories in the 1900 factory list, and factories in the 1900 stratified sample are matched forward to the 1908 factory list.[11]

A factory is a definite match to another factory if it has the same name, is located in the same place, has the same founding date, and produces the same product. When any of these matching criteria is not satisfied, I code the difference as a dummy variable in the data (see the next section and Table 5.21 for a full list of these matching criteria). For example, suppose I find a cotton weaving factory with the same name and location in both 1894 and 1900, but in 1900, the factory also produces dye. In this case, I would code the two factories as match but also put a 1 in the "Changed Specialty" column.

Table 5.21 Panel A shows the numbers of factories that can be matched from one year to another. In 1894, 7,400 factories in the population can be matched forward to the population factories in 1900. 3,363 of the factories observed in 1894 can be matched forward to both 1900 and 1908. In 1908, 6,930 factories can be matched

[11]In other words, future researchers wishing to fill in the gaps in the data must match the additional factories in 1900 forward to 1908, but the matching for 1894 to 1900 is already done.

back to the sample of factories in 1900. 3,438 of the factories in 1908 can be matched all the way back to 1894. Of the 15,637 factories that appear in the 1900 data, 3,271 have data in 1894 and 1908 as well. There is no way to know whether unmatched factories that cannot be matched because they were not yet founded or did not survive or whether they cannot be matched because they census simply missed them in a given year.

Table 5.21 Panel B shows the number of factories matched from 1894 forward to 1900 and from 1908 back to 1900 by degree of matching certainty. A "rough match" allows for added or subtracted partners, name changes, successors, added or subtracted establishments, mergers, offshoots, and any other changes. A "less certain match" allows for location changes, differences in founding date, and changes in specialization. A "certain match" allows for no changes. As I apply stricter matching criteria, the number of matches falls, though more quickly for matches between 1894 and 1900 than between 1900 and 1908. This is perhaps because the 1900 and 1908 volumes were constructed by the same authorities using most of the same procedures.

In Section 5.5, I discuss descriptive statistics and regressions using the factory-level and aggregate data. In Section 5.5.2 I compare matched factories to other factories in each year's cross section and also compare factories by matching criteria.

5.3.3 Stratification by Region/Industry Groups

The database includes variables describing a stratified sub-sample of the factory-level data. Stratification allows the researcher to have a great deal of control over standard errors and the representativeness of the sample by sampling from mutually exclusive subsets of the population, which we call strata.[12] The primary requirement

[12]See Kish (1965), Chapter 3, for a full description of stratified samples.

for constructing a stratified sample is that each individual (in our case, each factory) must belong to exactly one stratum. The strata I will use are industry-region groups. Each factory in each factory list belongs to exactly one industry chapter and exactly one province (and hence exactly one region). Furthermore, the 1900 and 1908 aggregate volumes suggests groupings for provinces into regions (and from which we can infer a grouping for 1894). See Tables 5.1 through 5.3 for lists of provinces grouped by region.

The sample over-samples factories in the Central Industrial and Prebaltic provinces but otherwise maintains the proportions of factories in each region and industry found in the population. This accomplishes two goals: first, to compose a representative sample of the industrial sector of the Russian Empire and second, to capture relatively rare corporation-owned factories, which tend to be located in Moscow and St. Petersburg. Corporations are often the biggest, best-performing factories in the Russian Empire and therefore may be of interest to other researchers.

The samples from the 1894, 1900, and 1908 factory lists were composed using the following steps:

1. Count the number of factories in each industry-region cell.

2. Calculate what proportion of the total number of factories are represented by this cell.

3. For a sample of size n, calculate the number of factories in cell i that will be sampled. The target sample size for each year was 5,000 factories.

4. Calculate the proportion of the factories in each cell that will be part of the sample. Increase the proportion of factories sampled from the Central Industrial and Prebaltic Regions. I doubled these proportions. In some cases, it was

not possible to double the proportion, since there were not enough observations in the population; in these cases, I sampled every factory in that cell.

5. Recalculate using these new proportions the number of factories in each cell i that will be sampled for a sample size of n. If that number is smaller than 2, sample 2 factories. If there are fewer than 2 total factories in that cell, sample the 1 factory in that cell.

6. Recalculate the sample size and save the number of factories to be sampled in each region - industry cell.

7. Collect a random sample of n_j factories from each cell j. I used numbers generated from a uniform distribution in Matlab. Selecting every kth factory might have led to some bias, since sometimes the names of factories indicate some characteristic of the factory, for example location or enterprise form.

Because the resulting sample does not maintain the same proportions of factories in regions and industries as appears in the population, sampling weights should be used when calculating statistics using the factory-level data. The usual suggested procedure is to use post-stratification weights,[13] which take into account the proportion of the population represented by each stratum as well as over- and under-sampling within strata. For observation i in stratum j, the formula for post-stratification weights is:

$$W_{ij} = \frac{N_j/N}{n_j/n} \qquad [1]$$

Here, N_j is the proportion of the population in stratum j, N is the total population size, n_j is the proportion of the sample in stratum j, and n is the total sample

[13]See, for example, the Stata manual entry on post-stratification, which can be found at http://www.stata.com/manuals13/svypoststratification.pdf, or a similar explanation for SAS at http://www.atlas.illinois.edu/support/stats/resources/spss/create-post-stratification-weights-for-survery-analysis.pdf.

size. For example, suppose that I sample a total of 5,030 observations from a population of 17,000. Within a certain stratum, there are 200 observations, and from those, I sample 50. Then, for observations in this stratum, the weight is:

$$W_{ij} = \frac{200/17000}{50/5030} = 1.1835 \quad [2]$$

Number of factories in the sample, by region and industry, are reported in Table 5.11, 5.13, and 5.15 and post-stratification weights are reported in Tables 5.12, 5.14, and 5.16. Table 5.17 shows the resulting sample sizes and numbers of corporations and corporation-owned factories in the sample. The sample size in each year is about 5,000.

Corporation-owned factories are identified by matching factory names, industries, and locations to the corporations in the RUSCORP database (Owen 1992), a dataset describing all corporations founded in the Russian Empire. I have identified all the factories in the population that belong to corporations, not just the factories in the sample, which allows me to validate that the sample has managed to capture a greater proportion of corporations. Tables 5.18, 5.19, and 5.20 show the number of factories and number of corporation-owned factories in the population and sample for each year. In almost every case, the percentage of corporation-owned factories is higher in the sample than in the population; over-sampling the Central Industrial and Prebaltic regions has indeed captured more corporations. Industries in which the proportion of corporation-owned factories is higher in the population than in the sample tend to have very few corporations in the population (see, for example, the Animal Products industry).

5.4 Data Files, Organization, and Variable Definitions

This section presents a description of the data as it appears in excel and Stata files. Since the Stata file (File F) is a redacted version of files C, D, and E, this description will focus on the Files A through E. The content of this section relies heavily on Tables 5.22 through 5.39, which list descriptions of the data files and all variables contained in each data file.

This dataset consists of both factory-level and aggregate data (See Table 5.22). Files A and B are Microsoft Excel spreadsheet data files that contain the aggregate data for 1900 and 1908, respectively. Files C, D, and E are Microsoft Excel files that contain the factory-level data for 1894, 1900, and 1908, respectively. These files have some information, for example factory names, industries and regions, so that other researchers could fill in additional factory information at low cost if desired. Finally, File F is a Stata format (.dta) file that only contains observations for which data has been entered. In other words, it contains the stratified samples from 1894, 1900, and 1908 and additional matched factories from 1908.

Each of the data files contains many fields, including information from the factory volumes and matching criteria. Full descriptions of each of these variables are listed in Tables 5.23 through 5.29, and Tables 5.30 through 5.39 define any codes and abbreviations used in the data files. The file with the most variables in the 1894 factory-level file (File C), since this volume is incredibly detailed and since these factories are matched forward to 1900.

5.5 Descriptive Statistics and Regressions

In the previous sections, I described the construction of the database. This section presents some descriptive statistics and regressions obtained using the factory-level and aggregate data files. I argue that the weighted factory-level sample closely resembles statistics for the population of factories. I also present characteristics of matched and unmatched factories: factories that can be matched across years tend to be bigger in terms of revenue, workers, and power and slightly more productive in terms of revenue per workers. Matched factories do not seem to differ according to matching criteria. Finally, when estimating production functions, there is a tradeoff between using aggregate data and factory-level data: the aggregate data has additional, possibly important variables, but the factory-level regressions have lower standard errors, have higher R-squared values, and allow for additional controls thanks to a large sample size.

5.5.1 Matching Moments

In this section, I compare weighted and unweighted statistics from the 1894 factory-level population and stratified sample, and I compare the population and weighted and unweighted statistics from 1900 and 1908 to each other and to values from the aggregate volumes. The weighted statistics closely approximate the population values in 1894, 1900, 1908, and the population and weighted values closely resemble the values from the 1900 and 1908 aggregate volumes.

Table 5.40 shows the poulation and unweighted and weighted sample means for the 1894 factory-level data (there is no aggregate volume). Applying post-stratification weights decreases the means for revenue, total workers, and machine power. This is expected, since the factory-level data oversampled the regions containing Moscow and St. Petersburg, which tend to have larger factories, a result I

confirm in Table 5.43, explained below. Applying weights increases the means for revenue per worker and machine power per worker, however, perhaps because the weights have a proportionately larger effect on number of workers than on revenue or machine power. The weighted values are very similar to those reported for the population.

The weighted and unweighted sample means and aggregate measures for 1900 are reported in Table 5.41. The results are in general as shown in the previous table, though we can compare the factory-level measures to the aggregate measures. With weights, the measures for revenue and workers per establishment are remarkably close to their counterparts in the population and the aggregate volume; the weights compensate for the oversampling of the Central Industrial and Prebaltic regions. However, the weights actually raise revenue per worker farther away from the aggregate numbers, which one should keep in mind when using this variable. Table 5.42 shows the same results for 1908, and the results are similar.

Table 5.43 shows mean revenue per establishment, workers per establishment, power per establishment, revenue per worker, and power per worker for the Central Industrial and Prebaltic Regions using the 1900 and 1908 aggregate data. As argued above, average revenue per establishment, workers per establishment, and machine power per establishment are higher in these regions than in the rest of European Russia (shown in Tables 5.41 and 5.42).

5.5.2 Matching Criteria and Comparisons of Matched to Unmatched Factories

Figure 5.8 shows how factories that can be matched across years differ from factories that can only appear in one year. Since a factory must survive in order to be observed by the census enumerators, we expect matched factories to have

may of the characteristics of factories that survive, though the differences may be a bit diluted since some factories cannot be matched because enumerators missed them. Thus, we expect matched factories to be bigger and more productive. Figure 7 shows this to be somewhat true: there is very little difference between factories that can only be matched across two period, though matched factories are slightly larger. Factories that survive three periods have more obvious differences: they have higher revenue, more workers, more machine power, and appear to have slightly more revenue per worker in 1894 and 1900, but this difference is hard to observe in 1908.

