

CIRJE-F-416

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in the Japanese Cotton Industry, 1905-1935:**

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April 2006

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Selection or Imitation? :
Organizational Evolution in the Japanese Cotton Industry, 1905-1935:

by

Tetsuji Okazaki*

Abstract

This paper explores the mechanisms by which the industrial organization of the Japanese cotton spinning industry changed over time, focusing on the rise and fall of the firms that integrated spinning and weaving processes. The basic idea is to decompose the change in the proportion of integrated firms into factors representing “selection” and “imitation” in an evolutionary sense. It was found that the factor which made the largest contribution differed between the growing phase and the declining phase of integrated firms. In the growing phase, imitation, namely the change in the attribute of the incumbent firms, was the major factor in the proportion change. On the other hand, in the declining phase, selection, in particular, birth rate, was the major factor, not only in the case where the proportion is measured in terms of firm number but also in terms of production.

Key words: evolution, selection, imitation, institution, industrial organization, Japan
JEL classification numbers: L22, L23, L67, M65, O33

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1. Introduction

This paper explores how production organizations changed over time from historical and evolutionary perspectives. The mechanism by which institutions and organizations change over time is one of the major questions addressed in the literature on institutions (Aoki 2001; North 2005; Greif 2006). There are basically two alternative approaches to this issue, namely the classical game theory approach and the evolutionary game theory approach (Greif 1998, 2006, p.10). In the former approach, an institutional change is understood to be the result of the change in a “quasi-parameter,” which in turn results from cumulative outcomes of games played by rational players in a society. In other words, introducing the concept of “quasi-parameter,” Greif (2006) mediates between an endogenous institutional change and the assumption of rational forward-looking players.

In contrast, in the evolutionary game approach, an institutional change is viewed as a result of an evolutionary game played by bounded rational players in a society, who gradually, i.e. not instantly, learn to adapt or do not adapt [NDH2]their behaviors. Namely, such evolutionary factors as mutation, random experimentation, selection and imitation make the distribution of agents with certain attributes change over time (Young 1993, 2001; Okazaki and Okuno-Fujiwara 1998; Aoki 2001).

Which of these two alternative approaches is more appropriate remains a question for empirical research. An essential point is the contribution selection makes to an institutional change. Here, the contribution of selection refers to the fraction of an institutional change which is explained by the change in the distribution of players in a society. This fraction is consistent only with regard to the evolutionary approach. Okazaki (2004) developed a framework for measuring the contribution selection and imitation make to an institutional change. In this framework, the change over time of the distribution of firms with a certain institutional attribute is decomposed into the contribution of birth rate, death rate, growth rate and conversion rate. The former three factors represent “fitness” in the evolutionary (Darwinian) sense, which leads to selection, while the latter factor represents imitation¹.

Okazaki (2004) applied this framework to the evolution of the financial system in postwar Japan, and found that while the contribution of imitation was larger, the contribution of selection was substantial as well, which implies that the evolutionary approach has at least partial validity. The contribution made by selection and imitation is supposed to depend upon institutions, and the above measuring

¹ In Okazaki (2004), conversion rate is included in fitness factors, but it is appropriate to exclude it because fitness is a concept implying selection.

framework is quite general. It is desirable to ascertain what the major evolutionary forces are with respect to various kinds of institutional changes. Here, we focus on the industrial organization of the cotton industry in pre-war Japan.

The cotton industry was a leading industry in the pre-war Japanese economy and was based on the modern Western technology introduced into Japan in the early 1880s. At first, cotton companies specialized in the spinning process and sold the products to small-scale weavers concentrated in several districts, but as early as the 1890s, some cotton spinning companies began to integrate the weaving process. Following this, the cotton industry in Japan was composed of specialized weavers, specialized cotton spinning companies and companies integrating the spinning and weaving processes, and their proportions characterized the industrial organization of the cotton industry. The change of this structure over time is the main object of this paper.

Conventionally, it was taken for granted that large integrated firms were overwhelming more competitive and dominated the cotton industry (Shinobu 1946), but since the 1970s, the development of specialized weavers that agglomerated in certain districts has been stressed by several researchers (Yamazaki 1969, 1970; Abe 1989; Tanimoto 1998). As a matter of fact, the proportion of integrated firms in cotton cloth production as well as in cotton yarn production, which went up at first, stagnated and then started to decline after the First World War. In this paper we explore the evolutionary mechanism behind this change in industrial organization.

The rest of the paper is organized as follows. In section 2 we briefly overview the history of the cotton industry in Japan, and describe the evolution of industrial organization. Section 3 explains the data as well as the results of survivability and growth regressions. Section 4 presents the results of the evolutionary analysis, and section 5 concludes the paper.

