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Impacts of the Industrial Revolution on Wages and Skills of Workers: The Silk Weaving Industry in Early Twentieth-Century Japan

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Abstract

This paper explores the implications of technological change on the wages and skills of workers in early twentieth-century Japan. The Japanese economy experienced essential elements of the industrial revolution, such as the adoption of the factory system and mechanization, in this period. Exploiting detailed plant-level data on the silk weaving industry, we compare wage and composition of workers between powered plants and non-powered plants. We found that (a) the wage, (b) the relative wage of male adult workers to female adult workers, and (c) the ratio of male workers, were all higher at powered plants than non-powered plants. (a) reflects the higher marginal productivity of labour, while (b) and (c) reflect the emergence of a new type of skilled worker, i.e. mechanics.

Key words: Industrial Revolution, Standard of living, Technological change, Wage, Technology–skill complementarity, Textile industry, Japan

JEL classification numbers: D22, D24, D33, J31, L67, N35, N65, O33

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1. Introduction

Implications of the British Industrial Revolution on the lives of the working class have been attracting great interest from economists and economic historians since the nineteenth century. A classic book by Friedrich Engels vividly describes the dismal situation of industrial workers in early nineteenth-century London and Manchester (Engels 1845), which has long been influential in the Marxist literature (Hobsbaum, 1957, 1968). This pessimistic view was criticized by scholars who stressed the improvement in the living standard through the Industrial Revolution (Ashton 1949; Hartwell 1959, 1961). The 'Standard of Living Debate' between the pessimists and optimists has not yet been settled (Feinstein 1998; Voth 2004; Wallis 2014).

This literature basically focuses on the aggregate measures of the standard of living, such as per capita GDP, average real wage, average height, and life expectancy. This paper intends to provide a new perspective to the literature using data from early twentieth-century Japan. Japan, as a backward country, experienced the industrial revolution from the late nineteenth century to the early twentieth century. That is, in this period, various industries adopted the factory system, and many factories installed machines, imported and domestic, driven by inanimate power. One of the typical cases of the Japanese industrial revolution was the weaving industry. Initially, large cotton spinning firms began to produce cotton fabrics using power looms imported from the U.K. in the late 1880s (Kajinishi ed. 1964, p.182). Then, power looms, which came to be produced in Japan, diffused to small- and medium-sized regional weaving firms for cotton, silk, and wool fabrics (Minami, Ishii and Makino 1982; Minami and Makino 1988; Saito and Abe 1987).

This paper focuses on silk weaving plants in Fukui Prefecture, one of the largest silk weaving clusters in early twentieth-century Japan. For Fukui Prefecture, detailed plant-level data are available, which enable us to analyse the implications of the new technology of power looms on wages and skills of workers. One distinctive advantage of our data is that we can observe handloom plants as well as power loom plants. In Fukui Prefecture, power looms were first installed in 1906 and diffused swiftly after that. For several years, however, power loom plants and handloom plants coexisted, which allows us to compare wages and attributes of workers between power loom plants and handloom plants, and thereby understand the impacts of the industrial revolution on the working class at the micro level.

This paper also relates to the literature on the technology–skill complementarity. Goldin and Sokoloff (1982) found that the employment and wage of females and children increased relative to those of males in larger manufacturing plants in early nineteenth-century U.S. and interpreted the findings as deskilling caused by technical change. Goldin and Katz (1996, 1998) stressed that in late nineteenth-century technology–skill complementarity emerged, which was based on further technical progress including batch and continuous-process. Technology–skill complementarity has been extensively studied in the field of economic history (Atack et al. 2004; Feldman and Van der Beek 2016; Van Lottum and Van Zanden 2014; Okazaki 2020). We provide new evidence on this issue.

The remainder of the paper will be organized as follows. Section 2 briefly overviews the development of the silk weaving industry in Japan. Section 3 presents the data and descriptive observations. Section 4 presents the results of regression analyses, and Section 5 discusses the implications of the results. Section 6 concludes.

2. The industrial revolution and development of the silk weaving industry in Japan: An overview.

Japan, which had been under a feudal regime and a seclusion policy, began its modern economic growth in the late nineteenth century. The turning point was the opening of the country in 1859 and political regime change, the Meiji Restoration in 1868. Since then, the Japanese government and private sector extensively adopted modern institutions and technologies from Western countries, which provided the basis for economic development. While the average annual growth rate of real GDP per capita was just 0.19% from 1820 to 1870, it increased to 1.68% from 1870 to 1920[1]. The structure of the economy changed substantially during this process. The percentage of agriculture and forestry industry was as high as 70.1% in 1872 but declined to 52.5% by 1920[2]. Industrialization was an engine of modern economic growth in Japan. It is notable that the organization of industry changed at the same time. The first manufacturing census for 1909 indicates that there were 32,032 factories with five or more workers, and the total number of workers in those factories was 780,490 (Ministry of International Trade and Industry, 1961, p.4), which is 23.4% of total workers in the manufacturing sector. We can say that factories already had a substantial portion of the manufacturing sector. Furthermore, 28.2% of total manufacturing factories used inanimate power, mainly steam power (Minami 1976, p.222, p.226). Based on these observations, most literature on Japanese economic history has considered that Japan experienced an industrial revolution, similar to the British industrial revolution, in the early twentieth

[1] Calculated from the Maddison Historical Statistics (https://www.rug.nl/ggdc/historicaldevelopment/maddison/).
[2] Calculated from Umemura (1988, pp.196–199, pp.216–217).

century (Oishi eds. 1975; Nishikawa and Abe eds., 1990; Okazaki 1997; Gordon 2002; Flath 2014; Fukao, Nakamura and Nakabayashi eds., 2017).

The industry that led the Japanese industrial revolution was the textile industry. Panel A of Figure 1 shows that textile production increased sharply, and that its percentage of total manufacturing production was as high as 27.0–35.3% in the 1900s. The textile industry was composed of two large subsectors, namely, the fabric and thread industries. The former is the weaving industry. The latter includes the silk reeling industry producing raw silk and the cotton spinning industry producing cotton yarns. It is well documented that the silk reeling industry and the cotton spinning industry played an important role in the Japanese industrial revolution (Takamura 1971; Ishii 1972; Nakabayashi 2003; Braguinsky et al. 2015). The role of the weaving industry was also substantial. Its percentage of total manufacturing production was 10.4–15.1% in the 1900s (Panel B of Figure 1). In addition, the textile industry was the largest export industry. The percentage of textile and fabric in Japan's total exports was 49.3–56.7% and 10.7–14.4% in the 1900s (Panels A and B of Figure 2). The weaving industry, in turn, was composed of those producing silk, cotton, and wool fabrics, and the silk weaving industry, the focus of this paper, held a substantial share of the weaving industry, both in terms of production and exports (Figure 3).

Figure 1, Figure 2, Figure 3

The weaving industry experienced organizational and technological changes in the 1900s. We can observe these changes in the *Noshomu Tokeihyo (Statistical Report of the Department of Agriculture and Commerce)*. It should be noted that the statistics cover both the silk weaving and cotton weaving industries. Concerning organizations, factories diffused in the weaving industry. *Noshomu Tokeihyo* classifies fabric producers into four types, namely, factory, home workshop, putting-outer and outworker. This classification reflects that the putting-out system still played a substantial role. Factory refers to a plant that employs 10 or more workers, while home workshop refers to a plant that employs less than 10 workers. Figure 4 shows the number of workers who worked for each type of producer, where we add up putting-outer and outworker because they worked together under the putting-out system. We find that factory workers increased, whereas workers under the putting-out system and home workshops, especially the former, declined.

Figure 4

At the same time, a distinctive technological change, namely, diffusion of power looms took place (Minami, Ishii and Makino 1982; Saito and Abe 1987; Minami and Makino 1988). Figure 5 shows the percentage of power looms of the total number of looms including power looms and handlooms in the weaving industry. The percentage of power looms, which was just 3.1% in 1905 increased to 20.5% by 1914. This technological change was related to the organizational change above. That is, not surprisingly, power looms were adopted much faster by factories than by other types of producers. For factories, the percentage of power looms reached as high as 68.1% by 1914 (Figure 5). Diffusion of the factory system and inanimate power indicate that the Japanese weaving industry in this period experienced the essential elements of the industrial revolution.

Figure 5

3. Descriptive analyses

Hereafter, we focus on the silk weaving industry in Fukui Prefecture, for which detailed plant-level data are available. Fukui Prefecture is located around the middle of the Japan Sea Side (Figure 6). Fukui was a relatively small and poor prefecture. That is, in 1909, its population was 42nd largest of the total 47 prefectures, and its per capita GDP was 30th largest. On the other hand, industrialization progressed earlier in Fukui Prefecture. That is, in terms of the ratio of the value added by the manufacturing industries to the prefectural GDP, it was 19.6% in 1909, which was the 8th highest among the 47 prefectures[3]. The manufacturing industry in Fukui Prefecture specialized in the textile industry. According to the statistics of the factories employing five or more workers, the percentage of the textile industry in the total manufacturing production was 86.9% for Fukui Prefecture, whereas it was 49.4% for Japan in total (Ministry of International Trade and Industry 1961, pp.200–201, 220–221). In particular, Fukui Prefecture specialized in the silk weaving industry. Indeed, the percentage contribution of Fukui Prefecture to total silk fabric production in Japan was as high as around 20% in the 1900s (Figure 7).

Figure 6, Figure 7

The *Statistical Yearbook of Fukui Prefecture*, the basic data source of this paper, provides two sets of data on the silk weaving industry. The first provides data that cover

[3] Calculated from the data of Yuan et al. (2009).

all types of producers, including factory, home workshop, putting-outer, and outworker, and are aggregated by city and county. The second provides data on factories at the plant-level. The plant-level data cover all the industries, but here we focus on silk weaving factories.

First, we observe the features of the silk weaving industry in Fukui Prefecture including all types of producers based on the aggregated data. Figures 8 and 9 are the counterparts of Figures 4 and 5 for the silk and cotton weaving industries in Japan. It is evident that the silk weaving industry in Fukui Prefecture experienced the same organizational and technological changes, and that the changes in Fukui silk weaving were much larger and swifter. That is, factory workers, the percentage of which was 34.6% in 1905, came to have a dominant position (59.8%) by 1914. There were no power looms in 1905, but the percentage of power looms became as high as 62.0% in 1914. Furthermore, it was 74.2% for factories. We can say that the silk weaving industry in Fukui Prefecture dramatically experienced the industrial revolution in the 1900s.