Figure 5.9 shows that the distributions of key variables are essentially identical for each degree of matching. This is encouraging for researchers who would like to use the largest possible sample of matches without worrying about matching criteria, though the matching criteria are available just in case.

5.5.3 Aggregate and Factory-Level Production Functions

A natural application of this data is the estimation of production functions for various industries or other subsets of factories in the Russian Empire. Table 5.44 shows how production functions estimated using the factory-level and aggregate data differ.

The production functions estimated in this section are log Cobb-Douglas, where r_{ijt} is log revenue, l_{ijt} is log total number of workers, and ϵ_{ijt} is the error term for factory i in industry j and year t. They have the general form

$$r_{ijt} = \alpha + \beta_l l_{ijt} + \epsilon_{ijt} \qquad [3]$$

or, when a capital measure (log total machine power, k_{ijt}) is available or materials materials (log total value of materials, m_{ijt}) is available,

$$r_{ijt} = \alpha + \beta_l l_{ijt} + \beta_k k_{ijt} + \beta_M m_{ijt} + \epsilon_{ijt} \qquad [4]$$

Table 5.44 presents estimates of Equations 3 and 4 using factory-level and aggregate data for 1900 and 1908 (the years that have aggregate volumes). In the aggregate production functions, the unit of observation is the province-subindustry cell. Columns 1 and 2 present estimates of Equation 3 using the 1900 factory-level and aggregate data. The estimate of the labor coefficient for the aggregate data is remarkably close to that for the factory-level data, but the standard error for the factory-level is smaller, as we should expect, since there are many more observations in the factory-level data. There is no capital measure in the 1900 factory-level volume, but the aggregate volume has both a measure of capital and of total materials. Introducing these variables into the aggregate regressions greatly reduces the coefficient on labor; the materials coefficient in Column 3 is especially large, and the capital coefficient is very small.

Columns 4 through 8 of Table 5.44 present regressions of factory-level and aggregate productions functions for 1908. Columns 4 and 5 present estimates of Equation 3. The coefficient on labor in Column 4 is very close to the magnitude of the coefficient in Column 5, which shows the same regression estimated on aggregate data. The factory-level volume for 1908 contains a capital measure (total machine power), so log total machine power is introduced into the regression in Column 6. The coefficients on labor and capital in Column 6 show some differences compared to those in Column 7, which uses aggregate data: the capital coefficient is much larger when measured using factory-level data, perhaps because there is much greater variation in machine power use at the factory level. Again, the additional of a measure of materials has a large impact on the coefficients on labor and capital (Column 8). Thus, when performing any kind of analysis using the factory-level data, it is important to keep in mind that an important input, materials, is not observed.

5.6 Conclusion

This document has described the formation of a database of manufacturing establishments in the Russian Empire based on manufacturing censuses conducted in 1894, 1900, and 1908, including a description of the sampling scheme and all variables. These files, used together or separately, allow for detailed study of industrial enterprises in the Russian Empire at the end of the nineteenth and beginning of the twentieth century.

Tables

Table 5.1: Provinces Grouped by Region, 1894

Northern	**Central Blacksoil**	**Southern**	**Caucasus**
Arkhangelskaia	Voronezhskaia	Astrakhanskaia	Bakinskaia
Vologodskaia	Kurskaia	Bessarabia	*Batumskaia*
Novgorodskaia	Orlovskaia	*Dagestanskaia*	Elizavetpolskaia
Olonetskaia	Penzenskaia	Donskaia Ob.	Zakatalskaia
Pskovskaia	Poltavskaia	Ekaterinoslavskaia	*Karsskaia*
	Riazan	Kubanskaia Oblast	*Sukhumskaia*
Eastern	Saratov	Tavricheskaia	Tiflis
Viatskaia	Simbirskaia	*Terskaia*	Kutaiiskaia
Kazan	Tambovskaia	Khersonskaia	Erivanskaia
Orenburgskaia	Tula	*Stavropolskaia*	Chernomorskaia
Perm	Kharkovskaia		
Samarskaia	Chernigovskaia	**Previslitskii**	***Western Siberia***
Uralskaia Ob.		Warsaw	*Akmolinskaia*
Ufa	**Northwestern**	Kalishskaia	*Semipalatinskaia*
	Vilenskaia	Keletskaia	*Tobolskaia*
Prebaltic	Vitebskaia	Liublinskaia	*Tomskaia*
Kurlandskaia	Grodnenskaia	Lomzhinskaia	*Turgaiskaia*
Lifliandskaia	Kovenskaia	Petrokovskaia	
St. Petersburg	Minsk	Plotskaia	***Eastern Siberia***
Estlandskaia	Mogilevskaia	Radomskaia	*Amurskaia*
		Suvalskaia	*Eniseiskaia*
Central Industrial	**Southwestern**	Sedletskaia	*Zabaikalskaia*
Vladimir	Volinskaia		*Irkutskaia*
Kaluzhskaia	Kiev	***Turkestan***	*Primorskaia*
Kostromskaia	Podolskaia	*Zakaspiiskaia*	*Yakutskaia*
Moscow		*Samarkandskaia*	
Nizhny Novgorod		*Semirechenskaia*	
Smolensk		*Syr-Darinskaia*	
Tver		*Ferganskaia*	
Yaroslavl			

Provinces in italics do not appear in 1900. Chernomorskaia is considered part of the Caucasus in 1894 since it is part of the Caucasus in 1900. There are no factories in: Zakatalskaia, Chernomorskaia, Batumskaia, Zabaikalskaia, Tomskaia, Akmolinskaia, Zakaspiiskaia, Karskaia, Primorskaia, Yakutskaia.

Table 5.2: Provinces Grouped by Region, 1900

Table 2: Provinces Grouped by Region, 1900

Northern	**Central Blacksoil**	**Southern**
Arkhangelskaia	Voronezhskaia	Astrakhanskaia
Vologodskaia	Kurskaia	Bessarabia
Novgorodskaia	Orlovskaia	Ekaterinoslavskaia
Olonetskaia	Penzenskaia	Donskaia Oblast
Pskovskaia	Riazanskaia	Kubanskaia Oblast
	Saratovskaia	Tavricheskaia
Eastern	Simbirskaia	Khersonskaia
Viatskaia	Tambovskaia	
Kazanskaia	Tulskaia	**Previslitskii**
Orenburgskaia	Chernigovskaia	Varshavskaia
Permskaia	Poltavskaia	Kalishskaia
Samarskaia	Kharkovskaia	Keletskaia
Ufimskaia		Liublinskaia
	Northwestern	Lomzhinskaia
Prebaltic	Vilenskaia	Petrokovskaia
Lifliandskaia	Vitebskaia	Plotskaia
Kurlandskaia	Grodnenskaia	Radomskaia
Peterburgskaia	Kovenskaia	Suvalskaia
Estlandskaia	Minskaia	Sedletskaia
	Mogilevskaia	
Central Industrial		**Caucasus**
Vladimirskaia	**Southwestern**	Chernomorskaia
Kaluzhskaia	Volinskaia	Bakinskaia
Kostromskaia	Kievskaia	Elizavetpolskaia
Moskovskaia	Podolskaia	Zakatalskaia
Nizhegorodskaia		Tiflisskaia
Smolenskaia		Kutaiiskaia
Tverskaia		Erivanskaia
Yaroslavskaia		

Table 5.3: Provinces Grouped by Region, 1908

Northern	**Central Blacksoil**	**Southern**	**Caucasus**
Arkhangelskaia	Voronezhskaia	Astrakhanskaia	Bakinskaia
Vologodskaia	Kurskaia	Bessarabia	*Batumskaia*
Novgorodskaia	Orlovskaia	*Dagestanskaia*	Elizavetpolskaia
Olonetskaia	Penzenskaia	Donskaia Ob.	Zakatalskaia
Pskovskaia	Poltavskaia	Ekaterinoslavskaia	*Karsskaia*
	Riazanskaia	Kubanskaia Oblast	*Sukhumskaia*
Eastern	Saratovskaia	Tavricheskaia	Tiflisskaia
Viatskaia	Simbirskaia	*Terskaia*	Kutaiiskaia
Kazanskaia	Tambovskaia	Khersonskaia	Erivanskaia
Orenburgskaia	Tulskaia	*Chernomorskaia (*)*	
Permskaia	Kharkovskaia	*Stavropolskaia*	***Western Siberia***
Samarskaia	Chernigovskaia		*Akmolinskaia*
Uralskaia Ob.		**Previslitskii**	*Semipalatinskaia*
Ufimskaia	**Northwestern**	Varshavskaia	*Tobolskaia*
	Vilenskaia	Kalishskaia	*Tomskaia*
Prebaltic	Vitebskaia	Keletskaia	*Turgaiskaia*
Kurlandskaia	Grodnenskaia	Liublinskaia	
Liflandskaia	Kovenskaia	Lomzhinskaia	***Eastern Siberia***
Peterburgskaia	Minskaia	Petrokovskaia	*Amurskaia*
Estlandskaia	Mogilevskaia	Plotskaia	*Eniseiskaia*
		Radomskaia	*Zabaikalskaia*
Central Industrial	**Southwestern**	Suvalskaia	*Irkutskaia*
Vladimirskaia	Volinskaia	Sedletskaia	*Primorskaia*
Kaluzhskaia	Kievskaia		*Yakutskaia*
Kostromskaia	Podolskaia	***Turkestan***	
Moscovskaia		*Zakaspiiskaia*	
Nizhegorodskaia		*Samarkandskaia*	
Smolenskaia		*Semirechenskaia*	
Tverskaia		*Syr-Darinskaia*	
Yaroslavskaia		*Ferganskaia*	

Provinces in italics did not appear in 1900. Chernomorskaia is starred because it was considered part of the Caucasus in 1900.

Table 5.4: Factories and Workers Described by Each Census

Census Year	Total Number of Factories Surveyed	Number of Workers Described	Population of the Russian Empire (Millions)
1894	17,534	1,083,075	123.9
1900	12,707	1,343,279	132.9
1908	20,010	2,254,503	155.4

Sources: Statisticheskie svedenii po obrabativaiuschei fabrichno-zavodskoi promyshlennosti Rossiiskoi Imperii za 1908 g. [Statistical Summary of Industrial Factories in the Russian Empire in 1908]; Arcadius Kahan, Russian Economic History: The Nineteenth Century 69; Ezhegodnik Rossii 1908 g. [Yearbook of Russia, 1908] 54. The population number for 1894 is really that for 1895 from Kahan's table.

Table 5.5: Workers and Factories in Each Year, 1900 Basis (Apples to Apples)

Census Year	Total Number of Factories Surveyed	Number of Workers Described	Population of the Russian Empire (Millions)
1894	17,534	1,083,075	123.9
1900	12,707	1,343,279	132.9
1908	20,010	2,254,503	155.4

Sources: Statisticheskie svedenii po obrabamivaiuschei fabrichno-zavodskoi promyshlennosti Rossiiskoi Imperii za 1908 g. [Statistical Summary of Industrial Factories in the Russian Empire in 1908]; Arcadius Kahan, Russian Economic History: The Nineteenth Century 69; Ezhegodnik Rossii 1908 g. [Yearbook of Russia, 1908] 54. The population number for 1894 is really that for 1895 from Kahan's table.