2. Overview of organizational evolution

The history of the modern cotton industry in Japan began in 1882 when Osaka Cotton Spinning Co. successfully started operations using Western technology. The success of this company stimulated new entries, and cotton yarn production increased rapidly, substituting imports. At first, cotton spinning companies sold almost all of their products to domestic weavers, who had previously used imported yarn. The weaving industry was composed of numerous small-scale weavers, agglomerating in several prefectures including Osaka, Hyogo, Aichi, Ehime, Shizuoka and Saitama. In many cases, those small-scale weavers were organized by merchants into the putting

out system (Ushijima and Abe 1996; Tanimoto 1998).

On the other hand, from the late 1880s, cotton spinning companies began to set up weaving factories, introducing Western power looms (Kajinishi ed.1964, pp.181-183). The emergence of integrated firms equipped with power looms substantially changed the organization of the cotton weaving industry. While cloth production by non-integrated weavers was stagnant until around 1910, that of integrated firms rapidly increased. As a result, the proportion of integrated firms went up sharply (Figure 1).

Figure 1[NDH3]

However, the landscape changed again in the 1910s, when production by non-integrated weavers accelerated. This was basically due to diffusion of power looms among non-integrated weavers, which, in turn, was stimulated by competition with integrated firms. In the 1900s, progress in industrialization pushed up wage rates, which made it difficult for non-integrated weavers using labor-intensive technology to compete with integrated firms in the cloth market. At the same time, domestic machinery producers began to supply relatively cheap power looms. As a result, non-integrated weavers introduced power looms to enhance productivity and save labor inputs, especially in those districts specializing in plain cotton cloth, such as Osaka and Aichi (Kajinishi ed. 1964, p.210; Takamura 1971, p.144), and this trend continued over the entire pre-war period (Ushijima and Abe 1996).

The growth of non-integrated weavers changed the organization of the cotton industry. The proportion of integrated firms in the cotton cloth market stopped increasing in the early 1910s, and a long-term decline began. The proportion dropped from 41% in 1914 to 28% in 1936 (Figure1). The cotton industry, which once seemed to be dominated by integrated firms, developed a structure that included non-integrated weavers and the cotton yarn market was divided between non-integrated weavers and cotton spinning companies.

The same process can be observed by referring to the data on the uses of cotton yarn produced by cotton spinning companies (Figure2). Here, cotton spinning companies include integrated firms as well as non-integrated firms specialized in cotton spinning. The ratio of yarn consumed by the integrated weaving process to yarn production rapidly went up from the early 1900s and this upward trend continued until the middle of the 1920s when the ratio started to decline. It is notable that this decline was a part of the long-term downward trend which continued until the early

1980s². In the rest of the paper, we will explore the evolutionary mechanism behind this change in the industrial structure.

Figure 2

3. Survivability and growth of cotton spinning firms

The data used in the rest of the paper are taken from *Menshi Boseki Jijo Sankosho* (*Statistical Handbook of Cotton Spinning Industry*) edited by the Japan Cotton Spinning Association. It has been published every six months since 1903. This source contains firm-level data on cotton yarn production, cloth production, cotton yarn consumption, employment, number of spindles, number of establishments and foundation year for all the members of the Japan Cotton Spinning Association, whose share of cotton yarn production in Japan was close to 100%³. For the samples, we use all of the firms whose data are available in the *Handbook*, with respect to the latter half of the years 1905, 1910, 1915, 1920, 1925, 1930 and 1935, just before the Sino-Japanese War.

Table 1 provides the basic features of the sample firms. Whereas there were 50 cotton spinning firms in 1905, the number of firms had declined substantially by 1910, and then gradually increased again. The movement of cotton yarn production differed considerably from that of the firm number. Production continued to increase rapidly until 1915, and after that the production growth rate became volatile. That is, high growth periods and stagnant periods followed each other in turn. In the late 1910s and 1920s, cotton yarn production growth became sluggish, but in the late 1920s and early 1930s it resumed its former fast growth.

In Table 1 we can also see the proportion of integrated firms in terms of firm number as well as their share of cotton yarn production. Here, a firm is identified as integrated if the self-consumption of cotton yarn was positive. The trend in the proportion of integrated firms is similar to that in Figure 2. In terms of firm number, the proportion of integrated firms was just 20% in 1905, but it rose sharply until 1925 to be as high as 78%. On the other hand, in the late 1920s, the proportion of integrated firms dropped slightly, and then declined substantially in the early 1930s. In terms of cotton yarn production, the share of integrated firms was higher, but the trend is similar.

² It is notable that since the early 1980s, the ratio has gone up again, but it is beyond the scope of the paper.

³ The share of cotton yarn production of member companies was 97.8% in 1935 (Handbook of Cotton Spinning Industry, latter half of 1935 issue).

Table 1

Table 2 summarizes the basic statistics for the samples, focusing on firm age and cotton yarn production. Age is defined as the number of years the company had existed minus the foundation year. On average, integrated firms were older than non-integrated ones. At the same time, integrated firms were substantially larger than non-integrated ones in terms of production. One of the reasons for this was that many non-integrated firms converted into integrated ones, as we will see later.