Figure 8, Figure 9

Hereinafter, we focus on factories, for which detailed plant-level data are available. The *Statistical Yearbook of Fukui Prefecture* provides plant-level data from 1904 to 1917. The data include information about the industry, plant name, location (town and village), owner name, foundation year, major product, power source, total horsepower, daily working hours, number of workers by gender and age category, wage per day by gender and age category. We use the data from 1904 to 1914. One of the reasons we do not use the data from 1915 is that the age category was revised in 1915. Both female and male workers were classified as an adult at 14 years old (Femaleadult and Maleadult) and as children if less than 14 years old (Femalechild and Malechild), until 1914. The threshold was moved to 15 years old in 1915. Another reason is that we want to exclude the impact of World War I. Although the information on looms is not available, we can identify power loom plants by the information on the power source. That is, we regard those plants using inanimate power as power loom plants, and the other plants as handloom plants. The change over time in the numbers of powered and non-powered plants in our samples is illustrated in Figure 10. We find a swift substitution of non-powered plants by powered plants, which is consistent with Figure 9 based on the aggregated data[4]. There were 1

[4] Concerning the development of the silk weaving industry and diffusion of power looms in Fukui Prefecture, see Kandachi (1974), Fukui Prefecture ed. (1994), Kogita (2001) and Hashino (2006, 2012).

city (Fukui City) and 11 counties in Fukui Prefecture, but 2 counties were omitted from our samples. Table 1 tabulates the samples by city and county. Although Fukui City had the largest number of plants, seven other counties had many plants as well. The most rapid adoption of power looms occurred in Ono County, Nanjo County and Fukui City.

Figure 10, Table 1

The basic statistics are reported in Table 2. Worker refers to the number of total workers. That is:

Worker = Femaleadult + Femalechild + Maleadult + Malechild + Femaleoddjobber + Maleoddjobber

Hours refers to daily working hours. WageX is the wage per day of each worker group X, and Hourwage is the wage per hour (Wage/Hour). As we discuss in Section 5, the wage per day is not the daily wage but the sum of the piece-rate wage in a certain period divided by the number of days in that period.

We define Maleratio, Childratio, Rwagemaleadult, and Rwagefemalechild as:

Maleratio = (Maleadult + Malechild)/
(Femaleadult + Femalechild + Maleadult + Malechild)
Childratio = (Femalechild + Malechild)/
(Femaleadult + Femalechild + Maleadult + Malechild)
Rwagemaleadult = Wagemaleadult/Wagefemaleadult
Rwagefemalechild = Wagefemalechild/Wagefemaleadult

Looking at Panel A of Table 2, we find that there was substantial variation in plant scale. In principle, a 'factory' was defined as a plant employing 10 or more workers, as mentioned above, but a small number of plants with fewer than 10 workers (18 observations out of a total 4,431 observations) are included. A major percentage of workers were female adults, but there were non-negligible numbers of female child workers and male adult workers. Female adult workers earned the highest wage on average. A little surprisingly, the average wage per day of female adult workers was 12.5% higher than for male adult workers. In addition, the average wage per day of female adult workers was around three times higher than the female child wage.

Panels B and C of Table 2 compare powered plants with non-powered plants. Some significant differences are observed. First, powered plants were substantially larger than non-powered plants, on average. It is notable that there were very large non-powered plants. Indeed, the largest plant with 698 workers was non-powered. Second, Maleratio was higher at powered plants. Third, the wages per day of adult workers, both female and male, were substantially higher at powered plants. Fourth, unlike at non-powered plants, the male adult wage was higher than the female adult wage at powered plants.

Table 2

These observations are suggestive for considering the implications of technological change on the wages and lives of workers during the industrial revolution, but we must note that there are many other factors, including location-specific factors and year-specific factors. Indeed, the literature on the diffusion of power looms points out that power looms were adopted in the areas where wages increased (Minami, Ishii and Makino 1982; Saito and Abe 1987). Higher wages at powered plants in Table 2 may reflect this causal relationship. Hence, to identify the impact of technological change, we conduct regression analyses, exploiting our detailed plant-level data, in the next section.

4. Regression analyses

To investigate the impact of the adoption of power looms on the wages and lives of workers, we estimate the following baseline model:

$$Y_{it} = \alpha + \beta Power_{it} + \gamma Ln(Worker_{it}) + \delta_r + \lambda_t + \varepsilon_{it}$$

Y_{it} represents the condition of the workers at plant i in year t. $Power_{it}$ is the dummy variable that takes the value 1 if plant i adopted power looms in year t, and 0 otherwise. δ_r and λ_t are city/county and year fixed effects, respectively. $Worker_{it}$ is the number of workers at plant i in year t. ε_{it} is the error term.

First, we use the wage per day (in log) of each category of workers (female adult, female child, male adult, and male child) as the dependent variable. The estimation results are reported in Table 3. Column (1) of Panel A indicates that the wage per day of female adult workers at powered plants was 16.4% higher than that at non-powered plants, on average after controlling for year fixed effects and city/county fixed effects. Column (2) reports the result when we add plant scale to the explanatory variables.

Plant scale had a positive impact on the wage, but the impact of power looms is almost unchanged. In columns (3) and (4), we control for year and city/county fixed effects. The wage per day of female adult workers at powered plants was 15–16% higher than that at non-powered plants, in this case as well. The results in columns (3) and (4) indicate that the wage per day in powered plants was higher within the same city/county in the same year. This strongly suggests that the higher wage at powered plants was not just a reflection of the condition of the labour market where they were located. Panels B, C, and D of Table 3 report the estimation results when we use the wages per day of female child workers, male adult workers, and male child workers, respectively. For female child and male adult, we can consistently confirm a positive impact of power looms on the wage of around 10% or more, whereas for male child workers, the positive impact is not statistically significant if we control for plant scale as well as year and city/county fixed effects.

Table 3

The higher wage per day at powered plants may reflect longer working hours. To check this, we regress the log of daily working hours (Ln(Hours)) on the same variables. The estimation results are reported in Table 4. Column (1) indicates that on average, daily working hours were 4.3% longer at powered plants than non-powered plants, and as column (2) indicates, this result is almost unchanged after controlling for the plant scale. However, when we control for year and city/county fixed effects, the impact of power looms becomes insignificant.

Table 4

Considering the impact on working hours, we look at the wage per hour, namely, the wage per day divided by daily working hours. Table 5 is the counterpart of Table 3 when we change the dependent variable from the wage per day to the wage per hour. The results are qualitatively the same as those in Table 3. That is, except for male child workers, the wage per hour at powered plants was significantly higher than that at non-powered plants on average, and these results are robust even if we control for year and city/county fixed effects.

Table 5

The literature on technology–skill complementarity has been focusing on the impact of technological changes on the relative wage and the composition of the labour force (Goldin and Sokoloff 1982; Goldin and Katz 1998). If technological change increases the demand for skills, the relative wage of skilled workers would rise and the ratio of skilled to unskilled workers will increase. We can study this issue using our data. First, we look at the relative wage between genders. That is, we regress Rwagemaleadult (= Wagemaleadult/Wagefemaleadult) on the same explanatory variables as the previous regressions. The estimation results are reported in Panel A of Table 6. The coefficients of Power are positive and statistically significant. We see that the relative wage of male adult workers was around 10–20% higher at powered plants than at non-powered plants. Powered plants tended to employ male adult workers with higher skills. In Panel B of Table 6, we use Rwagefemalechild (= Wagefemalechild/Wagefemaleadult) as the dependent variable. We find that for this variable there was no significant difference between powered plants and non-powered plants.

Second, we examine the difference in the composition of workers. For this purpose, we use Maleratio and Childratio as the dependent variables. The estimation results are reported in Panels A and B of Table 7. It is found that Maleratio was consistently 5–6% points higher at powered plants. Assuming that the skill level of male workers was higher, we can interpret the result as that adoption of power looms increased the demand for skills, which is consistent with technology–skill complementarity. Concerning Childratio, when we control for year and city/county fixed effects, the coefficient of Power is negative and statistically significant. This result is also consistent with technology–skill complementarity.

5. Discussion

Regressions in the previous section consistently indicate a higher wage at powered plants than at non-powered plants. To understand the reason for this, we look at descriptive documents. A report by the silk weaving association in Fukushima Prefecture (Kawamata Silk Weaving Association 1910, pp.85–89) states that the piece-rate system was applied in the silk weaving industry in Fukui Prefecture and that a worker produces six units of fabric in one month with a handloom, whereas she produce 15 units of fabric with two power looms. Because a worker did not need to move the shuttle of a power loom, she could operate two power looms at the same time. Meanwhile, the piece wage per unit of fabric was 1.1 yen with a handloom, whereas it was 0.6 yen with power looms. This implies the monthly earning of a worker was 6.6 yen with a handloom, whereas it was 9.0 yen with power looms[5]. Even though a firm reduced the piece rate for power

[5] Inoue (1913, p.82) writes on the silk weaving industry in Fukui, Ishikawa, and

looms, a worker could still earn a higher wage thanks to the much higher productivity of power looms.

We can see that power looms enhanced the marginal productivity of labour, and thereby increased firms' willingness to pay higher wages. This would result in a shift of workers from handloom plants to power loom plants, which indeed occurred. An owner of a silk weaving plant in Ishikawa Prefecture, next to Fukui Prefecture, stated (Fukushima Prefecture 1912, pp.454–455):

> We have just operated 300 sets of handlooms, but the earning of female workers is by far lower with handlooms than with power looms. Hence, we have discarded most workers, and now only workers with a close relationship with our firm and unwaged apprentices remain. We intend to substitute power looms for handlooms and are now installing 50 sets of power looms … Even if we pay a wage higher than other handloom plants, the monthly earning of a female worker is 7–8 yen. Meanwhile, at a power loom plant, she will earn more than 10 yen without effort. Hence, we cannot keep female workers. To compete with other plants, we should install power plants as soon as possible now.

The swift shift from handlooms to power looms in Fukui Prefecture shown in Figures 8 and 10 reflect the competitive pressure from power loom plants in the labour market (Matsumura 2010).