Table 5.6: Factories Subject to the Excise Tax, 1900

Industry	Number of Plants
Distilling	2,111
Yeast-Based Distilling	75
Wineries	2,645
Fortified Spirits	88
Beer and Mead	1,234
Oil and Gas	156
Sugar	268
Refineries	23
Tobacco	248
Matches	123

Source: 1900 Statistical Summary, which cites Statistics of Production in Industries Subject to the Excise Tax, 1900.

Table 5.7: Variables by Year

Year	Enterprise-Level	Province and Industry-Level
1894	Revenue, Total Workers, Product Description, Workforce Composition, Fuels, Machines *Manuscripts: Materials, Hours*	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 5.8: Number of Factories by Cell (Population), 1894

Region	Animal Products (Number, Power)	Chemicals (Number, Power)	Cotton	Flax, Hemp, and Jute	Foods and Flavorings A	Metals and Machines	Mineral Products	Mixed Materials	Paper	Silk	Wood	Wool
Caucasus	12	74	1	0	89	28	28	0	25	52	26	2
Central Blacksoil	326	132	40	129	1,827	205	199	24	85	0	75	68
Central Industrial	495	167	427	168	706	368	283	200	175	202	220	255
Eastern	294	67	5	20	509	94	48	36	64	0	71	39
Northern	36	18	0	12	102	15	34	0	17	0	53	1
Northwestern	121	51	2	16	907	29	63	8	66	3	51	232
Prebaltic	87	91	39	13	757	260	181	54	179	4	207	111
Previslitskii	128	50	75	5	778	230	160	93	104	6	144	309
Southern	91	49	16	2	836	200	176	3	80	0	86	12
Southwestern	59	22	0	0	685	65	83	3	46	0	60	49
Totals	1,649	721	605	365	7,196	1,494	1,255	421	841	267	993	1,078

Table 5.9: Number of Factories by Cell (Population), 1900

Region	Animal Products (Number, Power)	Chemicals (Number, Power)	Cotton	Flax, Hemp, and Jute	Foods and Flavorings A	Metals and Machines	Mineral Products	Mixed Materials	Paper	Silk	Wood	Wool
Caucasus	27	77	2	0	33	42	49	3	34	68	29	2
Central Blacksoil	149	54	89	151	717	288	200	6	136	0	184	67
Central Industrial	407	131	431	178	263	419	320	112	190	209	317	210
Eastern	171	31	4	19	200	106	88	2	51	0	106	31
Northern	49	16	0	12	35	19	61	1	30	0	93	264
Northwestern	174	28	2	18	214	59	134	31	118	7	127	177
Prebaltic	46	78	37	19	98	256	194	40	187	5	152	19
Previslitskii	141	63	154	8	231	293	259	115	140	19	213	66
Southern	64	38	12	9	540	262	196	27	119	0	128	12
Southwestern	26	14	0	0	169	60	89	2	67	0	77	31
Totals	1,254	530	731	414	2,500	1,804	1,590	339	1,072	308	1,426	879

Table 5.10: Number of Factories by Cell (Population), 1908

Region	Animal Products (Number, Power)	Chemicals (Number, Power)	Cotton	Flax, Hemp, and Jute	Foods and Flavorings A	Metals and Machines	Mineral Products	Mixed Materials	Paper	Silk	Wood	Wool
Caucasus	13	11	19	0	28	115	29	0	43	97	25	1
Central Blacksoil	95	57	49	88	717	266	174	9	143	0	252	55
Central Industrial	194	96	416	104	230	372	247	111	223	148	303	224
Eastern	183	42	39	17	281	122	105	7	72	0	136	25
Northern	36	15	0	13	20	24	55	0	29	0	116	0
Northwestern	192	24	4	23	181	74	114	10	100	7	190	201
Prebaltic	56	88	36	17	142	308	183	49	311	3	236	40
Previslitskii	130	67	203	11	247	345	280	167	163	21	267	425
Southern	58	42	16	3	593	316	196	24	158	0	159	13
Southwestern	25	20	0	0	230	93	97	3	58	0	146	32
Totals	982	462	782	276	2,669	2,035	1,480	380	1,300	276	1,830	1,016

Table 5.11: Number of Factories Sampled by Cell, 1894

Region	Animal Products (Number, Power)	Chemicals (Number, Power)	Cotton	Flax, Hemp, and Jute	Foods and Flavorings A	Metals and Machines	Mineral Products	Mixed Materials	Paper	Silk	Wood	Wool
Caucasus	4	3	1	0	7	9	10	0	7	13	6	2
Central Blacksoil	30	6	18	30	139	58	39	2	28	0	37	12
Central Industrial	317	76	336	132	193	331	251	88	156	165	220	183
Eastern	34	3	2	4	40	22	18	2	13	0	21	8
Northern	10	2	0	3	7	10	12	0	6	0	21	0
Northwestern	35	4	2	4	42	13	27	5	24	2	25	35
Prebaltic	29	55	33	13	77	201	152	33	146	4	120	16
Previslitskii	30	12	31	2	45	55	52	23	26	4	42	65
Southern	15	7	2	2	106	54	39	3	24	0	26	3
Southwestern	6	2	0	0	34	13	18	2	11	0	16	8
Totals	510	170	425	190	690	766	618	158	421	188	534	332

Table 5.12: Post-Stratification Weights, 1894

Region	Animal Products (Number, Power)	Chemicals (Number, Power)	Cotton	Flax, Hemp, and Jute	Foods and Flavorings A	Metals and Machines	Mineral Products	Mixed Materials	Paper	Silk	Wood	Wool
Caucasus	.86	7.06	.29	3.64	3.64	.89	.80	N/A	1.02	1.15	1.24	.29
Central Blacksoil	3.11	6.30	.64	1.23	3.76	1.01	1.46	3.44	.87	N/A	.58	1.62
Central Industrial	.45	.63	.36	.36	1.04	.32	.32	.65	.32	.35	.29	.40
Eastern	2.48	6.49	.72	1.43	3.68	1.22	.76	5.15	1.41	N/A	.97	1.40
Northern	1.03	2.58	N/A	1.15	4.17	.43	.81	N/A	.81	N/A	.77	N/A
Northwestern	.99	3.65	.29	1.15	6.18	.64	.67	.46	.79	.43	.58	1.90
Prebaltic	.86	.47	.34	.29	2.81	.37	.34	.47	.35	.29	.49	1.99
Previslitskii	1.22	1.19	.69	.72	4.95	1.20	.88	1.16	1.15	.43	.98	1.36
Southern	2.04	2.05	2.43	.29	2.56	1.08	1.36	.29	.97	N/A	.97	1.15
Southwestern	2.82	3.15	N/A	N/A	5.77	1.43	1.32	.43	1.20	N/A	1.07	1.75

Table 5.13: Number of Factories Sampled by Cell, 1900

Region	Animal Products (Number, Power)	Chemicals (Number, Power)	Cotton	Flax, Hemp, and Jute	Foods and Flavorings A	Metals and Machines	Mineral Products	Mixed Materials	Paper	Silk	Wood	Wool
Caucasus	4	3	2	0	7	9	10	2	7	13	6	2
Central Blacksoil	30	6	18	30	141	53	39	2	32	0	37	12
Central Industrial	321	77	342	134	195	339	254	89	159	167	226	185
Eastern	34	3	2	4	40	25	18	2	13	0	21	8
Northern	10	2	0	3	7	10	12	1	6	0	19	0
Northwestern	35	4	2	4	42	13	27	5	23	2	25	35
Prebaltic	29	55	27	16	78	206	154	33	144	4	121	16
Previslitskii	30	12	31	2	45	54	52	23	26	4	42	65
Southern	15	7	2	2	107	54	39	6	23	0	26	3
Southwestern	6	2	0	0	34	13	18	2	10	0	16	8
Totals	514	171	427	195	696	776	623	165	443	190	539	334

Table 5.14: Post-Stratification Weights, 1900

Region	Animal Products (Number, Power)	Chemicals (Number, Power)	Cotton	Flax, Hemp, and Jute	Foods and Flavorings A	Metals and Machines	Mineral Products	Mixed Materials	Paper	Silk	Wood	Wool
Caucasus	6.50	17.33	1.00	N/A	4.57	4.67	3.20	1.50	4.14	4.69	4.83	1.00
Central Blacksoil	4.97	9.00	4.89	4.83	5.06	5.77	5.03	2.50	3.84	N/A	3.84	4.97
Central Industrial	1.27	1.70	1.26	1.31	1.34	1.23	1.26	1.24	1.12	1.25	1.40	1.14
Eastern	5.03	9.33	2.00	4.25	4.98	3.36	4.89	1.00	3.92	N/A	4.95	3.88
Northern	4.90	8.00	N/A	3.33	4.43	1.80	4.83	1.00	5.00	N/A	4.84	4.97
Northwestern	4.97	6.50	1.00	4.50	5.07	4.31	4.56	6.20	5.39	2.50	4.96	5.03
Prebaltic	1.59	1.42	1.37	1.19	1.21	1.24	1.24	1.21	1.34	1.00	1.25	1.19
Previslitskii	4.60	4.50	N/A	3.00	5.13	5.33	4.96	4.87	5.12	4.75	5.05	1.02
Southern	3.80	4.86	3.00	2.00	5.05	4.72	4.90	3.50	4.39	N/A	4.92	4.00
Southwestern	4.17	1.50	N/A	N/A	4.65	4.54	4.78	1.00	5.70	N/A	4.81	3.75

Table 5.15: Number of Factories Sampled by Cell, 1908

Region	Animal Products (Number, Power)	Chemicals (Number, Power)	Cotton	Flax, Hemp, and Jute	Foods and Flavorings A	Metals and Machines	Mineral Products	Mixed Materials	Paper	Silk	Wood	Wool
Caucasus	6	4	3	0	9	16	12	0	10	20	7	1
Central Blacksoil	41	8	23	43	225	82	51	3	39	0	55	22
Central Industrial	194	88	394	104	225	369	247	103	190	148	267	214
Eastern	55	6	11	7	67	38	28	1	23	0	34	12
Northern	15	4	0	7	20	16	18	0	9	0	32	0
Northwestern	55	7	3	9	55	21	37	6	34	4	43	52
Prebaltic	39	75	36	17	99	254	175	43	202	3	164	24
Previslitskii	48	17	54	1	65	90	81	17	41	7	66	94
Southern	23	12	3	3	163	87	62	8	39	0	44	7
Southwestern	8	3	0	0	56	23	24	3	16	0	26	13
Totals	484	224	527	191	1004	996	735	184	603	182	737	439