Table 2

As stated in section 1, birth rate (entry rate), death rate (exit rate) and growth rate are the basic factors representing “fitness,” which leads to the selection of a certain institutional attribute. With respect to two of those factors, death rate and growth rate, we can econometrically analyze how they worked, using the above data set. The model to be estimated is based on a standard model which has been used for testing Gibra’s Law in the industrial organization literature (Evans 1987; Agrwal and Gort 1996). To the standard explanatory variables, scale and age of a firm, we add a variable denoting the organizational attribute.

$$\text{Prob}(\text{SURVIVE}_t=1)=\text{Prob}[e_t>V(\text{AGE}_{t-1}, \text{PROD}_{t-1}, \text{INTEG}_{t-1})] \quad (1)$$

$$\text{GROWTH}_t=G(\text{AGE}_{t-1}, \text{PROD}_{t-1}, \text{MERGER}_t \text{INTEG}_{2t-1}) \quad (2)$$

where GROWTH_t refers to the production growth of each firm from year $t-1$ to t . As our data set has the data for every fifth year, 1905, 1910, 1915, 1920, 1925, 1930, 1935, “ $t-1$ ” here means the year five years before t . AGE and PROD refer to each firm’s age and cotton yarn production respectively. MERGER_t is a dummy variable which equals 1 if a firm merged with another company between $t-1$ and t , and 0, otherwise. This is added to control for the effect of a merger increasing production. INTEG_{t-1} is a dummy variable which equals 1 if the firm had an integrated organization in period t , and 0, otherwise. INTEG_{2t-1} is a dummy variable if a firm had an integrated organization both in period $t-1$ and period t . There were some cases where integrated firms converted to non-integrated ones, as we will see below.

Because some of the firm population in period $t-1$ exited by period t , the growth rates of those firms cannot be observed. At the same time, it is possible that growth

rate correlated with probability of exit. Therefore, in order to correct the sample selection bias, first we estimate equation (1), and then using the estimation result, estimate (2). It is a standard sample selection correction estimation (Heckman 1979; Amemiya 1984; Green 2000), but here we are interested in the estimation result of (1) itself, because it shows the effect of integrated organization on the survivability of a firm.

As we are focusing on the change over time of evolutionary forces, equation (1) and (2) are estimated by period. The results are reported in Table 3. With respect to the survivability equation (1), coefficients of INTEG are not significant in all of the periods. However, we can see a trend. Whereas, in the 1900s and 1910s, the coefficients are positive in two periods out of three, after that the coefficients are negative in all of the periods. In this sense, the effect of integrated organization on firm survivability changed from positive to negative around 1920.

Table 3

With respect to growth regressions, we have more statistically significant results. In 1905-10, and 1915-20, the coefficients of INTEG2 are positive and significant, which implies that integrated firms tended to grow faster than non-integrated firms during these periods after we control for sample selection bias by survivability. On the other hand, in the 1920s and 1930s, the coefficients of INTEG2 are not significant. Furthermore, in the 1920s, they are negative, although not significant. These results indicate that while integrated organization had a positive effect on firm growth until the 1910s, it disappeared after that. Combining it with the finding on firm survivability, we can infer that the “fitness” of an integrated organization declined in the 1920s and 1930s. Then, the next questions are what was the contribution of the other fitness factor, birth rate, and how firms reacted to this situation through choosing organizational forms.

4. Evolutionary analysis of organizational change

The basic idea of Okazaki (2004) examines an institutional change as a change in the composition of the firm population as well as in a change in each firm’s attribute. We can measure the pervasiveness of a certain institutional or organizational attribute by the proportion of firms which have that attribute in the whole firm population. The proportion is measured in terms of firm number as well as production, sales etc. Comparing the proportions between the initial year and the final year in a certain

period, we can see whether a particular institution or organization proliferated or declined over that period. In the case where the proportion is measured in terms of production, the change in the proportion can be decomposed into the following four factors, (i) difference in growth rates of firms which existed in the initial year and survived during the period, (ii) difference in exit (death) rates, (iii) difference in entry (birth) rates, and (iv) change in attributes during the period. In the case where the proportion is measured in terms of firm number, the change can be decomposed into (ii), (iii) and (iv). Factor (i), (ii) and (iii) can be interpreted as measures of “fitness” in the Darwinian sense, which lead to selection. And factor (i) represents imitation.

Where the share of integrated and non-integrated firms is measured in terms of firm number, the formula of decomposition is as follows (Okazaki 2004).

$$I^1 = (1-d_i)(1-c_i) I^0 + b_i I^0 + (1-d_n)c_n N^0 \quad (3)$$

$$N^1 = (1-d_n)(1-c_n) N^0 + b_n N^0 + (1-d_i)c_i N^0 \quad (4)$$

I^t : Number of integrated firms in year t

N^t : Number of non-integrated firms in year t

b_j : Entry (birth) rate of integrated (i) or non-integrated (n)⁴

d_j : Exit (death) rate of integrated(i) or non-integrated (n)⁵

c_j : Ratio of the firms which converted from integrated to non-integrated (i) or from non-integrated to integrated (n)⁶

Using this formula and assuming each of the following conditions, we can calculate the counterfactual number of integrated and non-integrated firms in time 1 (I^1 , N^1). In order to identify the contribution of the fitness factors (ii), (iii) or (iv), we assume the following counterfactual conditions, respectively. Each of these conditions does not cause any change in the proportion of integrated firms. In this sense, they are the conditions neutral with regard to organizational evolution⁷.