Regression analyses also revealed that the ratio of male adult workers was higher at powered plants and that the relative wage of male adult workers to female adult workers was also higher at powered plants. Inoue (1913, pp.84–85) classified workers of the silk weaving industry in Fukui, Ishikawa, and Toyama Prefectures into three types, namely, (a) workers for preparation, (b) workers for weaving, and (3) mechanics, and writes that mechanics, who take charge of all the tasks for managing power looms such as oiling and repairing, are newly employed since the installation of power looms. The higher ratio of male adult workers and their higher relative wage would be because adoption of power looms generated a new type of skilled workers, i.e. mechanics, who also emerged in late nineteenth-century U.S. (Goldin and Katz 1998).

Toyama Prefectures that a worker could produce 3–4 units of fabric with a handloom in a month, whereas a worker could produce 16 units of fabric with two sets of power looms in a month. Meanwhile, the piece wage per unit of fabric was 1.0 yen with a handloom, whereas it was 0.5 yen with power looms, which implies a worker earned more than twice as much with power looms.

6. Conclusion

The British industrial revolution had a profound impact on the lives of the working class. Regarding the direction and nature of the impact, the Standard of Living Debate has been continuing since the nineteenth century. Motivated by the literature on the debate and the literature on technology–skill complementarity, this paper explores the effect that power looms had on the wages and skills of workers in early twentieth-century Japan. In this period, the Japanese economy experienced the essential elements of the industrial revolution, such as the adoption of the factory system and mechanization. Exploiting detailed plant-level data on the silk weaving industry, we compared wages and composition of workers between powered and non-powered plants. We found that (a) wages, (b) the wage of male adult workers relative to female adult workers, and (c) the ratio of male workers, were higher at powered plants than non-powered plants. (a) reflects the higher marginal productivity of labour, while (b) and (c) were caused by the emergence of a new type of skilled worker, i.e. mechanics.

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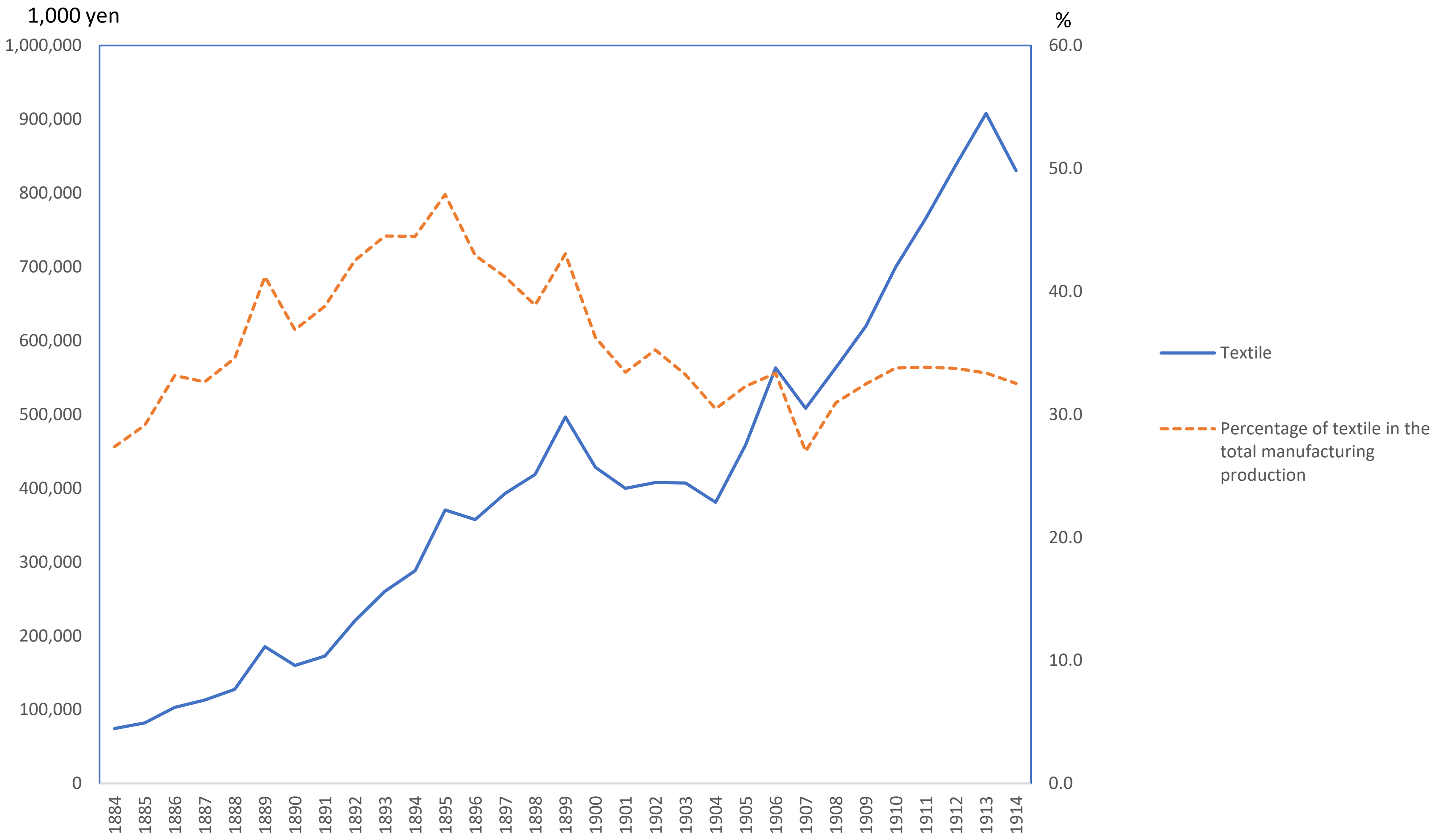
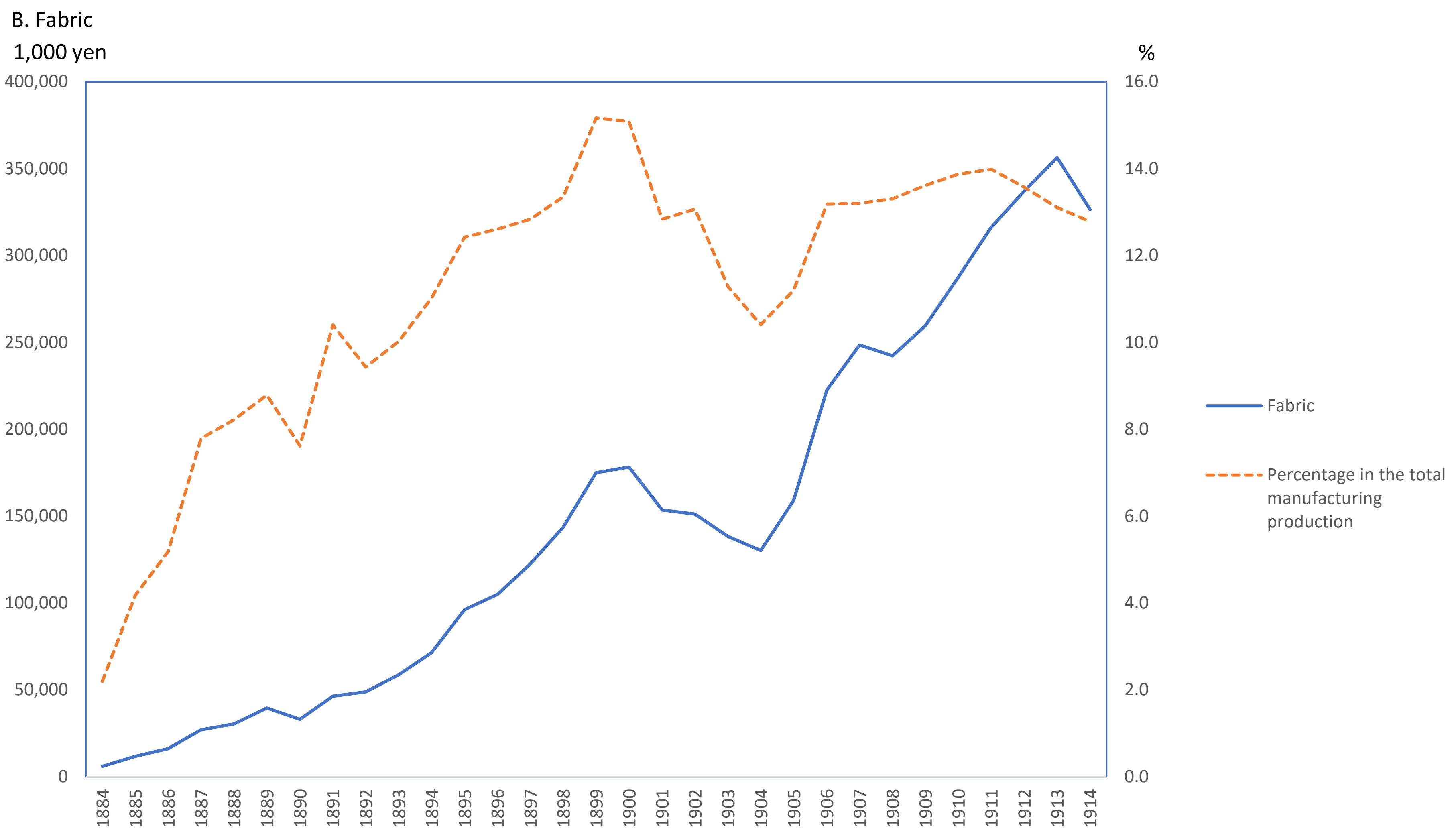
Figure 1 Development of the textile industry in Japan