Table 5.16: Post-Stratification Weights, 1908

Region	Animal Products (Number, Power)	Chemicals (Number, Power)	Cotton	Flax, Hemp, and Jute	Foods and Flavorings A	Metals and Machines	Mineral Products	Mixed Materials	Paper	Silk	Wood	Wool
Caucasus	.95	1.50	3.40	N/A	1.95	6.78	1.53	N/A	2.47	3.52	2.14	.60
Central Blacksoil	1.71	4.88	1.40	.60	2.80	2.51	2.39	1.80	2.78	N/A	3.58	2.40
Central Industrial	.60	.69	.67	.60	1.06	.61	.60	.69	.78	.60	.74	.67
Eastern	2.95	5.70	7.80	2.04	3.80	3.05	3.09	N/A	2.88	NA	3.36	1.60
Northern	1.96	3.00	N/A	1.65	1.35	1.25	2.45	N/A	2.48	N/A	3.31	N/A
Northwestern	2.95	2.76	.60	2.52	2.35	2.80	2.28	.90	2.28	1.40	4.01	3.14
Prebaltic	1.03	.88	.60	.60	1.00	.84	.66	.80	1.14	.60	1.07	1.33
Previslitskii	2.27	2.95	3.40	N/A	3.02	3.38	2.95	12.94	3.45	2.04	3.23	3.38
Southern	1.91	3.15	1.20	.60	3.05	3.18	2.69	1.89	3.62	N/A	3.29	1.80
Southwestern	2.14	3.20	N/A	N/A	3.70	3.70	2.88	.60	2.90	N/A	4.83	2.07

Table 5.17: Factories and Corporate Factories by Year

Year	No. of Factories in the Database	Corporation-Owned Factories
1894	16,885	508
1900	12,855	822
1908	13,489	807

Source: Gregg Imperial Russian Manufacturing Database. Corporate enterprises are identified by matching factory names, locations, and industries to the RUSCORP Database.

Table 5.18: Number of Factories and Corporation-Owned Factories in the Sample and Population, 1894

Industry	Factories in Sample	Factories in Population	Corp.-Owned Fact. in Sample	Corp.-Owned Fact. in Population	% in Sample	% in Pop.
Animal Products	510	1788	1	9	.20	.50
Chemicals	170	733	11	45	6.47	6.14
Cotton	425	666	92	130	21.65	19.52
Flax, Hemp, Jute	190	366	12	20	6.32	5.46
Foods	690	7561	8	143	1.16	1.89
Metals and Machines	766	1514	29	26	3.79	1.72
Mineral Products	618	1274	17	26	2.75	2.04
Mixed Materials	158	421	2	4	1.27	0.95
Paper	441	851	21	31	4.76	3.64
Silk	188	269	1	1	0.53	0.37
Wood	534	1008	8	24	1.50	2.38
Wool	332	1083	16	36	4.82	3.32

Table 5.19: Number of Factories and Corporation-Owned Factories in the Sample and Population, 1900

Industry	Factories in Sample	Factories in Population	Corp.-Owned Fact. in Sample	Corp.-Owned Fact. in Population	% in Sample	% in Pop.
Animal Products	514	1254	7	23	1.36	1.83
Chemicals	171	530	27	81	15.79	15.28
Cotton	427	731	107	153	25.06	20.93
Flax, Hemp, Jute	195	414	21	34	10.77	8.21
Foods (Untaxed)	776	1805	80	171	10.31	9.47
Metals and Machines	623	1505	39	85	6.26	5.65
Mineral Products	165	341	10	17	6.06	4.99
Mixed Materials	443	1072	33	59	7.45	5.50
Paper	190	308	2	3	1.05	0.97
Silk	696	2443	27	58	3.88	2.37
Wood	539	1426	32	67	5.94	4.70
Wool	334	879	20	44	5.99	5.01

Table 5.20: Number of Factories and Corporation Owned Factories in the Sample and Population, 1908

Industry	Factories in Sample	Factories in Population	Corp.-Owned Fact. in Sample	Corp.-Owned Fact. in Population	% in Sample	% in Pop.
Animal Products	712	1426	7	18	0.98	1.26
Chemicals	281	569	40	92	14.23	16.17
Cotton	607	1134	113	162	18.62	14.29
Flax, Hemp, Jute	271	378	14	19	5.17	5.03
Foods	1115	3413	26	82	2.33	2.40
Metals and Machines	842	2086	86	169	10.21	8.10
Mineral Products	982	1858	23	39	2.34	2.10
Mixed Materials	229	452	13	18	5.68	3.98
Paper	662	1505	26	64	3.93	4.25
Silk	271	372	8	17	2.95	4.57
Wood	857	2127	16	30	1.87	1.41
Wool	502	1174	28	41	5.57	3.49

Table 5.21: Factories Matched by Year

Panel A: Total Factories Matched by Year

Year	Population Number of Factories	Number of Population Factories Matched	Factories that Appear in All Three Years (Sample)
1894	17,534	7,400 (to 1900)	3,363
1900	15,637		3,271
1908	19,597	6,930 (to 1900)	3,438

Panel B: Counts of Factories by Degree of Matching Certainty

Years Matched:	1894 to 1900	1908 to 1900
Rough Match	7,400	6,930
Less Certain Match	5,058	4,719
Certain Match	2,798	4,403

Source: Gregg Imperial Russian Manufacturing Database. This table shows the number of factories matched from 1894 forward to 1900 and from 1908 back to 1900. A "rough match" allows for added or subtracted partners, name changes, successors, added or subtracted establishments, mergers, offshoots, and any other changes. A "less certain match" allows for location changes, differences in founding date, and changes in specialization. A "certain match" allows for no changes.

Table 5.22: Data Files

File Name	Description	Format	Size
File A	1900 Aggregate Data	xlxs	801 KB
File B	1908 Aggregate Data	xlxs	690 KB
File C	1894 Micro Data	xlxs	6.1 MB
File D	1900 Micro Data	xlxs	2.2 MB
File E	1908 Micro Data	xlxs	3.2 MB
File F	Stata File with 1894, 1900, and 1908 Factory-Level Data	dta	49.4 MB

Table 5.23: Variables in the 1894 Factory-Level Data File

Field	Explanation	Units
id	Factory/Year id number	Numeral
FormRuscorp	= 1 if factory is owned by a corporation	[0,1]
PSZ*	Law number of corporation	Vol. No.- Law No.
PSZ1900*	Law number of corporation next period	Vol. No.- Law No.
Factory Name		String
Founding Year		Four Digits (Year)
1894 Obs No	Factory id in File C	
Province	Province No.; Tables 27 and 28	Code: 1-92
Region	See Table 1	String
RegNum	See Table 21	Numeral 1 - 13
SampleSelected	= 1 if the factory is sampled	[0,1]
ObsNo1900 (_ - d)	Factory id in 1900 if matched	Numerals
Matching Notes		String
Merger	Factory in 1900 is a merger of 2 +	[0,1]
Offshoot	Factory in 1900 is an offshoot	[0,1]
Added Establishment	Factory is an added establishment in 1900	[0,1]
Removed Establishment	Establishment removed in 1900	[0,1]
Added Partner	Partner added in 1900	[0,1]
Removed Partner	Partner removed in 1900	[0,1]
Changed Partner	Partner changed in 1900	[0,1]
Successor	Factory in 1900 is owned by son or daughter	[0,1]
Name Change	Factory in 1900 has a different name	[0,1]
Changed Location	Factory in 1900 has a different location	[0,1]
Different Founding Date	Factory in 1900 has a different founding date	[0,1]
Changed Specialty	Factory in 1900 has a different specialty	[0,1]
Industry	Factory in 1900 has a different industry entirely	[0,1]
Activity Name	The factory's activities	[0,1]
Activity (1 - 17)	Activities separated; Cotton Only	[0,1]
Integrated	Cotton Only	[0,1]
Working Days		Number
Machine Type (1 - 5)	See Table 30	String
Machine Number (1 - 5)		Number
Machine Power (1-5)		Horsepower
Number of Boilers		Number
Square Feet of Boilers		Square Feet

*These variables only have values if the factory is owned by a corporation (PSZ) or owned by a corporation in the next period (PSZ1900).

Table 5.24: Variables in the 1894 Data File (Cont...)

Number of L. Boilers		Number
Square Feet of L. Boilers		Square Feet
Plant Fuel (1- 2)	Fuel Code (See Table 31)	Rubles
Mineral Fuel (1 - 4)	Fuel Code (See Table 31) , dot, Rub. Amt.	Fuel Code.Rub. Amt.
Men	(Manuscript: Men older than 17)	Number
Women	(Manuscript: Women older than 17)	Number
Adolescent Men	(Manuscript: Men 15-17 years old)	Number
Adolescent Women	(Manuscript: Women 15-17 years old)	Number
Boys	(Manuscript: Men younger than 15)	Number
Girls	(Manuscript: Women younger than 15)	Number
Total	Total Workers	Number
On the Side	Workers Outside the Factory	Number
Output		Rubles
Output in Italics	Output produced with someone else's materials	Rubles
Factory Number	The volume's factory id	Numeral
Product 1 - 6	The factory's products; Cotton Only	String

Table 5.25: Variables in the 1900 Factory-Level Data File

Field	Explanation	Units
id	Continuation of Factory/Year id Nos	Numeral
Form Ruscorp	=1 if factory is owned by corporation	[0,1]
PSZ	Law number of corporation	Vol. No.- Law No.
PSZ 1908	Law number of corporation next period	Vol. No.- Law No.
Factory Name	Factory's name in the volume	String
Selected	=1 if the factory is sampled	[0,1]
Obs No	Factory's id in 1900	Numeral
Province	Province No.; Tables 27 and 28	Code: 1-92
Industry		String
SubindustryCode	See Table 29	Numeral
Region		String
Year Founded		Numeral (Year)
Total Yearly Output	Revenue	Rubles
Number of Workers	Total Workers	Number
Orders	Revenue from work on free materials	Rubles
Output in Parentheses	Volume does not define	Rubles
Workers in Parentheses	Volume does not define	Number
Orders in Parentheses	Volume does not define	Rubles
Notes	Extra notes from the volume	String

*These variables only have values if the factory is owned by a corporation (PSZ) or owned by a corporation in the next period (PSZ1908).