⁴ (Number of integrated new comers)/ I^0 , and (number of non-integrated new comers)/ N^0

⁵ (Number of exiting integrated firms)/ I^0 , and (number of exiting non-integrated firms)/ N^0

⁶ (Number of firms which were integrated in time 0 and were nonintegrated in time 1)/($I^0-d_i I^0$) and (Number of firms which were non-integrated in time 0 and were integrated in time 1)/($I^1-d_n N^0$)

⁷ Alternatively, we may assume two of the conditions (5)-(7) to isolate the contribution of the remaining factor. In this case, the contribution of the remaining factor is $I^1/(I^1+N^1)-I^0/(I^0+N^0)$. We executed the decomposition by this formula and obtained a similar result.

$$d_i=d_n=(d_iI_0+d_nN_0)/(I_0+N_0) \quad (5)$$

$$b_i=b_n=(b_iI_0+b_nN_0)/(I_0+N_0) \quad (6)$$

$$c_i=c_n=0 \quad (7)$$

The difference between the actual proportion and the counterfactual proportion, namely $I^1/(I^1+N^1)-I^0/(I^0+N^0)$ is interpreted as being the result of the contribution of each of the factors, (ii), (iii) and (iv).

Table 4 decomposes the proportion change of integrated firms in terms of firm number, using formulas (1) and (2), and Table 5 shows the evolutionary parameters. It should be noted that the sum of the contributions of the three factors is not exactly the same as the proportion change due to the interaction effects of the factors. However, they are approximately the same. In the period 1905-10, the proportion of integrated firms rose substantially, by 16.1% percentage points. Conversion contributed around a half of the change, and death rate was the second largest factor. In this sense, selection as well as imitation played an important role in organizational evolution in this period.

Table 4, 5

Let us look at the background data provided in Table 6. In 1905, there were 10 integrated firms and 40 non-integrated firms. While 8 out of 10 integrated firms survived until 1910, only 21 out of 40 non-integrated firms survived over the same period. This difference of death rates reflects the large contribution of death rate shown in Table 4. At the same time, while all of the 8 surviving integrated firms did not change their organizations, 18 out of the 21 surviving non-integrated firms converted to integrated firms by 1910. In other words, most of the non-integrated firms in 1905 exited from the market or converted to integrated firms. Furthermore, 5 of 7 newcomers were integrated.

Table 6

In the next period, 1910-15, the evolution toward integrated organization slowed down. The contribution of selection represented by death rate and birth rate became negative and cancelled out part of the positive contribution made by imitation. As a result of the change in 1905-1910, there were 13 integrated firms and 24 non-integrated firms in 1910 (Table 7). Eight out of 13 integrated firms survived until 1915, while 16 out of 24 non-integrated firms survived in the same period. Unlike the

previous period, the death rate was slightly higher for integrated firms. Meanwhile, 11 out of 16 newcomers were non-integrated. Entry had a negative effect on the proportion of integrated firms as well. That is why the contribution of birth rate was negative in this period. On the other hand, whereas all of the 8 surviving integrated firms did not change their organizations, 13 out of 16 surviving non-integrated firms converted to integrated ones.

Table 7

In the period 1915-1920, effects of death rate and entry rate became positive again, which accelerated the evolution toward integrated organizations. Conversion (imitation) contributed around a half, but the total contribution of selection equalled it. Within selection, the contribution made by birth rate was larger. There were 16 integrated and 24 non-integrated firms in 1915 (Table 8). While only 3 out of 16 integrated firms exited in this period, 10 out of 24 non-integrated firms exited. Also, 13 out of 27 newcomers were integrated. Conversion from non-integrated firms to integrated firms did not occur, while 4 out of the 14 non-integrated firms that survived until 1920 converted into integrated firms.

Table 8

In the next period, 1920-25, the evolution toward integrated organizations accelerated still more. The proportion of integrated firms went up by 22.4 percentage points. All of the evolutionary factors made a positive contribution to the proportion of integrated firms, and the magnitude of each factor exceeded 6 percentage points. The total contribution of selection was close to two thirds of the total increase in the proportion of integrated firms. There were 30 integrated firms and 24 non-integrated firms in 1920. Out of these, 7 integrated and 12 non-integrated firms exited during this period, which means the exit rate was much higher for non-integrated firms (Table 9). Meanwhile, 13 out of 15 newcomers were integrated firms. These facts reflect the large contribution made by selection in this period.