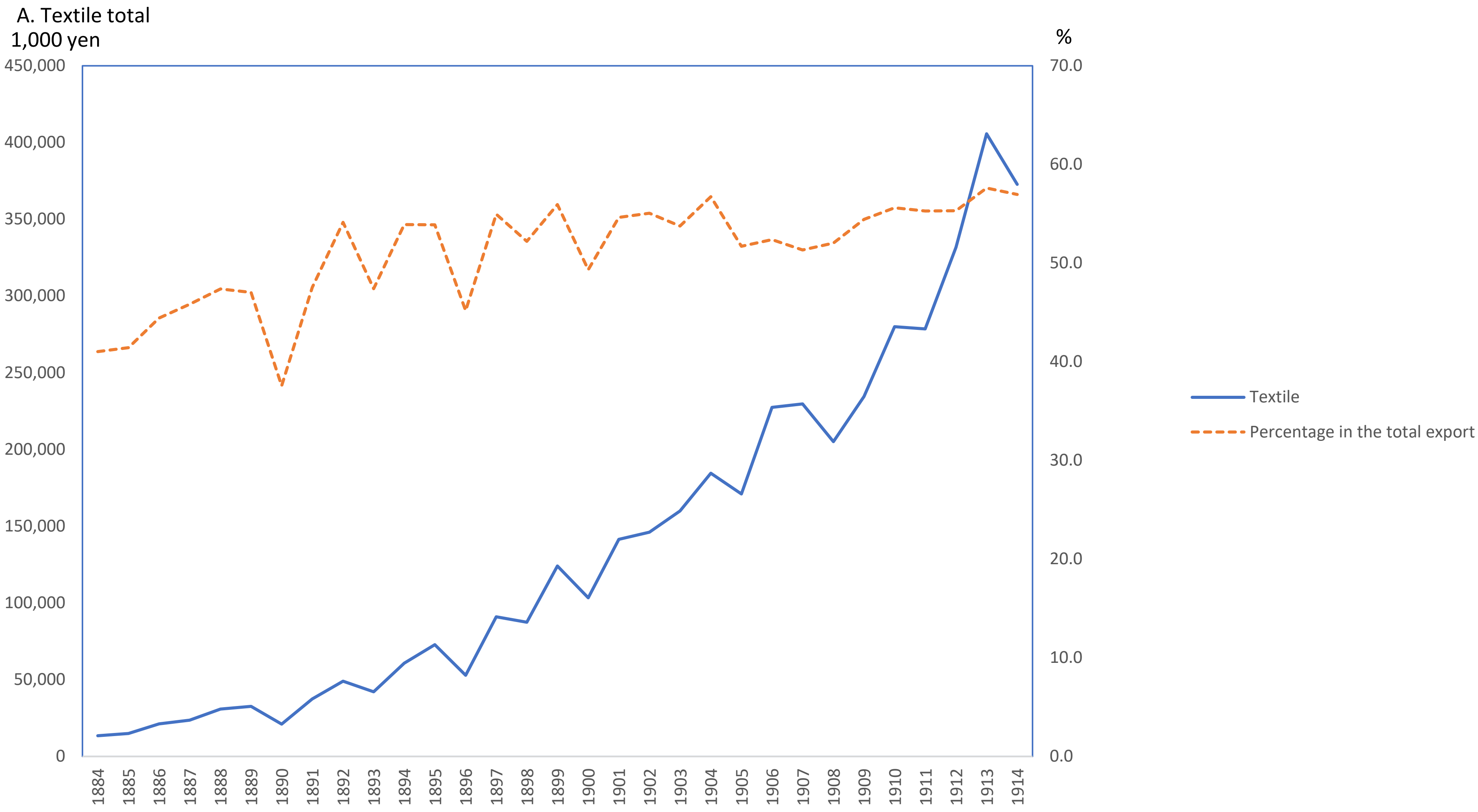
A. Textile total

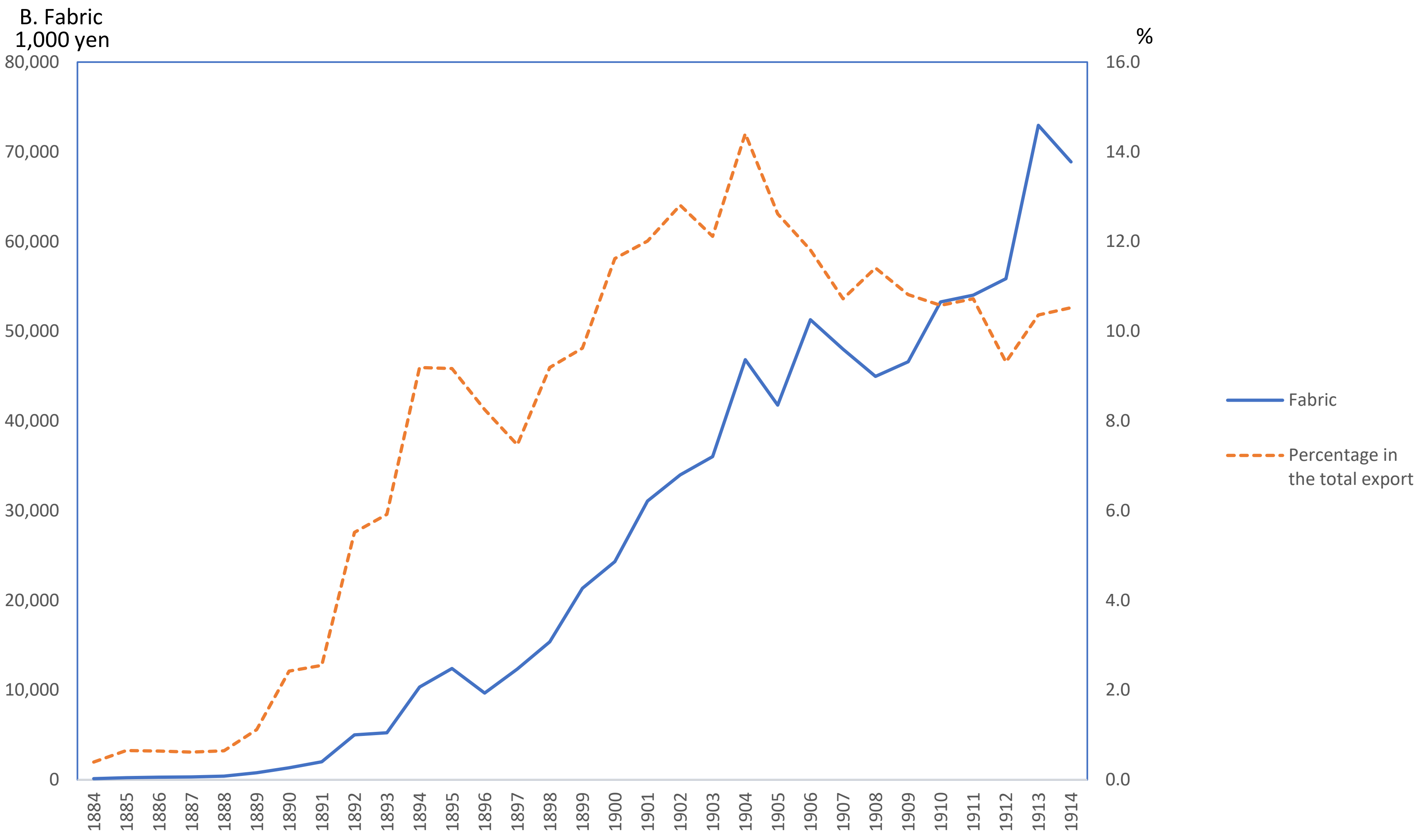




Source: Shinohara (1972), pp.140-143, pp.194-195.