Table 5.26: Variables in the 1908 Factory-Level Data File

Field	Units	Units
id	Continuation of Factory/Year id Nos	Numeral
Form Ruscorp	=1 if factory is owned by corporation	[0,1]
PSZ	Law number of corporation	Vol. No.- Law No.
PSZ Last Year	The factory's corporation No. from last year	Vol. No.- Law No.
Factory Name	Factory's name in the volume	String
Industry		String
SubindustryCode	See Table 29	Numeral
Province	Province No.; Tables 27 and 28	Code: 1-92
Obs No 1908	Factory's id in 1900	Numeral
Sample Selected	=1 if the factory is sampled	[0,1]
Selected 1908	= 1 if the factory is matched to 1900	[0,1]
Obs No	The factory's obs no in 1900 if matched	Numeral
Merger	Factory in 1908 is a merger of 2 +	[0,1]
Offshoot	Factory in 1908 is an offshoot	[0,1]
Added Establishment	Factory is an added establishment in 19008	[0,1]
Removed Establishment	Establishment removed in 1908	[0,1]
Added Partner	Partner added in 1908	[0,1]
Removed Partner	Partner removed in 1908	[0,1]
Successor	Factory in 1908 is owned by son or daughter	[0,1]
Name Change	Factory in 1908 has a different name	[0,1]
Changed Location	Factory in 1908 has a different location	[0,1]
Changed Specialty	Factory in 1908 has a different specialty	[0,1]
Total Yearly Output	Revenue	Rubles
Number of Workers	Total Workers	Number
Orders	Revenue from work on free materials	Rubles
Kind of Machine		String
Power	Total horsepower of all machine	Horsepower
Has (Machine Type)	16 Possible Types; See File D	[0,1]
Notes	Extra notes from the volume	String
Reg Num	See Table 26	Numeral

*These variables only have values if the factory is owned by a corporation (PSZ) or owned by a corporation in the previous period (PSZ Last Year). The information for PSZ Last Year comes from matching to the 1900 factory list.

Table 5.27: Variables in the 1900 Aggregate Data File (File A)

Field	Units
Industry	String
Sub-Industry	String / Code: Table 29
Province	Code: 1-68 (Table 27)
Number of Establishments	Number
Total Value of Output	Thousands of Rubles
Orders	Thousands of Rubles
Men Older Than 15	Number
Men Younger Than 15	Number
Women Older Than 15	Number
Women Younger Than 15	Number
Total Men	Number
Total Women	Number
Total Workers	Number
Production Workers	Number
Support Staff	Number
Workers Outside the Factory	Number
Number of Steam Boilers	Number
Surface Area of Steam Boilers	Number
Number of Steam Engines	Number
Power of Steam Engines	Number
Number of Kerosine, Benzine, Fuel, and Gas Engines	Number
Power of Kerosine, Benzine, Fuel, and Gas Engines	Number
Number of Fuel By-Product Engines	Number
Power of Fuel By-Product Engines	Number
Number of Other Machines	Number
Power of Other Machines	Number
Quantity of Charcoal	Thousands of Pounds
Quantity of Coke	Thousands of Pounds
Quantity of Fuel By-Products	Thousands of Pounds
Quantity of Garbage as Fuel	Thousands of Pounds
Quantity of Firewood	Cubic sazhen
Quantity of Peat	Cubic sazhen
Cost of Russian Machine Maintenance	Thousands of Rubles
Cost of Foreign Machine Maintenance	Thousands of Rubles
Value Raw Materials	Thousands of Rubles
Cost of Fuels	Thousands of Rubles
Wages to Workers in the Factory	Thousands of Rubles
Wages to Workers on the Side	Thousands of Rubles
Other Wages	Thousands of Rubles

Table 5.28: Variables in the 1900 Aggregate Data File (File A) (Cont...)

Orders to Other Factories	Thousands of Rubles
Administration	Thousands of Rubles
Building Insurance	Thousands of Rubles
Property Insurance	Thousands of Rubles
Taxes	Thousands of Rubles
Doctors (in the Factory)	Thousands of Rubles
Schools (in the Factory)	Thousands of Rubles
Other Benefits to Workers	Thousands of Rubles
Workers' Dormitories	Thousands of Rubles

Table 5.29: Variables in the 1908 Aggregate Volume (File B)

Field	Units
Industry	String
Sub-Industry	String*
Province	Code: 1-68 (Tables 27 and 28)
Number of Establishments	Number
Total Value of Output	Thousands of Rubles
Orders	Thousands of Rubles
Men Older Than 15	Number
Men Younger Than 15	Number
Women Older Than 15	Number
Women Younger Than 15	Number
Total Workers	Number
Workers Outside the Factory	Number
Number of Steam Boilers	Number
Surface Area of Steam Boilers	Number
Number of Steam Engines, Locomotives, and Turbines	Number
Power of Steam Engines, Locomotives, and Turbines	Number
Number of Oil, Kerosene, Benzine, and Gas Engines	Number
Power of Oil, Kerosene, Benzine, and Gas Engines	Number
Number of Water-Powered Motors	Number
Power of Water-Powered Motors	Number
Number of Electric Motors	Number
Power of Electric Motors	Number
Quantity of Solid Mineral Fuels (Coal, Coke, Anthracite)	Thousands of Pounds
Quantity of Charcoal	Thousands of Pounds
Quantity of Liquid Mineral Fuels	Thousands of Pounds
Quantity of Firewood	Cubic sazhen
Quantity of Peat	Cubic sazhen
Other Fuels	Thousands of Rubles
Cost of Foreign Machine Maintenance	Thousands of Rubles
Value Raw Materials	Thousands of Rubles
Cost of Fuels	Thousands of Rubles
Wages to Workers in the Factory	Thousands of Rubles
Benefits to Workers in the Factory	Thousands of Rubles
Wages to Workers on the Side	Thousands of Rubles
Support Expenses	Thousands of Rubles

*There are slight differences between the subindustries that appear in the 1900 volume and those that appear in the 1908 volume. I have only coded the subindustries for the 1900 volume. See Table 30.

Table 5.30: Region Numbers

Northern	1
Eastern	2
Prebaltic	3
Central Industrial	4
Central Blacksoil	5
Northwestern	6
Southwestern	7
Southern	8
Previslitskii	9
Caucasus	10
Turkestan	11
Western Siberia	12
Eastern Siberia	13

Table 5.31: Province Numbers

Arkhangelskaia	1	Orlovskaia	35
Astrakhanskaia	2	Penzenskaia	36
Bakinskaia	3	Permskaia	37
Bessarabskaia	4	Petrokovskaia	38
Chernigovskaia	5	Plotskaia	39
Donskaia Oblast	6	Podolskaia	40
Ekaterinoslavskaia	7	Poltavskaia	41
Elizavetpolskaia	8	Pskovskaia	42
Erivanskaia	9	Radomskaia	43
Estlandskaia	10	Riazanskaia	44
Grodnenskaia	11	Samarskaia	45
Kalishskaia	12	Saratovskaia	46
Kaluzhskaia	13	Sedletskaia	47
Kazanskaia	14	Simbirskaia	48
Keletskaia	15	Smolenskaia	49
Kharkovskaia	16	Peterburgskaia	50
Khersonskaia	17	Suvalskaia	51
Kievskaia	18	Tambovskaia	52
Kostromskaia	19	Tavricheskaia	53
Kovenskaia	20	Tiflisskaia	54
Kubanskaia	21	Tulskaia	55
Kurlandskaia	22	Tverskaia	56
Kurskaia	23	Ufimskaia	57
Kutaiiskaia	24	Viatskaia	58
Lifliandskaia	25	Vilenskaia	59
Liublinskaia	26	Vitebskaia	60
Lomzhinskaia	27	Vladimirskaia	61
Minskaia	28	Volinskaia	62
Mogilevskaia	29	Vologodskaia	63
Moscovskaia	30	Voronezhskaia	64
Nizhegorodskaia	31	Varshavskaia	65
Novgorodskaia	32	Yaroslavskaia	66
Olonetskaia	33	Zakatalskaia	67
Orenburgskaia	34	Chernomorskaia	68

Table 5.32: Provinces Only Appearing in 1894 and 1908

Amurskaia	69
Batumskaia	70
Dagestanskaia	71
Zabaikalskaia	72
Irkutskaia	73
Sir Darinskaia	74
Terskaia	75
Tobolskaia	76
Tomskaia	77
Akmolinskaia	78
Eniseiskaia	79
Zakaspiiskaia	80
Karskaia	81
Primorskaia	82
Semipalatinskaia	83
Stavropolskaia	84
Yakutskaia	85
Samarkandskaia	86
Semirechenskaia	87
Turgaiiskaia	88
Uralskaia	89
Ferganskaia	90

Others	
Khivinskaia Vladeniia	91
Khivinskoe Khanstvo	92

Table 5.33: Industry Numbers and Subindustry Numbers

Cotton	**1**
Cotton Quilting	11
Cotton Spinning	12
Vicuna	13
Cotton Thread	14
Cotton Weaving	15
Cotton Weaving Distribution Offices	16
Velvet	17
Cotton Spinning and Weaving	18
Cotton Weaving with Dyeing and Finishing	19
Cotton with Weaving, Dyeing, and Distribution	110
Cotton Dyeing and Finishing	111
Cotton Weaving, Dyeing, and Finishing	112
Cotton Engraving (?)	113
Wool	**2**
Wool Scouring	21
Wool Quilting	22
Mechanized Wool Spinning	23
Worsted	24
Wool Weaving	25
Wool Weaving and Distribution Offices	26
Wool Weaving and Spinning	27
Wool Weaving, Dyeing, and Finishing	28
Wool Dyeing and Finishing	29
Wool Cloth	211
Wool Manufacturers (Cloth and Linen)	212
Felt	213
Silk	**3**
Silk Unwinding	31
Silk Twisting	32
Silk Winding and Unwinding	33
Silk Spinning from Combings	34
Silk Weaving	35
Silk Weaving and Distribution Offices	36
Silk Weaving with Dyeing and Finishing	37
Silk Bands	38
Silk Bands with Distribution Offices	39
Silk Dyeing and Finishing 310 Full Silk Processing	311

Table 5.34: Industry Numbers and Subindustry Numbers (Cont...)

Flax, Hemp, and Jute	**4**
Flax Cleaning	41
Jute Cleaning	42
Flax Spinning	43
Hemp Spinning	44
Hemp Spinning, Rope, and String	45
Flax, Hemp, and Jute Weaving	46
Flax, Hemp, and Jute Weaving and Distribution Offices	47
Flax Spinning, Hemp Weaving, and Jute Weaving	48
Flax Weaving, Bleaching, and Finishing	49
Flax Weaving, Bleaching, and Finishing with Distribution Offices	410
Full Manufacturing	411
Bleaching and Finishing	412
Hemp Spinning, Flax Weaving, and Rope	413
Jute Processing	414
Chemical Soaking of Flax	415
Mixed Materials	**5**
Tulle, Lace, and Embroidery (Mechanized)	51
Ribbons, laces, belts, girdles...	52
Belts, Hoses, Canvas...	53
Gold or Silver Thread and Spinning	54
Belosh.., gold, ties, and corsets...	55
Artful flowers and feathers	56
Hats: Feather, felt, wool, silk, straw, and fabric	57
Umbrellas	58
Buttons	59
Dolls and Toys	510
Dyeing, Spot Removing, and Laundry	511
Factories Producing Cloth and Linoleum	512
Production of Haberdashery Related Items Not Listed	513
Paper	**6**
Wood-Pulp	61
Cellulose (Chemical Wood Pulp)	62
Writing Paper	63
Wall paper and printed paper...	64
Tar Paper Roofing	65
Book and Notebook Binding	66
Manufacturing:ï¿½Cardboard, lampshades...	67
Rolling Papers	68
Paper Sleeves, Items Made from Paper Pulp, Papier Mache	69
Envelopes	610
Printing, lithographic...	611

Table 5.35: Industry Numbers and Subindustry Numbers (Cont...)