Table 9

As we saw above, 1925 was the year in which the proportion of integrated firms reached its peak. In the period 1925-30, the proportion of integrated firms declined for

the first time in the sample period. The evolutionary factor which had a negative effect was birth rate. While the proportion of integrated firms in 1925 was 78.0% (39/50), the proportion of integrated firms among newcomers was 57.1% (8/14). The proportion of integrated firms among newcomers was higher than in the period 1915-20 (48.1%, 13/27) (Table 8, 10). Thus, it can be interpreted that the negative effect of birth rate in this period partly reflects saturation of the integrated organization form. At the same time, the contribution made by conversion came to be zero.

Table 10

Finally, in the period 1930-35, the change which had initially emerged in the previous period now became clear. Not only did the negative contribution made by birth rate increase, but the contribution made by conversion also came to be negative for the first time. Only 1 firm out of 8 newcomers was integrated. Two firms converted from integrated to non-integrated, while one firm converted from non-integrated to integrated. Furthermore, the positive contribution made by death rate decreased. Finally, the proportion of integrated firms declined by 8.9 percentage points to 66.1% in this period.

Table 11

Where the share is measured in terms of production, we redefine the notations and rewrite the equations (1), (2) as follows.

$$I^1 = I^0(1-d_i)(1-c_i)g_{ii} + I^0b_i + N^0(1-d_n)c_{ng_{ni}} \quad (6)$$

$$N^1 = (1-d_n)(1-c_n)g_{nn} N^0 + b_n N^0 + (1-d_i)c_{ig_{in}} N^0 \quad (7)$$

I^t : Cotton yarn production of integrated firms in time t

N^t : Cotton yarn production of non-integrated firms in time t

b_j : Entry (birth) rate of integrated firms (i) or non-integrated (n) in terms of production⁸

d_j : Exit (death) rate of integrated firms (i) or non-integrated firms (n) in terms of production⁹

⁸ (Production of integrated newcomers/ I^0 , and production of non-integrated newcomers/ N^0 . Note that here and in the following notes I^t and N^t are in terms of sales.

⁹ (Production of exiting integrated firms)/ I^0 , and (production of exiting non-integrated

- c_j : Ratio of the firms which converted from integrated to non-integrated (i) or from non-integrated to integrated (n) in terms of production¹⁰
- g_{ii} : Growth rate of production of the firms which were integrated both in time 0 and time 1
- g_{ni} : Growth rate of the production of the firms which were integrated in time 0 and were non-integrated in time 1
- g_{nn} : Growth rate of production of the firms which were non integrated both in time 0 and time 1
- g_{in} : Growth rate of production of the firms which were integrated in time 0 and were non-integrated in time 1

As in the case of firm number, we can calculate the counterfactual production of integrated and non-integrated firms (I^1 , N^1), assuming each of the following conditions, (8)-(11). In order to identify the contribution of the fitness factors (i), (ii), (iii) and (iv), we assume the following counterfactual conditions, respectively. Again, the difference between the actual share and the counterfactual share, $I^1/(I^1+N^1)-I^0/(I^0+N^0)$, can be interpreted as the contribution of each of the above factors, (i), (ii), (iii) and (iv).

$$g_{ii}=g_{nn}=[g_{ii}I^0(1-d_i)(1-c_i)+g_{nn}N^0(1-d_n)]/[(1-d_i)(1-c_i)I^0+(1-d_n)(1-c_n)N^0] \quad (8a)$$

$$g_{in}=g_{ni}=[g_{ni}(1-d_i)c_iI^0+g_{in}(1-d_n)c_nN^0]/[(1-d_i)c_iI^0+(1-d_n)c_nN^0] \quad (8b)$$

$$d_i=d_n=(d_iI^0+d_nN^0)/(I^0+N^0) \quad (9)$$

$$b_i=I^0/(I^0+N^0) \text{ and } b_n=N^0/(I^0+N^0) \quad (10)$$

$$c_i=c_n=0 \quad (11)$$

The results of decomposition and parameters are reported in Tables 12 and 13, and the background data are in the tables contained in the appendix. Concerning the decomposition results, it should be noted that the difference between the proportion change and the sum of the contributions of the factors due to the interaction effects are not small, in particular for the period 1920-25. Therefore, we should be careful in interpreting the results¹¹. Compared with Table 4, the contribution of imitation is

firms)/ N^0

¹⁰ (Production of the firms which were integrated in time 0 and were non-integrated in time 1)/($I^0-d_iI^0$) and (Production of the firms which were non-integrated in time 0 and were integrated in time 1)/($N^0-d_nN^0$).

¹¹ As in the case of measuring the proportion in terms of firm number, we may assume three of the conditions (8)-(11) to isolate the contribution made by the remaining factor.

much greater in the growing phase of integrated organizations, except for the period 1905-10. Actually, from 1910 to 1925, the increase in the proportion of integrated firms can be totally explained by imitation. This reflects the following conditions. First, the non-integrated firms which converted into integrated firms were relatively large. Second, integrated firms were larger and older than non-integrated firms, as shown in Table 2. Given this condition as well as the fact that basically growth rate was negatively associated with firm size and age (Table 3), the contribution of growth rate tended to be negative, which, in turn, pushed up the positive contribution of imitation. On the other hand, in the declining phase for integrated organizations from 1925 to 1935, the results are similar to those in Table 4. The decline in the proportion of integrated firms is basically explained by the contribution of the birth rate factor (Table 12).