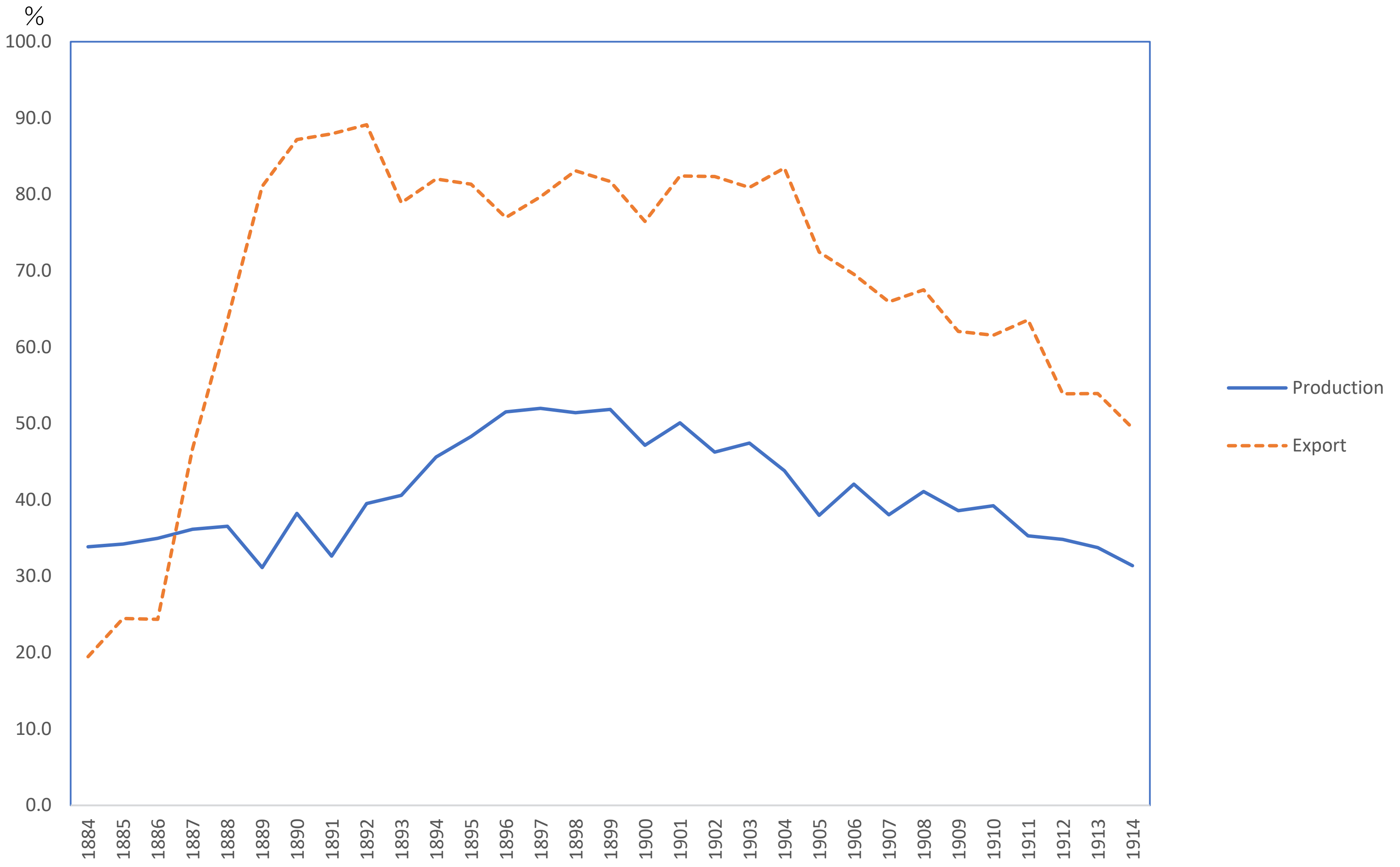
Figure 2 Export of textile from Japan





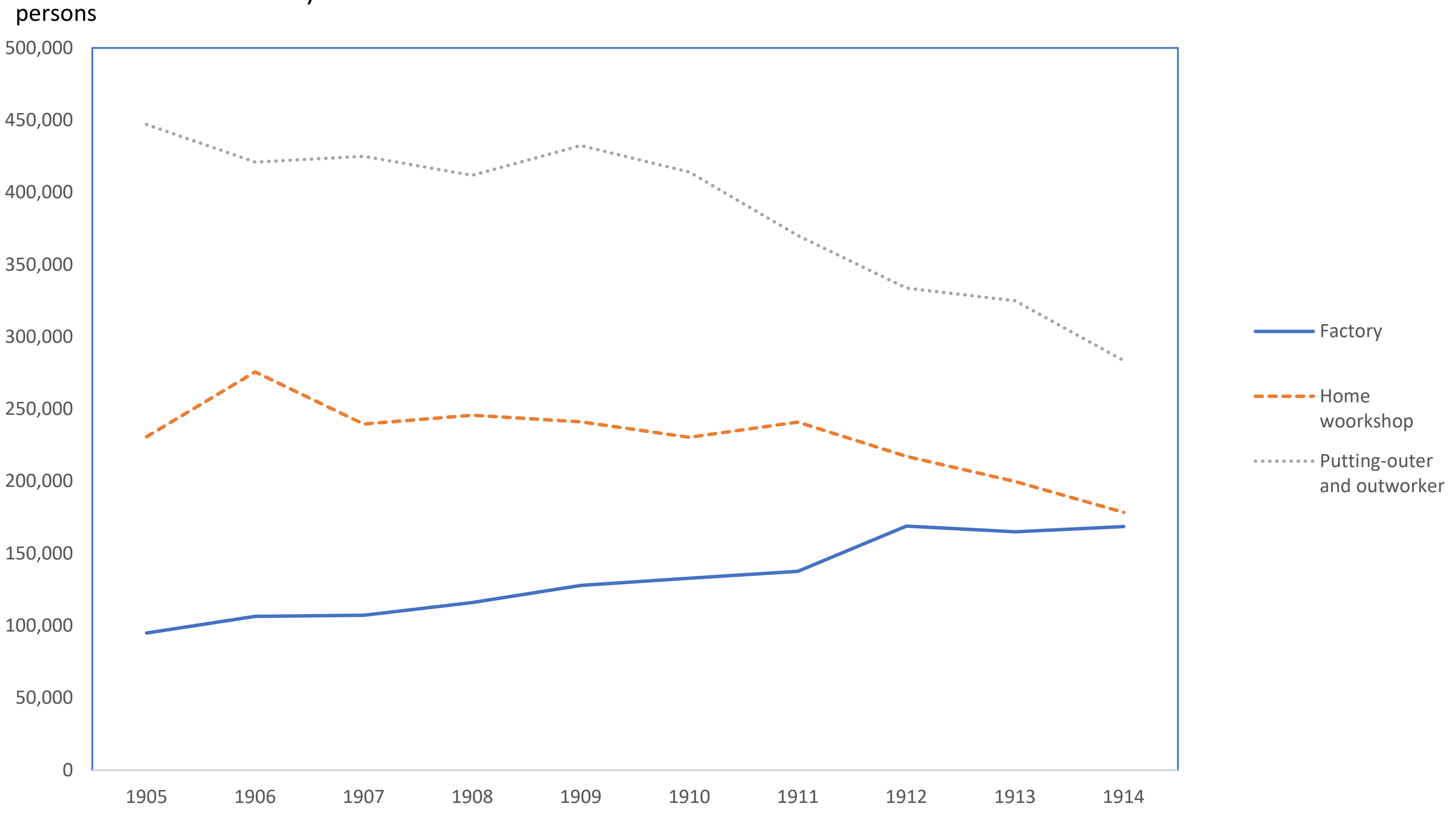
Source: Asahi Shinbunsha (1930), pp.248-249; Yamazawa and Yamamoto (1979), pp.176-177.

Figure 3 Percentage of silk fabric in the tatal fabric production and export



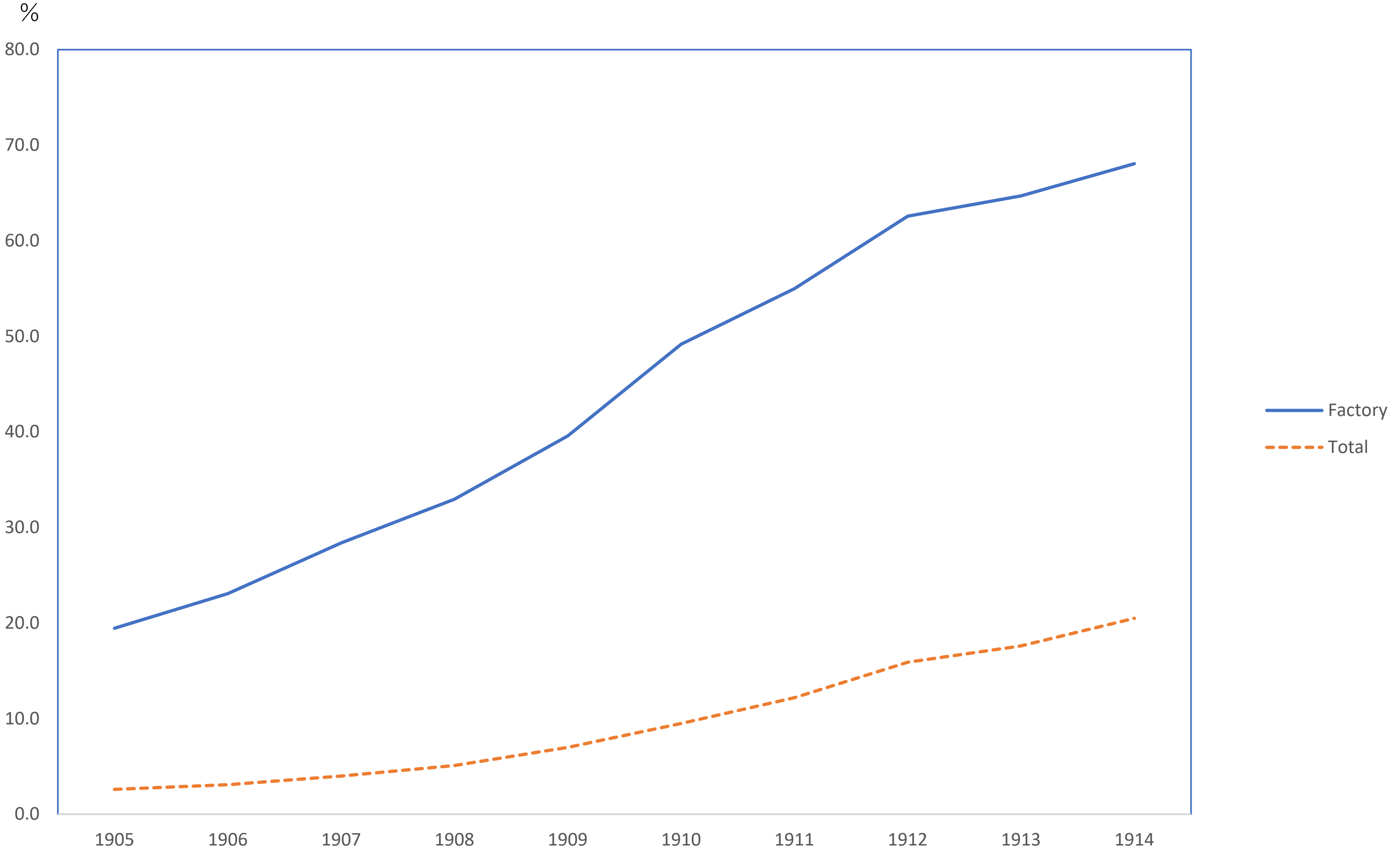
Source: Asahi Shinbunsha (1930), pp.158-149; Shinohara (1972), pp.194-195.

Figure 4 Diffusion of factories in the weaving industry in Japan (Number of workers)



Source: Ministry of Agriculture and Commerce, *Noshomu Tokeihyo (Statistical Report of the Department of Agriculture and Commerce)*, various issues.