Wood	**7**
Sawmills	71
Parquet and Joinery	72
Cooperage, Staves, and Shingles	73
Coffins	74
Boxes	75
Bentwood Furniture and Plywood Products	76
Woodwork, Billiards...	77
Frames, Moldings	78
Carvings, Iconostasis	79
Parts of Looms	710
Pins, Match Sticks, Etc	711
Pianos and Other Stringed Instruments	712
Accordions	713
Plugs	714
Mats, Sacks...	715

Table 5.36: Industry Numbers and Subindustry Numbers (Cont...)

Metals and Machines	**8**
Iron	81
Copper and Bronze	82
Iron, Copper, and Bronze	83
Bells	84
Copper, Brass, Zinc	85
Iron and Steel	86
Tube Mills	87
Mechanical Processing of Types of Iron	88
Machine-Building	89
Locomotive Wagons	810
Shipbuilding	811
Boilers	812
Farm Machinery	813
Ship Repair	814
Repair of Agricultural Machines and Tools	815
Repair of Factory Machinery	816
Various Repair	817
Lead	818
Iron, Tin, and Zinc	819
Shovels, Scythes, and Pitchforks	820
Cutlery	821
Production of Tin Cans	822
Hardware, Locks	823
Copper	824
Gold Leaf	825
Dishes	826
Ammunition and Cannons	827
Needles, Pins, and Hooks	828
Iron and zinc, iron and soldering...	829
Gold, Silver, and Jewelry	830
Physical, Optical, and Surgical Instruments...	831
Carded Ribbons	832
Carriages	833
Production of Shot (Ammunition)	834
(Parts Used in Textile Production)	835
Steel Pens	836
Production of Trade Tools of Various Kinds	837
Dishes, Weapons, Umbrella Parts...	838
Iron Furniture	839
Hand-manufacturing of screws, nails...	840

Table 5.37: Industry Numbers and Subindustry Numbers (Cont...)

Mineral Products	**9**
Glass	91
Porcelain	92
Ceramics	93
Cement	94
Lime, Plaster, and Chalk	95
Concrete	96
Pencils, Slate, and Asbestos	97
Bricks	98
Animal Products	**10**
Tanneries	1001
Patent Leather Belts, Parts of Shoes, Etc	1002
Manufacturing of Saddlery, Saddle Bags, Travel Items and Misc. Leather Products	1003
Sheepskin Tanneries Etc	1004
Gloves	1005
Shoes	1006
Glue from Leather Scraps and Scrapings	1007
Gut Products (Including Gut Strings)	1008
Rendering	1009
Soap, Candles, and Other Materials from Fat	1010
Parafin and Parafin Candles (Maybe)	1011
Bone-based Products	1012
Sorting and Processing of Hair, Lint, Feathers, and Bristles (Including Brushes)	1013
Wax Candles	1014
Various Horn and Bone Products	1015
Foods and Flavorings	**11**
Flour	1101
Groats	1102
Flour and Groats	1103
Macaroni and Vermicelli	1104
Bread Baking and Distribution	1105
Canned Goods, Cheeses, Dairy and Butter	1106
Butter Churning and Oil Extraction	1107
Mustard, Dried Ground Coffee, and Chicory	1108
Starch from Potatoes and Grains	1109
Starch and Molasses	1110
Kvass, Vinegar, Mineral Water and Fizzy Drinks	1111
Slaughterhouses, Grain Elevators, Etc	1112

Table 5.38: Industry Numbers and Subindustry Numbers (Cont...)

Chemicals	**12**
Chemicals	1201
Dyes	1202
Dry Distillation of Wood (?)	1203
Gas	1204
Cosmetics	1205
Resin	1206
Matches (Taxed)	1207
Oil (Taxed)	1208

Table 5.39: Codes for Types of Machines and Fuels

Panel A: Codes for Types of Machines

Russian Term	English Translation	Abbreviation in Data
Газов.	Gas Motor	Gas
П. Маш.	Steam Engine	Steam
В. Кол.	Water Wheel	Wheel
Тюрб.	(Steam) Turbine	S. Turb
Локб.	Locomobile	Loco
В. Тюрб.	Water Turbine	W. Turb
Конн.	Horse Engine	Horse
Керос.	Kerosine Motor	Kero
Спирт.	Spirit Motor	Spirit
Гидравл.	Hydraulic	HydroV

Panel B: Codes for Types of Fuels

Fuel Code in 1894 Data	Fuel Type
n	Oil
t	Peat
k	Kerosene
kk	Coke
b	Benzene
u	Coal

Table 5.40: Matched Moments (1894 Population and Sample)

	1894 Population Mean	1894 Stratified Sample Mean (Unweighted)	1894 Stratified Sample Mean (Weighted)
Revenue	93,341.07	135,231.60	93,895.72
per Factory	(434,861.40)	(623,133.20)	(473,065.90)
Workers	61.77	102.29	69.52
per Factory	(262.58)	(435.67)	(389.36)
Machine Power	35.16	52.40	34.48
per Factory	(194.12)	(279.44)	(189.98)
Revenue per Worker	1,605.60	1,215.39	1,469.41
	(4,843.07)	(1,970.25)	(2,250.51)
Machine Power per Worker	1.07	.65	1.11
	(2.79)	(2.02)	(2.67)

Standard deviations in parentheses. "Weights" are post-stratification weights.

Table 5.41: Matched Moments (1900 Population, Samples, and Aggregates)

	1900 Population Mean	1900 Stratified Sample Mean (Unweighted)	1900 Stratified Sample Mean (Weighted)	1900 Aggregate
Revenue per Factory	167,914.20 (691,852.30)	210,242.60 (896,932.60)	164,736.70 (720,811.10)	158,079.79
Workers per Factory	109.95 (816.51)	144.24 (562.59)	106.46 (439.19)	105.70
Machine Power per Factory	(Not in micro data)	(Not in micro data)	(Not in micro data)	67.19
Revenue per Worker	1,943.99 (4,603.01)	1,643.87 (5,707.90)	1,899.48 (5,073.54)	1,495.50
Machine Power per Worker	(Not in micro data)	(Not in micro data)	(Not in micro data)	.63

Standard deviations in parentheses. "Weights" are post-stratification weights.

Table 5.42: Matched Moments (1908 Population, Samples, and Aggregates)

	1908 Population Mean	1908 Stratified Sample Mean (Unweighted)	1908 Stratified Sample Mean (Weighted)	1908 Aggregate
Revenue per Factory	256,228.60 (1,029,681.00)	360,444.60 (1,437,227.00)	265,298.40 (1,087,661.00)	228,265.51
Workers per Factory	84.87 (387.77)	178.71 (642.83)	120.22 (462.03)	112.67
Machine Power per Factory	60.73 (339.66)	119.36 (551.20)	85.24 (414.06)	103.78
Revenue per Worker	2,793.11 (8,708.57)	2,188.10 (4408.46)	2,605.47 (5469.18)	2,025.99
Machine Power per Worker	1.17 (2.71)	.87 (1.88)	1.13 (2.30)	.92

Standard deviations in parentheses. "Weights" are post-stratification weights.

Table 5.43: Means from 1900 and 1908 Aggregate Volumes for Moscow and Prebaltic Provinces

	Central Industrial Region, 1900	Central Industrial Region, 1908	Prebaltic Region, 1900	Prebaltic Region, 1908
Revenue per Factory	228,059.90	400,272.40	335,641.00	326,161.40
Workers per Factory	168.52	232.47	176.33	123.40
Machine Power per Factory	92.05	151.53	156.02	143.71
Revenue per Worker	1,353.33	1,721.85	1,903.52	2,643.22
Machine Power per Worker	.55	.65	.88	1.16

The numbers for 1908 include only European Russia and industries that appear in the 1900 volume.

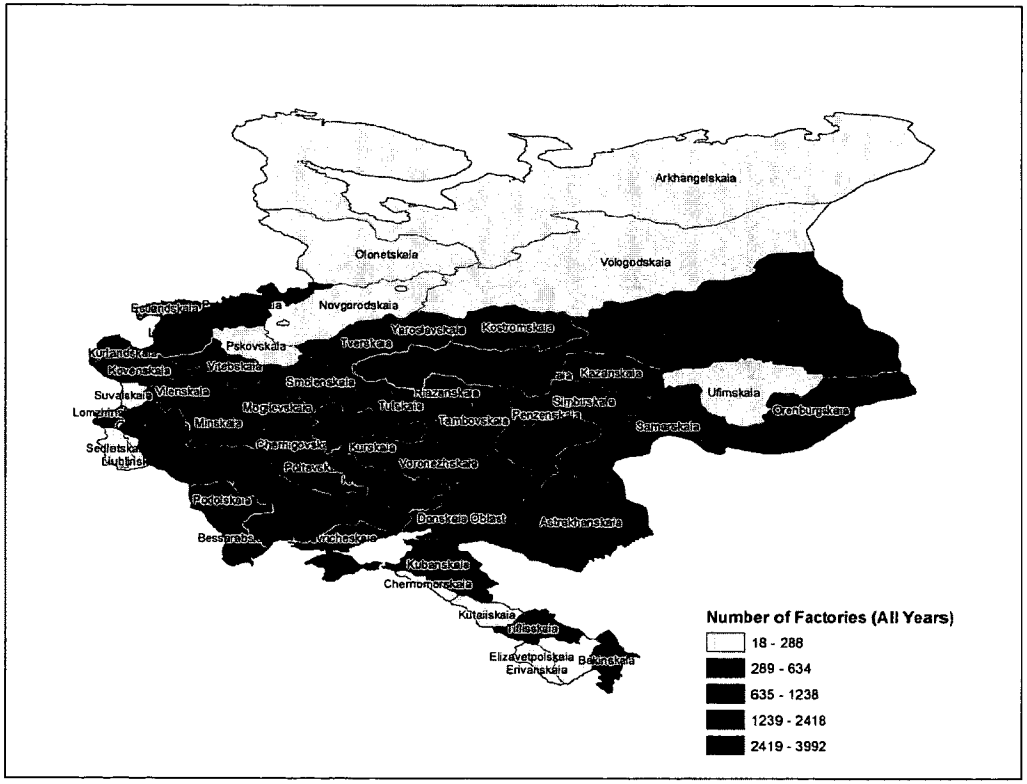
Table 5.44: Production Functions Estimated with Micro and Aggregate Data

OLS	Dependent Variable: Log Revenue							
	Micro [1]	Agg. [2]	Agg. [3]	Micro [4]	Agg [5]	Micro [6]	Agg. [7]	Agg. [8]
Log (Workers/ Factory)	1.03 (.011)	1.09 (.028)	.39 (.044)	1.07 (.0071)	1.05 (.026)	.77 (.011)	.91 (.030)	.39 (.058)
Log (Machine Power/Factory)			.061 (.015)			.33 (.0090)	.10 (.021)	.037 (.0099)
Log (Materials/ Factory)			.58 (.045)					.58 (.057)
Intercept	7.20 (.042)	.35 (.14)	.43 (.079)	7.23 (.036)	.66 (.11)	7.66 (.048)	.97 (.11)	.57 (.069)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	14,226	680	491	12,446	3,147	9,236	2,648	2,604
R-Squared	.6860	.7456	.9505	.6935	.7730	.7322	.7811	.9127
F-Stat	936.92	156.01	600.39	2,352.79	449.84	2,218.48	469.39	789.05
Year	1900	1900	1900	1908	1908	1908	1908	1908

Columns labeled "Micro" use the population of factories. Aggregate regressions weighted by number of factories (analytic weights). Robust standard errors in parentheses. In the aggregate regressions, the units of observation are province-industry cells. The aggregate regressions only include industries and regions observed in the micro data.