5. Concluding remarks

How do institutions and organizations change over time? This is a fundamental question for studies on institutions. To address this question, it is necessary to see whether institutions and organizations change due to a change in the mode of behavior of each player, or due to a change in the composition of the player population. In this paper, we investigated the mechanisms by which the industrial organization of the Japanese cotton spinning industry changed over time in the prewar period, focusing on the rise and fall of organizations integrating spinning and weaving processes.

From the 1890s the proportion of integrated firms rapidly increased, but started to decline in the late 1920s, and this down sloping trend continued until the early 1980s. This transition in the trend reflects that the effect of adopting an integrated organization on survivability and growth of a firm changed from positive to negative in the 1920s, as indicated by regression analyses. Decomposing the change in the share of integrated firms into factors representing selection and imitation was the major issue addressed in this paper. For this purpose, we used the framework developed by Okazaki (2004) and the firm-level data from the *Handbook of the Cotton Spinning Industry*.

It was found that the major factor which contributed to the change in the proportion of integrated firms differed between the growing phase and the declining phase of that form of firm organization. In the growing phase, imitation, namely the

However, using this alternative formula, we found that the difference between the proportion change and the sum of the contributions of the four factors are larger than the result in Table 11.

change in the organization of the incumbent firms, was the major factor influencing the change in proportion. At the same time, where we measured the proportion in terms of firm number, the contribution of the factors representing selection equalled the contribution of imitation. On the other hand, in the declining phase, selection, in particular, birth rate, was the major factor, both in the case where the proportion is measured in terms of firm number and in terms of production share.

We can derive a couple of implications from these findings. First, the findings in this paper indicate that selection as well as imitation contributed to the changes in economic organization, and that the evolutionary approach is useful to understanding institutional change, at least in some cases. Second, it is suggested that a major factor for institutional change may depend upon the phase of evolution. In particular, it was found that at evolutionary turning points, the contribution of birth rate was the largest. In other words, a new evolutionary trend was advanced mainly by the firms which newly entered the industry. This finding suggests the importance of new entries as a driving force for introducing new institutions.

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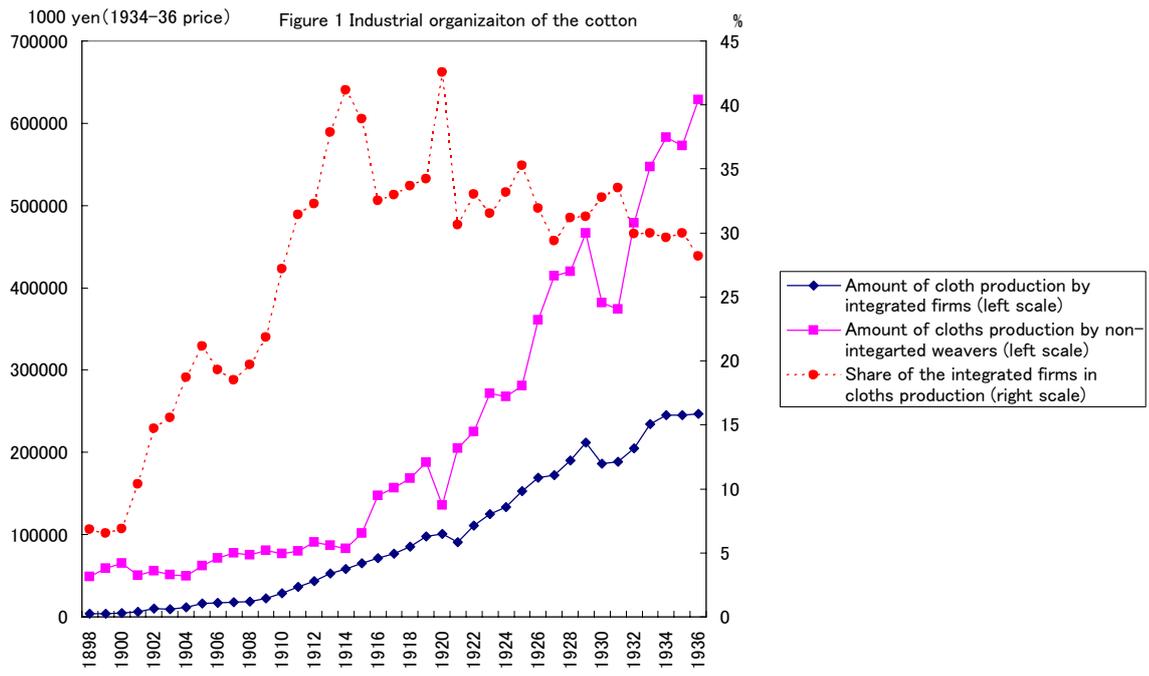