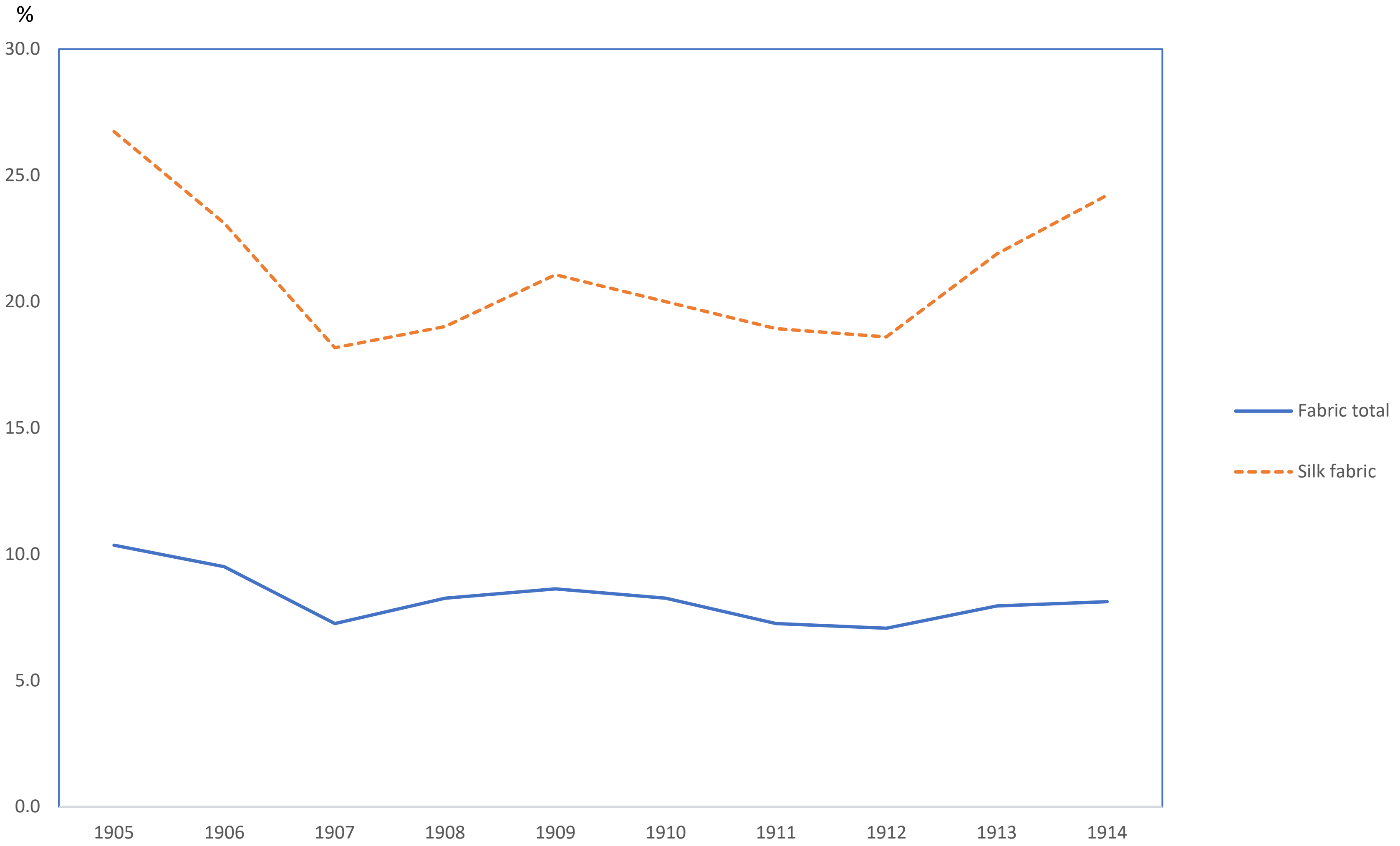
Figure 5 Diffusion of power looms in the weabing industry (powerlooms/total looms)



Source: See Figure 4.

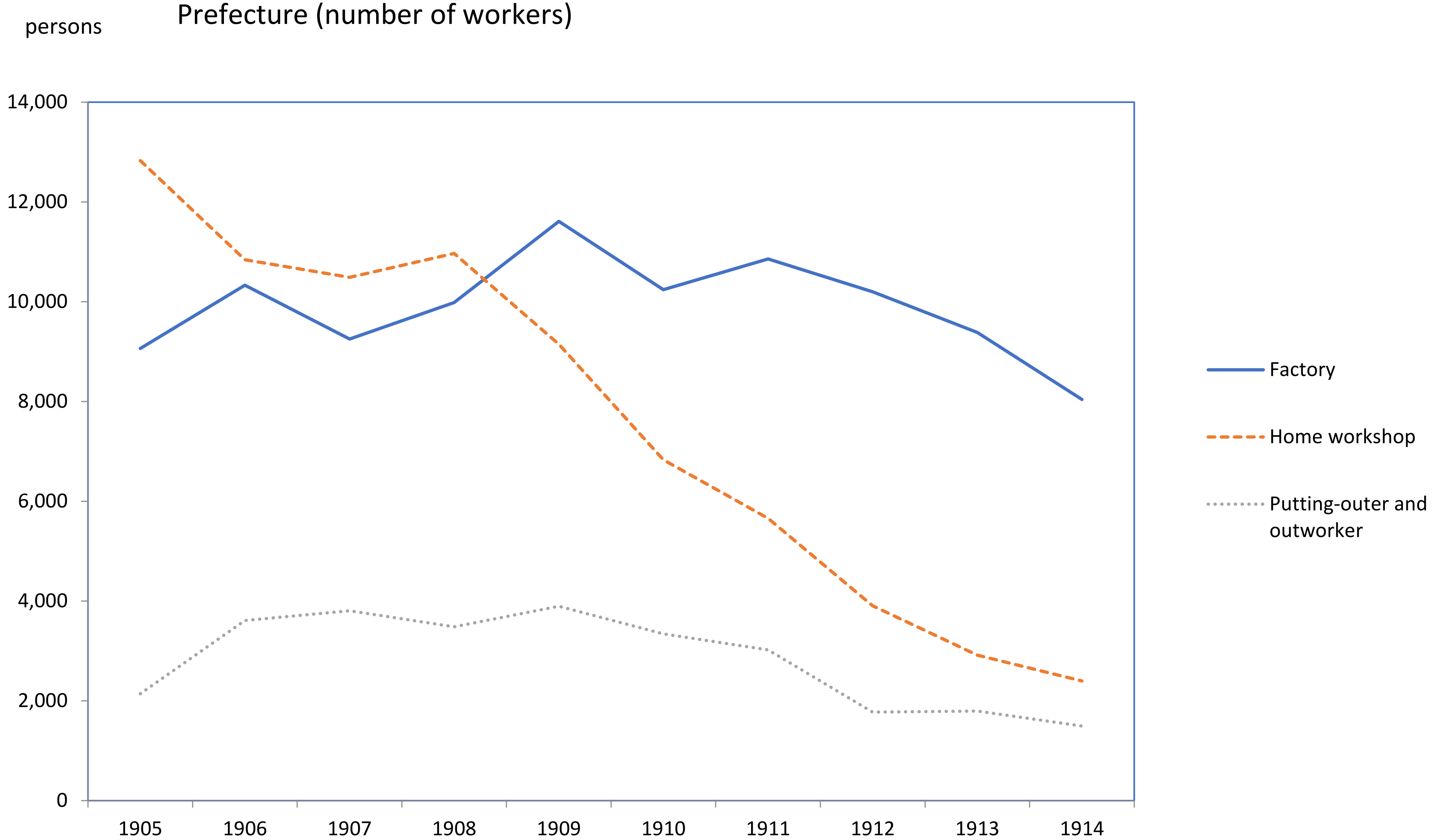
Figure 6 Map of Japan

Figure 7 Share of Fukui Prefecture in the fabric production



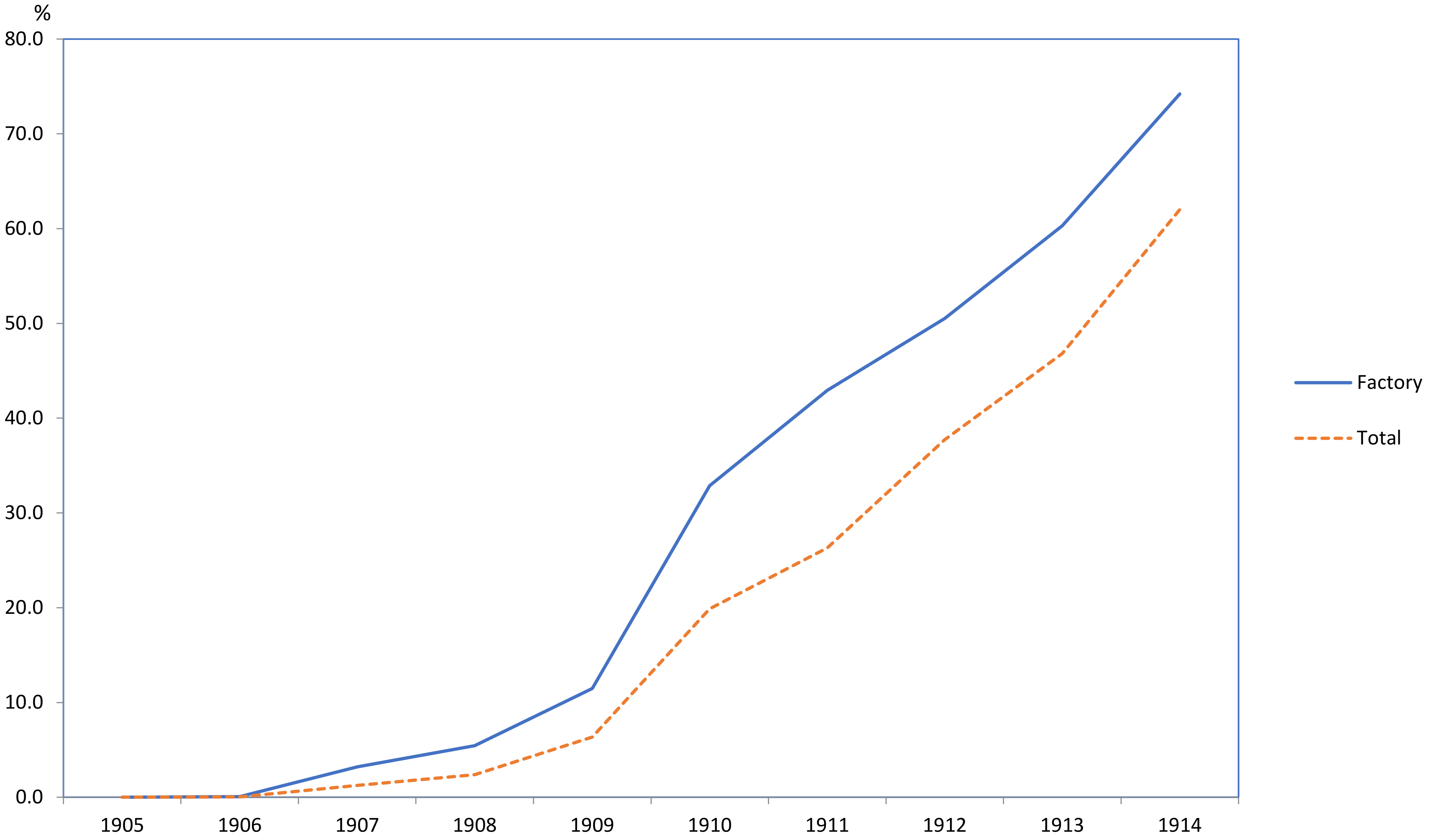
Source: Shinohara (1972), pp.194-195; Fukui Prefecture Office, *Fukui Ken Tokeisho (Statistical Yearbook of Fukui Prefecture)* , various issues.