Figures

Figure 5.1: Map of Factories in the Gregg Imperial Russian Manufacturing Database

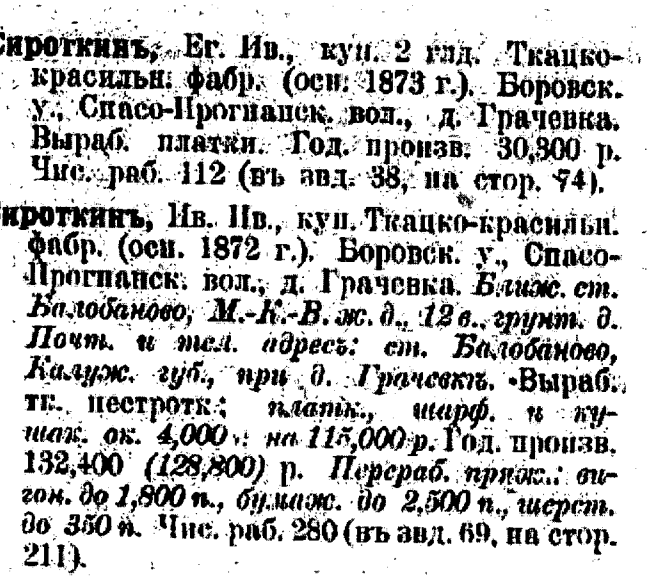


Source: Gregg Imperial Russian Manufacturing Database and GIS maps of the Russian Empire by Andre Zerger.

Figure 5.2: Petr Pavlovich Il'in and Mikhail Pavlovich Il'in Cotton Textile Weaving Factories

Source: 1894 Factory List, Page 3 (Vladimirskaia Guberniia). Translation: First Line: "Il'in, Petr. Pavl. City of Kovrov, Ivanovskaia (Street). (1842). Weaving." Second line: "Il'in, Mikh. Pavl. City of Kovrov, Ivanovskaia (Street). (1842). Weaving."

Figure 5.3: Egor Ivanovich Sirotkin and Ivan Ivanovich Sirotkin Cotton Textile Factories

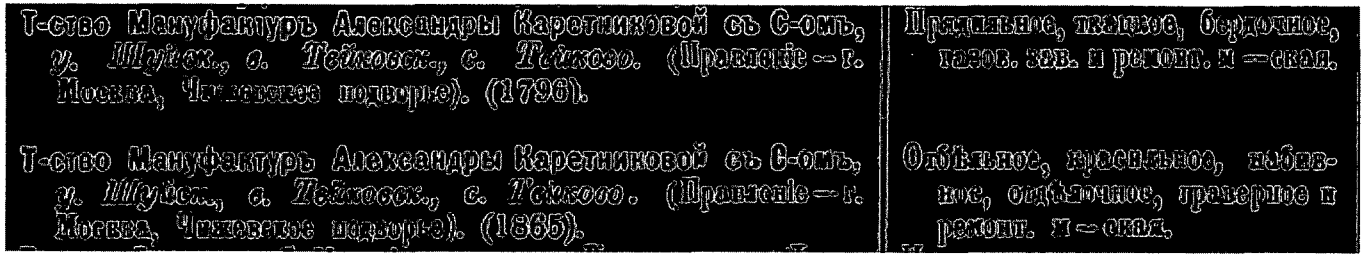


Сироткинъ, Ег. Ив., куп. 2 гид. Ткацко-красильн. фабр. (осн. 1873 г.). Боровск. у., Спасо-Прогнанск. вол., д. Грачевка. Вырab. платки. Год. произв. 30,300 р. Чис. раб. 112 (въ завд. 38, на стор. 74).

Сироткинъ, Ив. Ив., куп. Ткацко-красильн. фабр. (осн. 1872 г.). Боровск. у., Спасо-Прогнанск. вол., д. Грачевка. *Ближ. ст. Балобаново, М.-К.-В. ж. д., 12 в., грунт. д. Почт. и тел. адресъ: ст. Балобаново, Калужс. губ., при д. Грачевкѣ.* Выраб. тк. пестротк.; *платк., шарф. и кушак. ок. 4,000 г. на 115,000 р.* Год. произв. 132,400 *(128,800)* р. *Перераб. пряж.: вигон. до 1,800 п., бумаж. до 2,500 п., шерст. до 350 п.* Чис. раб. 280 (въ завд. 69, на стор. 211).

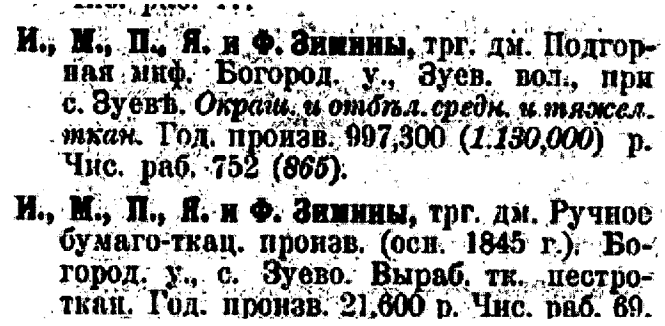
Source: 1900 Factory List, Page 10 (Kaluzhskaia Guberniia). Translation: First entry: "Sirotkin, Eg. Iv, 2nd Guild Merchant. Weaving and dyeing factory. (Founded 1873). Borovsk. uezd, Spaso-Prognansk. volost, Grachevka Road. Manufacturing of shawls. Yearly production: 30,300 rubles. Number of workers: 112 (38 in the factory, 74 "on the side")." Second entry:'Sirotkin, Iv. Iv. Weaving and dyeing factory. (Founded 1872). Borovsk. uezd, Spaso-Prognansk. volost, Grachevka Road. Close to Balobanovo Station, M-K-V Railroad, 12 versts. Mail and telephone address: St. Balabanovo, Kaluzh. Province, Grachevka Raod. Manufacturing of variegated fabrics: shawls, scarves, and sashes, about 4000 at 115,000 rubles. Yearly production: 132,400 (128,800) rubles. Processing of vicuna (up to 1,800 puds), cotton (up to 2,500 puds) and wool (up to 350 puds). Number of workers: 280 (69 in the factory, 211 "on the side")."

Figure 5.4: Aleksandra Karetnikova Cotton Textile Factories



Source: 1894 Factory List, Page 2 (Vladimirskaia Guberniia). Translation: First entry: "Manufacturing Partnership of Alexandra Karetnikova and Sons. Shuisk Uezd, Teikovsk. Volost, Village of Teikovo. (Administration: Moscow, Chichevskoe Compound.) (1796). Spinning, weaving, production of looms, gas factory, and repair shop." Second entry: "Manufacturing Partnership of Alexandra Karetnikova and Sons. Shuisk Uezd, Teikovsk. Volost, Village of Teikovo. (Administration: Moscow, Chichevskoe Compound.) (1865). Bleaching, dyeing, printed fabrik, engraving, and repair shop."

Figure 5.5: Zimini Cotton Textile Factories



И., М., П., Я. и Ф. Зимины, трг. дм. Подгорная мнф. Богород. у., Зуев. вол., при с. Зуевѣ. *Окрашиван. и отбѣл. средн. и тяжел. ткан.* Год. произв. 997,300 (*1.130,000*) р. Чис. раб. 752 (*865*).

И., М., П., Я. и Ф. Зимины, трг. дм. Ручное бумаго-ткац. произв. (осн. 1845 г.). Богород. у., с. Зуево. Вырабатывают тк. шестротканые. Год. произв. 21,600 р. Чис. раб. 69.

Source: 1900 Factory List, Page 16 (Moskovskaia Guberniia). Translation: First entry: "I., M., P., Ya., and F. Ziminy, Trading House. Factory in the foothills. Bogorodsk. Uezd, Zuev. volost, village of Zuev. Coloring and bleaching of average and heavy fabric. Yearly output: 997,300 (1,130,000) rubles. Number of workers: 752 (865)." Second entry: "I., M., P., Ya., and F. Ziminy, Trading House. Weaving by hand (Founded in 1845). Bogorodsk. Uezd, Zuev. volost, village of Zuev. Manufacturing of variegated fabrics. Yearly output: 21,600 rubles. Number of workers: 69."

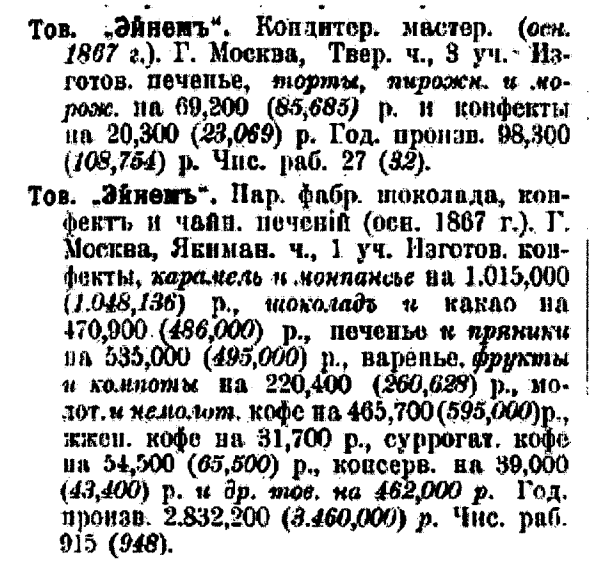
Figure 5.6: Smirnov Cotton Textile Factories

Смирновъ, Ал. Вас., пот. поч. гр. Бумагопрядильн. фабр. (осн. 1899 г.). Покров. у., Кудыкин. вол., д. Ликино. *Ближ. ст. Ликино, Орѣховск. подъѣздн. пути, ½ в., ст. Дрезна, М.-Н. ж. д., 7 в., грунт. д. Почт. и тел. адресъ конт.: Москва, Юшковъ пер., Шуйское подворье, №№ 29—30.* Год. произв. 61,300 *(1.216,843)* р. *Перераб. хлоп. ок. 91,700 п.* Чис. раб. 494 *(458).*

Смирновъ, Ал. Вас., пот. поч. гр. Бумаготкац. завд. (осн. 1881 г.). Покров у., Кудыкин. вол., д. Ликино. *Ближ. ст. Ликино, Орѣховск. подъѣздн. пути М.-Н. ж. д., проселоч. д. Адресъ для прост. корр: ст. Ликино, для заказной: Дулевское почт. отд.; конт.: Москва, Шуйское подворье, №№ 29—30.* Выраб. тк. шерстоткан. Год. произв. 120,500 р. *(91.425 п. на 1.988,700 р.). Перераб. бумаж. и вигонев. бум. пряж. и мал. ч. льнян. пряжи.* Чис. раб. 1,031.