Figure2 Self-consumption of cotton yarn/ total cotton yarn production

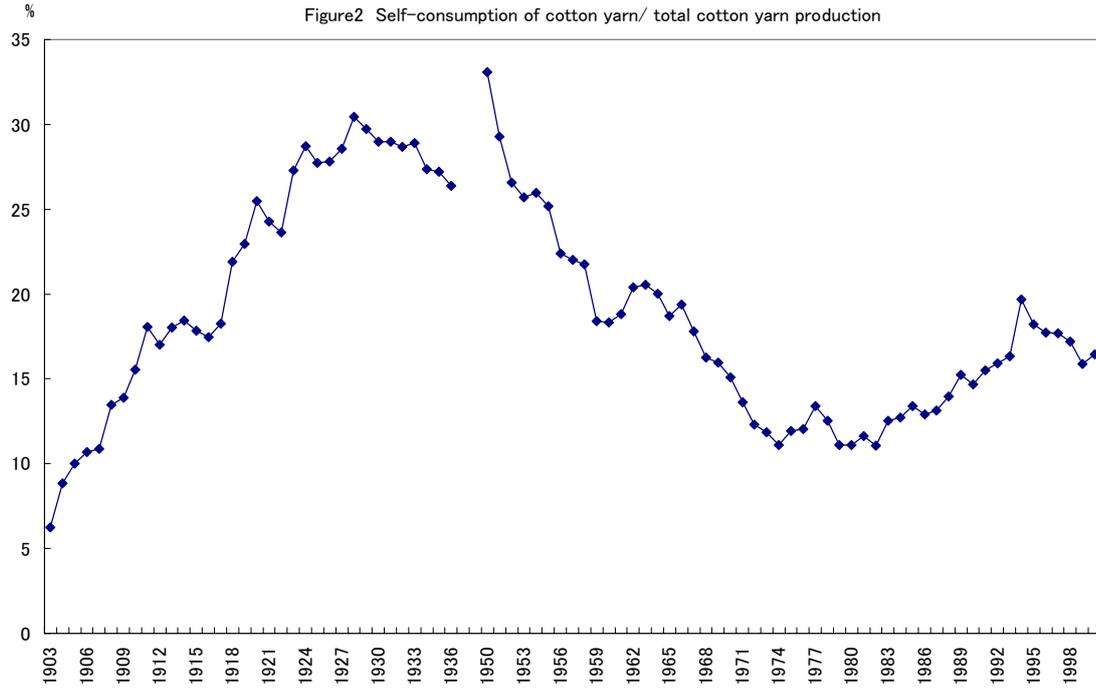


Table 1 Composition of firm population by organizational form

		1905	1910	1915	1920	1925	1930	1935
Number of firms	Integrated	10 (20.0)	13 (36.1)	16 (40.0)	30 (55.6)	39 (78.0)	45 (75.0)	41 (66.1)
	Non-integrated	40 (80.0)	23 (63.9)	24 (60.0)	24 (44.4)	11 (22.0)	15 (25.0)	21 (33.9)
	Total	50	36	40	54	50	60	62
Production	Integrated	203,346 (44.9)	344,114 (61.7)	652,483 (73.0)	695,746 (84.3)	1,127,979 (90.7)	1,043,004 (89.4)	1,484,690 (84.8)
	Non-integrated	249,750 (55.1)	213,655 (38.3)	241,925 (27.0)	129,295 (15.7)	116,333 (9.3)	124,074 (10.6)	266,977 (15.2)
	Total	453,095	557,769	894,408	825,040	1,244,312	1,167,078	1,751,667

Table 2 Basic statistics

			1905	1910	1915	1920	1925	1930	1935
Age(year)	Average	Total	11.3	14.9	13.8	11.4	17.0	20.9	24.3
		Integrated	15.3	17.3	15.9	15.0	18.5	22.6	28.1
		Non-integrated	10.3	13.6	12.3	6.8	11.6	15.8	16.8
	St.dev.	Total	7.0	8.3	10.8	10.6	11.1	12.1	13.2
		Integrated	7.0	7.4	10.5	11.5	11.7	11.9	12.8
		Non-integrated	6.7	8.6	10.9	7.4	6.9	11.8	10.6
	Max.	Total	25.0	30.0	35.0	34.0	43.0	50.0	55.0
		Integrated	25.0	28.0	29.0	34.0	43.0	50.0	55.0
		Non-integrated	25.0	30.0	35.0	33.0	26.0	48.0	42.0
	Min.	Total	0.0	2.0	0.0	1.0	4.0	3.0	1.0
		Integrated	2.0	4.0	0.0	2.0	5.0	4.0	6.0
		Non-integrated	0.0	2.0	0.0	1.0	4.0	3.0	1.0
Cotton yarn production (case)	Average	Total	9,062	15,494	22,360	15,279	24,886	19,451	28,037
		Integrated	20,335	26,470	40,780	23,192	28,923	23,178	36,212
		Non-integrated	6,244	9,289	10,080	5,387	10,576	8,272	12,076
	St.dev.	Total	15,011	23,749	37,566	31,165	39,434	28,686	46,476
		Integrated	27,045	32,443	52,933	39,503	43,589	31,965	55,080
		Non-integrated	8,579	14,552	13,124	9,313	10,534	8,839	10,775
	Max.	Total	90,379	104,742	165,157	143,731	188,009	149,805	292,693
		Integrated	90,379	104,742	165,157	143,731	188,009	149,805	292,693
		Non-integrated	50,248	60,740	50,047	46,063	28,407	37,353	44,905
	Min.	Total	228	92	157	110	971	808	1,621
		Integrated	2,324	1,170	1,612	181	1,017	1,104	1,748
		Non-integrated	228	92	157	110	971	808	1,621