Figure 8 Diffusion of factories in the silk weaving industry in Fukui Prefecture (number of workers)



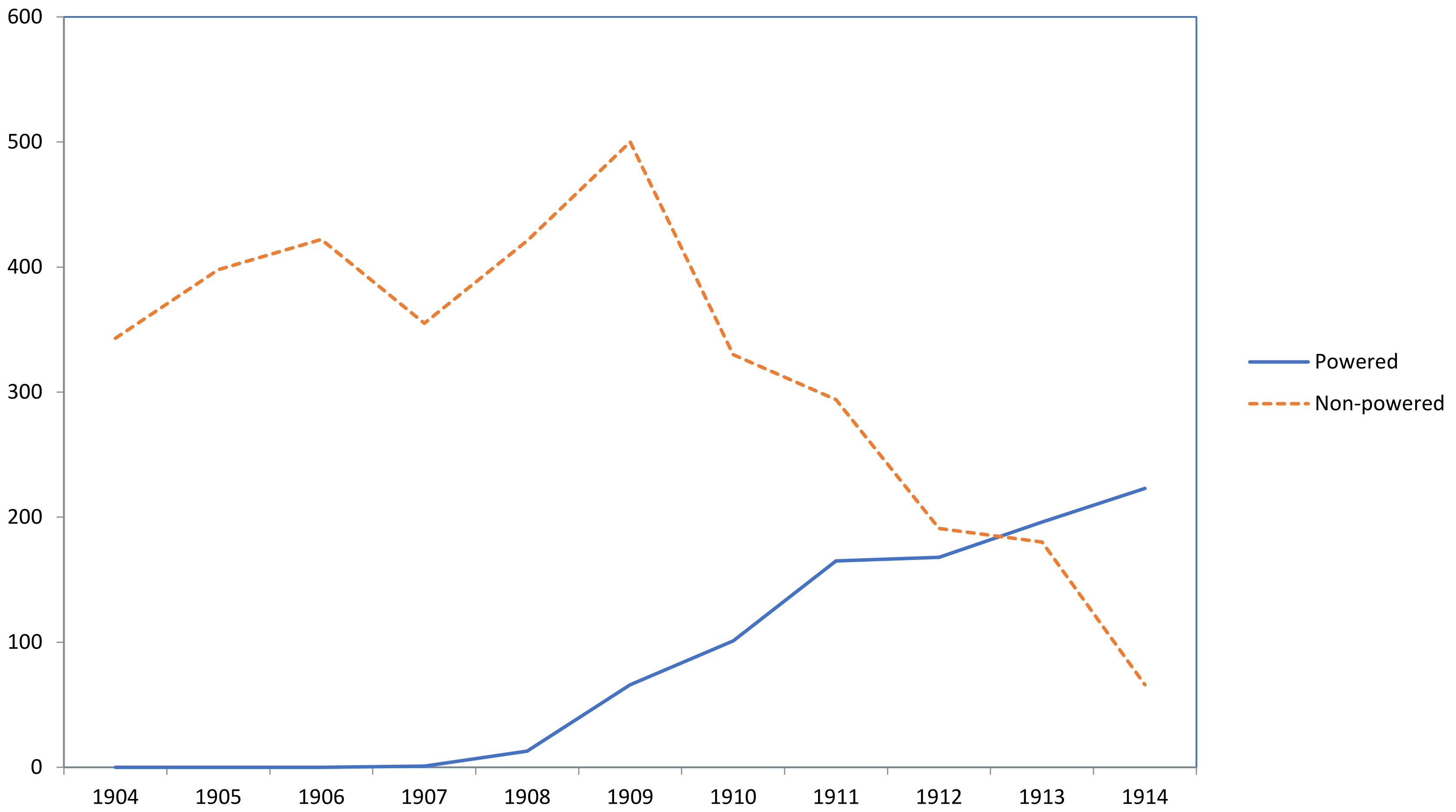
Source: Fukui Prefecture Office, *Fukui Ken Tokeisho (Statistical Yearbook of Fukui Prefecture*), various issues.

Figure 9 Diffusion of powerlooms in the silk weaving industry in Fukui Prefecture (powerlooms/ (powerlooms+ handlooms)



Source: See Figure 7.

Figure 10 Number of silk weaving factories in Fukui Prefecture by technology



Source: See the main text.

Table 1 Sample plants by city and county

	Total	Powered	Non-powered	Percentage of powered plants
Total	4,431	932	3,499	21.0
Fukui City	1,115	310	805	27.8
Asuwa County	556	24	532	4.3
Yoshida County	825	136	689	16.5
Sakai County	888	165	723	18.6
Ono County	344	143	201	41.6
Imadate County	443	117	326	26.4
Nyu County	163	8	155	4.9
Nanjo County	90	29	61	32.2
Onyu County	6	0	6	0.0
Oii County	1	0	1	0.0

Table 2 Basic statistics

A. Total

Variable	Obs	Mean	Std. Dev.	Min	Max
Worker	4,431	24.758	23.835	4.000	698.000
Ln(Worker)	4,431	3.007	0.567	1.386	6.548
Femaleadult	4,431	18.643	19.249	0.000	643.000
Femalechild	4,431	3.117	5.406	0.000	96.000
Maleadult	4,431	2.246	3.432	0.000	55.000
Malechild	4,431	0.520	1.382	0.000	30.000
Femaleoddjobber	4,431	0.103	1.539	0.000	90.000
Maleoddjobber	4,431	0.129	0.880	0.000	27.000
Hours	4,431	11.451	1.343	5.000	17.000
Ln(Hours)	4,431	2.431	0.118	1.609	2.833
Maleratio	4,431	0.108	0.100	0.000	1.000
Childratio	4,431	0.149	0.173	0.000	1.000
Wagefemaleadult	4,431	21.169	5.687	0.000	45.000
Wagefemalechild	4,431	7.222	6.491	0.000	45.000
Wagemaleadult	4,431	18.812	14.225	0.000	80.000
Wagemalechild	4,431	3.215	5.955	0.000	37.000
Hourwagefemaleadult	4,431	1.871	0.528	0.000	4.500
Hourwagefemalechild	4,431	0.631	0.570	0.000	4.500
Hourwagemaleadult	4,431	1.651	1.252	0.000	6.364
Hourwagemalechild	4,431	0.276	0.513	0.000	3.700
Ln(Wagefemaleadult)	4,416	3.022	0.261	1.386	3.807
Ln(Wagefemalechild)	2,661	2.446	0.291	0.693	3.807
Ln(Wagemaleadult)	3,068	3.259	0.295	0.693	4.382
Ln(Wagemalechild)	1,073	2.550	0.275	0.693	3.611
Ln(Hourwagefemaleadult	4,416	0.591	0.281	-1.099	1.504
Ln(Hourwagefemalechild)	2,661	0.005	0.304	-1.609	1.504
Ln(Hiourwagemaleadult)	3,068	0.825	0.302	-1.872	1.851
Ln(Hourwagemalechild)	1,073	0.092	0.281	-1.609	1.308
Rwagemaleadult	4,416	0.855	0.612	0.000	4.000
Rwagefemalechild	4,416	0.363	0.323	0.000	3.000

B. Powered plants

	Obs	Mean	Std. Dev.	Min	Max
Worker	932	31.116	28.921	7.000	383.000
Ln(Worker)	932	3.188	0.655	1.946	5.948
Femaleadult	932	24.266	22.271	1.000	310.000

Femalechild	932	2.128	4.486	0.000	70.000
Maleadult	932	3.980	4.993	0.000	46.000
Malechild	932	0.318	1.458	0.000	30.000
Femaleoddjobber	932	0.237	3.141	0.000	90.000
Maleoddjobber	932	0.188	1.353	0.000	25.000
Hours	932	11.572	1.180	8.000	15.000
Ln(Hours)	932	2.443	0.102	2.079	2.708
Maleratio	932	0.133	0.103	0.000	0.923
Childratio	932	0.080	0.108	0.000	0.645
Wagefemaleadult	932	27.214	5.050	0.000	45.000
Wagefemalechild	932	6.939	7.573	0.000	27.000
Wagemaleadult	932	29.996	13.500	0.000	70.000
Wagemalechild	932	2.069	5.770	0.000	37.000
Hourwagefemaleadult	932	2.371	0.475	0.000	4.500
Hourwagefemalechild	932	0.604	0.659	0.000	2.600
Hourwagemaleadult	932	2.602	1.188	0.000	6.364
Hourwagemalechild	932	0.180	0.505	0.000	3.700
Ln(Wagefemaleadult)	931	3.288	0.186	2.708	3.807
Ln(Wagefemalechild)	457	2.615	0.261	1.609	3.296
Ln(Wagemaleadult)	800	3.537	0.183	2.833	4.248
Ln(Wagemalechild)	115	2.781	0.279	2.079	3.611
Ln(Hourwagefemaleadult	931	0.845	0.202	0.069	1.504
Ln(Hourwagefemalechild)	457	0.173	-0.265	0.956	0.956
Ln(Hiourwagemaleadult)	800	1.090	0.197	0.194	1.851
Ln(Hourwagemalechild)	115	0.335	-0.285	0.486	1.308
Rwagemaleadult	931	1.110	0.506	0.000	2.778
Rwagefemalechild	931	0.261	0.282	0.000	1.000

C. Non-powered plants

	Obs	Mean	Std. Dev.	Min	Max
Worker	3,499	23.064	21.982	4.000	698.000
Ln(Worker)	3,499	2.958	0.531	1.386	6.548
Femaleadult	3,499	17.145	18.071	0.000	643.000
Femalechild	3,499	3.381	5.598	0.000	96.000
Maleadult	3,499	1.784	2.697	0.000	55.000
Malechild	3,499	0.574	1.356	0.000	21.000
Femaleoddjobber	3,499	0.067	0.606	0.000	21.000
Maleoddjobber	3,499	0.113	0.701	0.000	27.000
Hours	3,499	11.418	1.382	5.000	17.000