Source: 1900 Factory List, Page 7 (Vladimirskaia Guberniia). Translation: First entry: "Smirnov, Al. Vac. Hereditary citizen. Cotton spinning factory. (Founded 1899). Pokrov. uezd, Kudykin volost, Likino road. Close to Likino station, Orelkhovsk. route, 1/2 verst, st. Dresna, M-N Railroad, 7 versts. Mail and telephone address: Moscow, Iushkov Lane, Shiuskoe Compound, Numbers 29-30. Yearly output 61,300 (1,216,843) rubles. Processing of about 91,700 puds of cotton. Number of workers: 494 (458)." Second entry: "Smirnov, Al. Vac. Hereditary citizen. Cotton spinning factory. (Founded 1881). Pokrov. uezd, Kudykin volost, Likino road. Close to Likino station, Orelkhovsk. route, M-N Railroad. Address for correspondence: Likino Station, for orders: Dulevskoe mail department. Distribution: Moscow, Shuiskoe Compound, Numbers 29-30. Yearly output: 120,500 rubles (91,425 pounds and 1,988,700 rubles). Processing of cotton and vicuna yarn and (small gauge?) linen yarn. Number of workers: 1,031."

Figure 5.7: Einem Candy Company Factories

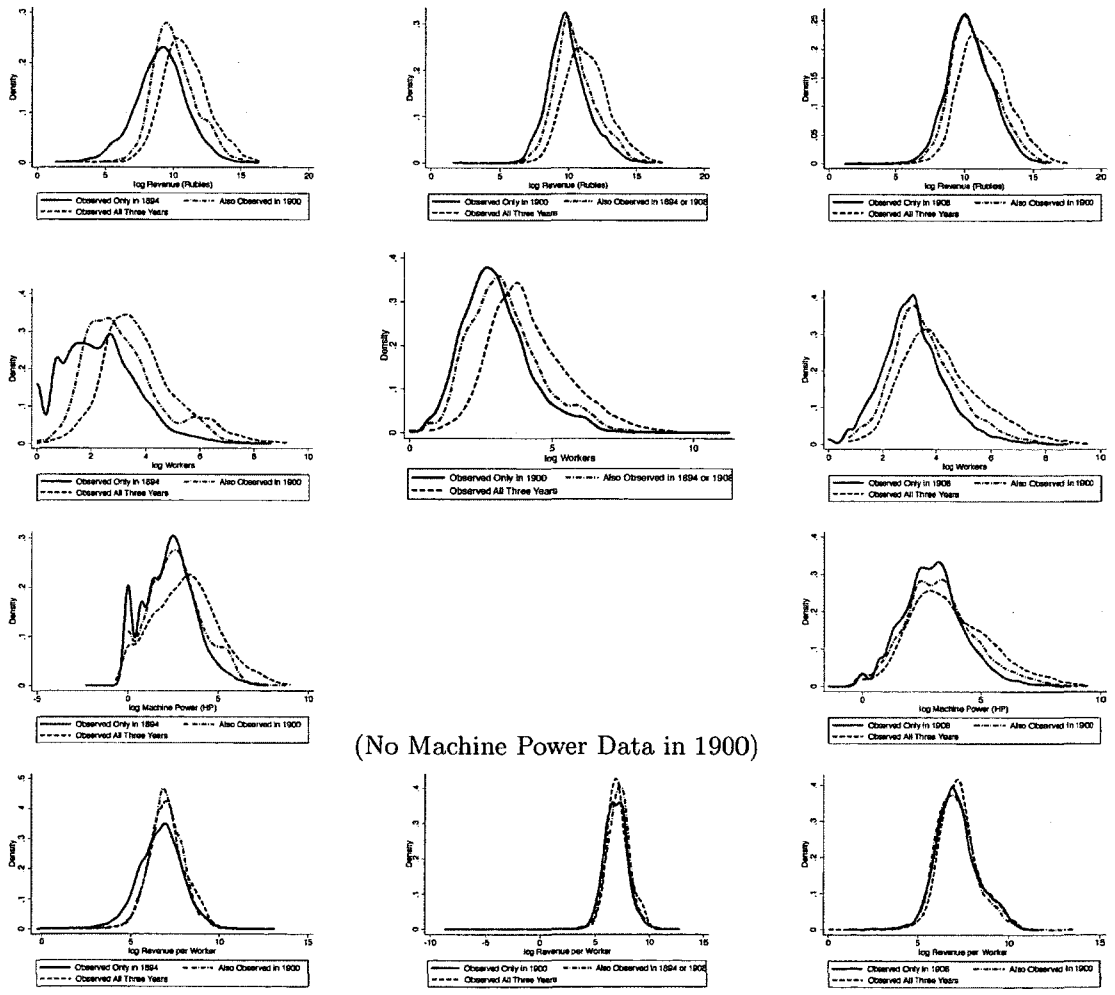


Тов. „Эйнемъ". Кондитер. мастер. (*осн. 1867 г.*). Г. Москва, Твер. ч., 3 уч. Изготов. печенье, *торты, пирожн. и морож.* на 69,200 (*85,685*) р. и конфекты на 20,300 (*23,069*) р. Год. пронав. 98,300 (*108,754*) р. Чис. раб. 27 (*32*).

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. пронав. 2.832,200 (*3.460,000*) *р.* Чис. раб. 915 (*948*).

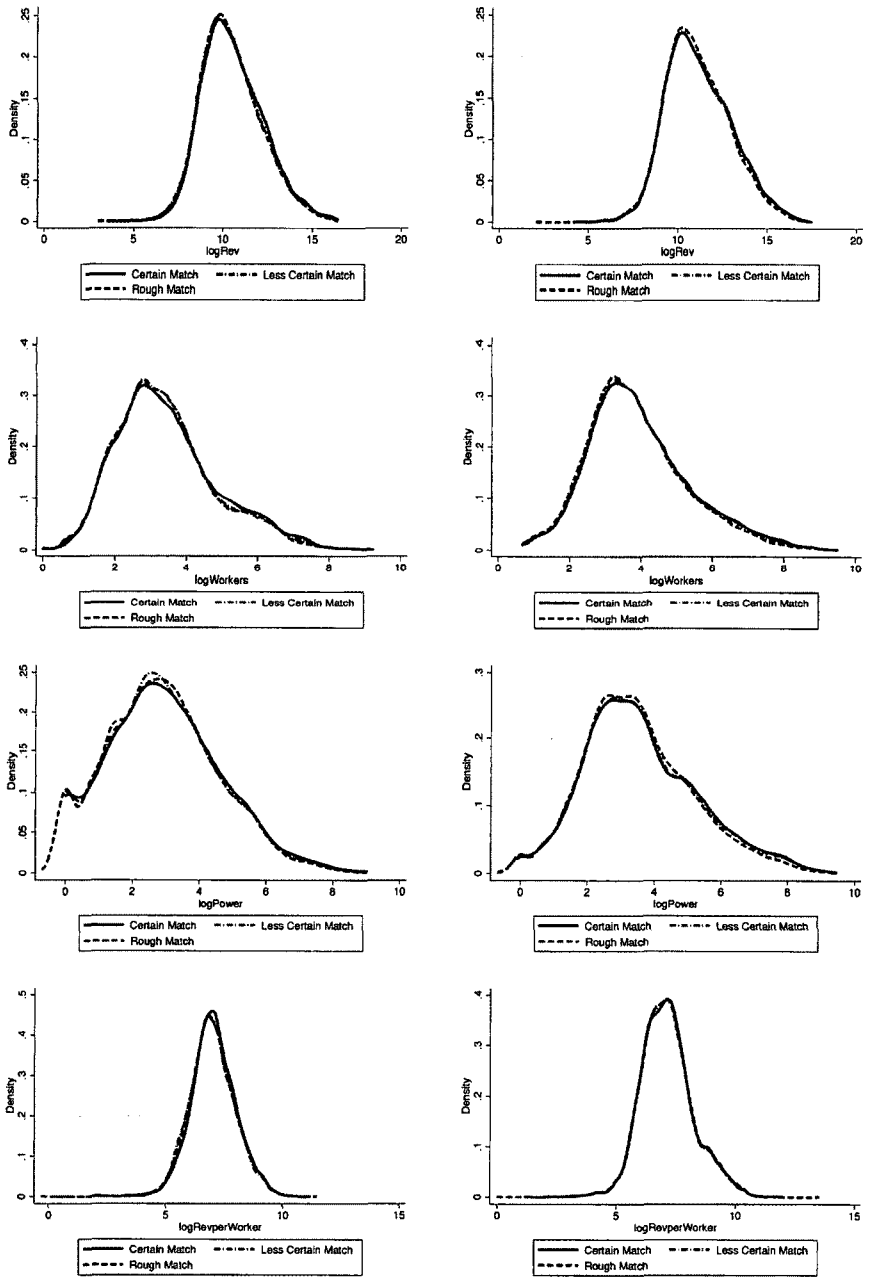
Source: 1900 Factory List, Page 589 (Moskovskaia Guberniia). Translation: First entry: "Einem Partnership. Master confectionary. (Founded 1867). City of Moscow, Tverskaia section, 3rd (part?). Preparation of cookies, cakes, pies, and ice crime at 69,200 (85,685) rubles and candy at 20,300 (23,069) rubles. Yearly output: 98,300 (108,754) rubles. Number of workers: 27 (32)" Second entry: "Einem Partnership. Chocolate, candy, and tea cookie factory (Founded 1867). City of Moscow, Yakiman section, 1st (part?). Preparation of candy, caramels, and fruit drops at 1,015,000 (1,048,136) rubles, chocolate and cocoa at 470,900 (486,000) rubles, cookies and gingerbread at 535,000 (495,000) rubles, jams, fruit, and compotes at 220,400 (260,628) rubles, ground and unground coffee at 465,700 (595,000) rubles, roasted coffee at 31,700 rubles, coffee substitutes at 54,500 rubles, preserves at 39,000 (43,400) rubles, and other goods at 462,000 rubles. Yearly output: 2,832,000 (3,460,000) rubles. Number of workers: 915 (948)"

Figure 5.8: Distributions of Revenue, Workers, Machine Power, and Revenue per Worker by Years Observed



Source: Gregg Imperial Russian Manufacturing Database (2015)

Figure 5.9: Distributions of Revenue, Workers, Machine Power, and Revenue per Worker by Match Certainty



Source: Gregg Imperial Russian Manufacturing Database (2015)

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