Ln(Hours)	3,499	2.428	0.122	1.609	2.833
Maleratio	3,499	0.102	0.098	0.000	1.000
Childratio	3,499	0.168	0.182	0.000	1.000
Wagefemaleadult	3,499	19.559	4.674	0.000	40.000
Wagefemalechild	3,499	7.297	6.170	0.000	45.000
Wagemaleadult	3,499	15.833	12.867	0.000	80.000
Wagemalechild	3,499	3.520	5.967	0.000	25.000
Hourwagefemaleadult	3,499	1.737	0.456	0.000	4.000
Hourwagefemalechild	3,499	0.638	0.544	0.000	4.500
Hourwagemaleadult	3,499	1.398	1.143	0.000	5.714
Hourwagemalechild	3,499	0.302	0.512	0.000	2.500
Ln(Wagefemaleadult)	3,485	2.951	0.231	1.386	3.689
Ln(Wagefemalechild)	2,204	2.410	0.285	0.693	3.807
Ln(Wagemaleadult)	2,268	3.161	0.262	0.693	4.382
Ln(Wagemalechild)	958	2.522	0.261	0.693	3.219
Ln(Hourwagefemaleadult	3,485	0.523	0.260	-1.099	1.386
Ln(Hourwagefemalechild	2,204	-0.030	0.300	-1.609	1.504
Ln(Hiourwagemaleadult)	2,268	0.731	0.276	-1.872	1.743
Ln(Hourwagemalechild)	958	0.063	0.266	-1.609	0.916
Rwagemaleadult	3,485	0.787	0.620	0.000	4.000
Rwagefemalechild	3,485	0.391	0.327	0.000	3.000

Table 3 Impact of power looms on daily wage

A. Dependent variable: Ln(Wagefemaleadult)

	(1)			(2)			(3)			(4)		
Power	0.164	(18.58)	***	0.154	(17.32)	***	0.161	(18.15)	***	0.153	(17.21)	***
Ln(Worker)				0.031	(6.13)	***				0.028	(6.13)	***
Const.	2.797	(238.69)	***	2.701	(137.20)	***	2.624	(130.15)	***	2.535	(102.41)	***
Year FE	Yes			Yes			Yes			Yes		
City/County FE	Yes			Yes			Yes			Yes		
Year and City/County FE	No			No			Yes			Yes		
# of obs.	4,416			4,416			4,416			4,416		
R^2	0.479			0.483			0.587			0.590		

B. Dependent variable: Ln(Wagefemalechild)

	(1)			(2)			(3)			(4)		
Power	0.107	(6.18)	***	0.104	(5.87)	***	0.104	(5.95)	***	0.099	(5.56)	***
Ln(Worker)				0.007	(0.81)					0.015	(1.66)	*
Const.	2.411	(172.08)	***	2.387	(77.01)	***	2.406	(234.90)	***	2.359	(79.34)	***
Year FE	Yes			Yes			Yes			Yes		
City/County FE	Yes			Yes			Yes			Yes		
Year and City/County FE	No			No			Yes			Yes		
# of obs.	2,661			2,661			2,661			2,661		
R^2	0.197			0.197			0.311			0.312		

C. Dependent variable: Ln(Wagemaleadult)

	(1)			(2)			(3)			(4)		
Power	0.187	(17.08)	***	0.171	(15.73)	***	0.129	(12.32)	***	0.115	(11.14)	***
Ln(Worker)				0.052	(8.28)	***				0.050	(8.91)	***
Const.	3.01	(213.49)	***	2.845	(118.69)	***	2.909	28.17	***	2.732	(28.34)	***
Year FE	Yes			Yes			Yes			Yes		
City/County FE	Yes			Yes			Yes			Yes		
Year and City/County FE	No			No			Yes			Yes		
# of obs.	3,068			3,068			3,068			3,085		
R^2	0.503			0.513			0.535			0.645		

D. Dependent variable: Ln(Wagemalechild)

	(1)			(2)			(3)			(4)		
Power	0.105	(2.81)	***	0.097	(2.56)	***	0.070	(1.76)	*	0.060	(1.49)	
Ln(Worker)				0.020	(1.56)					0.023	(1.79)	*
Const.	2.462	(123.09)	***	2.395	(50.27)	***	2.483	(205.16)	***	2.41	(56.49)	***
Year FE	Yes			Yes			Yes			Yes		
City/County FE	Yes			Yes			Yes			Yes		
Year and City/County FE	No			No			Yes			Yes		
# of obs.	1,073			1,073			1,073			1,073		
R^2	0.232			0.233			0.381			0.382		

Table 4 Impact of power looms on daily working hours

Dependent variable: Ln(Hours)

	(1)			(2)			(3)			(4)		
Power	0.043	(7.89)	***	0.039	(7.02)	***	0.008	(1.72)	*	0.005	(1.00)	
Ln(Worker)				0.014	(5.01)	***				0.011	(4.61)	***
Const.	2.439	(430.12)	***	2.395	(233.98)	***	2.481	(650.59)	***	2.446	(284.45)	***
Year FE	Yes			Yes			Yes			Yes		
City/County FE	Yes			Yes			Yes			Yes		
Year and City/County FE	No			No			Yes			Yes		
# of obs.	4,431			4,431			4,431			4,431		
R^2	0.167			0.171			0.401			0.404		

Table 5 Impact of power looms on hourly wage

A. Dependent variable: Ln(Hourwagefemaleadult)

	(1)			(2)			(3)			(4)		
Power	0.121	(11.96)	***	0.116	(11.32)	***	0.153	(15.63)	***	0.148	(15.04)	***
Ln(Worker)				0.016	(2.88)	***				0.016	(3.31)	***
Const.	0.357	(26.92)	***	0.307	(14.11)	***	0.143	(6.55)	***	0.092	(3.40)	***
Year FE	Yes			Yes			Yes			Yes		
City/County FE	Yes			Yes			Yes			Yes		
Year and City/County FE	No			No			Yes			Yes		
# of obs.	4,416			4,416			4,416			4,416		
R^2	0.441			0.442			0.575			0.576		

B. Dependent variable: Ln(Hourwagefemalechild)

	(1)			(2)			(3)			(4)		
Power	0.062	(3.33)	***	0.064	(3.32)	***	0.109	(5.73)	***	0.107	(5.50)	***
Ln(Worker)				-0.004	(-0.47)					0.006	(0.66)	
Const.	-0.058	(-3.73)	***	-0.044	(-1.33)		-0.075	(-6.47)	***	-0.094	(-3.03)	***
Year FE	Yes			Yes			Yes			Yes		
City/County FE	Yes			Yes			Yes			Yes		
Year and City/County FE	No			No			Yes			Yes		
# of obs.	2,661			2,661			2,661			2,661		
R^2	0.168			0.168			0.305			0.306		

C. Dependent variable: Ln(Hourwagemaleadult)

	(1)		(2)		(3)		(4)	
Power	0.145 (12.54)	***	0.133 (11.55)	***	0.117 (9.81)	***	0.106 (9.01)	***
Ln(Worker)			0.039 (6.08)	***			0.039 (6.26)	***
Const.	0.614 (39.85)	***	0.489 (19.14)	***	0.476 (4.18)	***	0.341 (3.04)	***
Year FE	Yes		Yes		Yes		Yes	
City/County FE	Yes		Yes		Yes		Yes	
Year and City/County FE	No		No		Yes		Yes	
# of obs.	3,068		3,068		3,068		3,068	
R^2	0.469		0.475		0.565		0.570	

D. Dependent variable: Ln(Hourwagemalechild)

	(1)		(2)		(3)		(4)	
Power	0.062 (1.61)	*	0.054 (1.38)		0.041 (0.90)		0.034 (0.73)	
Ln(Worker)			0.020 (1.46)				0.017 (1.22)	
Const.	-0.015 (-0.73)		-0.081 (-1.63)		-0.003 (-0.25)		-0.056 (-1.26)	
Year FE	Yes		Yes		Yes		Yes	
City/County FE	Yes		Yes		Yes		Yes	
Year and City/County FE	No		No		Yes		Yes	
# of obs.	1,073		1,073		1,073		1,073	
R^2	0.195		0.196		0.358		0.359	

Table 6 Impact of power looms on relative wage

A. Dependent variable: Rwagemaleadult

	(1)		(2)		(3)		(4)	
Power	0.219 (8.29)	***	0.131 (4.96)	***	0.215 (8.07)	***	0.131 (4.94)	***
Ln(Worker)			0.281 (20.12)	***			0.284 (20.62)	***
Const.	0.618 (17.93)	***	-0.261 (-4.73)	***	0.120 (2.68)	***	-0.777 (-13.41)	***
Year FE	Yes		Yes		Yes		Yes	
City/County FE	Yes		Yes		Yes		Yes	
Year and City/County FE	No		No		Yes		Yes	
# of obs.	4,416		4,416		4,416		4,416	
R^2	0.121		0.185		0.253		0.316	

B. Dependent variable: Rwagefemalechild

	(1)		(2)		(3)		(4)	
Power	0.016 (1.16)		0.002 (0.11)		0.002 (0.13)		-0.013 (-0.91)	
Ln(Worker)			0.046 (6.16)	***			0.048 (6.66)	***
Const.	0.543 (27.34)	***	0.398 (12.94)	***	0.823 (25.60)	***	0.671 (17.17)	***
Year FE	Yes		Yes		Yes		Yes	
City/County FE	Yes		Yes		Yes		Yes	
Year and City/County FE	No		No		Yes		Yes	
# of obs.	4,416		4,416		4,416		4,416	
R^2	0.201		0.207		0.324		0.330	

Table 7 Impact of power looms on the composition of workers

A. Dependent variable: Maleratio

	(1)			(2)			(3)			(4)		
Power	0.055	(13.09)	***	0.052	(12.18)	***	0.062	(14.49)	***	0.059	(13.55)	***
Ln(Worker)				0.008	(3.03)	***				0.101	(3.99)	***
Const.	0.127	(21.89)	***	0.103	(10.38)	***	0.050	(9.55)	***	0.180	(1.90)	*
Year FE	Yes			Yes			Yes			Yes		
City/County FE	Yes			Yes			Yes			Yes		
Year and City/County FE	No			No			Yes			Yes		
# of obs.	4,431			4,431			4,431			4,431		
R^2	0.113			0.114			0.171			0.174		

B. Dependent variable: Childratio

	(1)			(2)			(3)			(4)		
Power	0.008	(1.33)		0.007	(1.09)		-0.01	(-1.71)	*	-0.010	(-1.79)	*
Ln(Worker)				0.004	(1.09)					0.002	(0.65)	
Const.	0.339	(32.50)	***	0.325	(20.01)	***	0.532	(48.79)	***	0.525	(32.79)	***
Year FE	Yes			Yes			Yes			Yes		
City/County FE	Yes			Yes			Yes			Yes		
Year and City/County FE	No			No			Yes			Yes		
# of obs.	4,431			4,431			4,431			4,431		
R^2	0.294			0.294			0.519			0.520		