Note: 1 case=400 pounds.

Table 3 Determinants of survivability and growth of a cotton spinning firm

	1905-10	1910-15	1915-20	1920-25	1925-30	1930-35
Dependent variable: Survive						
Constant	-2.496 (-1.141)	1.889 (1.120)	-1.068 (-0.586)	-0.133 (-0.107)	-1.353 (-1.069)	4.017 (1.838) *
LPROD	0.317 (1.155)	-0.096 (-0.466)	0.175 (0.804)	0.026 (0.166)	0.231 (1.468)	-0.404 (-1.453)
AGE	-0.006 (-0.113)	-0.039 (-0.959)	-0.029 (-1.031)	0.040 (1.633)	0.040 (2.349) **	0.051 (1.267)
INTEG	0.138 (0.270)	-0.054 (-0.107)	0.638 (1.585)	-0.417 (-0.882)	-0.194 (-0.563)	-0.094 (-0.257)
Dependent variable: Growth						
Constant	0.021 (0.107)	0.216 (1.761) *	-0.282 (-1.893) *	1.327 (4.775) ***	0.032 (0.161)	0.239 (3.782) ***
LPROD	-0.013 (-0.571)	-0.005 (-0.300)	0.031 (1.744) *	-0.122 (-3.487) ***	0.005 (0.192)	-0.022 (-2.934) ***
AGE	0.005 (1.223)	-0.004 (-1.354)	-0.006 (-2.632) ***	0.000 (-0.104)	-0.002 (-0.720)	0.129 (1.848) *
MERGER	0.079 (1.695)	-0.012 (-0.402)	0.067 (160.461) ***	0.106 (2110.000) ***		0.051 (2.319) **
INTEG2	0.082 (4.349) ***	-0.009 (-0.296)	0.058 (1.768) *	-0.061 (-0.647)	-0.067 (-1.231)	0.009 (0.488)
LogLikelihood	14.175	15.955	20.337	-8.175	15.295	71.150
Obs.	50	36	40	54	50	60
Positive obs.	29	23	27	36	46	54

Note: *** significant at 1% level
 ** significant at 5% level
 * significant at 10% level

Table 4 Decomposition of the change in the proportion of integrated firms: Number of firms

%

		1905-1910	1910-1915	1915-1920	1920-1925	1925-1930	1930-1935
Total change		16.1	3.9	15.6	22.4	-3.0	-8.9
Contribution	Death rate	5.2	-0.7	2.9	6.0	1.4	0.7
	Birth rate	1.7	-0.3	4.1	8.4	-4.9	-8.1
	Conversion	8.3	5.0	7.4	6.0	0.0	-1.6

Table 5 Parameters of selection and imitation: Number of firms

	1905-1910	1910-1915	1915-1920	1920-1925	1925-1930	1930-1935
b_i	0.200	0.462	0.813	0.400	0.205	0.022
b_n	0.125	0.478	0.583	0.083	0.545	0.467
d_i	0.200	0.385	0.188	0.200	0.051	0.089
d_n	0.475	0.348	0.417	0.500	0.182	0.133
c_i	0.000	0.000	0.000	0.000	0.054	0.049
c_n	0.143	0.133	0.286	0.250	0.222	0.077

Table 6 Change of organizational form, 1905–1910

1905		1910			Exit	Total
		Survive	Total			
		Integrated	Non-integ	Total		
Firms existing in 1905	Integrated	8	0		8	2
	Non-integrated	3	18		21	19
	Total	11	18		29	21
Newcomers		2	5		7	0
Total		13	23		36	21

Table 7 Change of organizational form, 1910–1915

		1915			Exit	Total
		Survive	Total			
1910		Integrated	Non-integ	Total		
Firms existing in 1910	Integrated	8	0		8	5
	Non-integrated	3	13		16	8
	Total	11	13		23	13
Newcomers		5	11		16	0
Total		16	24		40	13
						52

Table 8 Change of organizational form, 1915–1920

		1920			Exit	Total
		Survive		Total		
1915		Integrated	Non-integ		Total	
Firms existing in 1915	Integrated	13	0	13	3	16
	Non-integrated	4	10	14	10	24
	Total	17	10	27	13	40
Newcomers		13	14	27	0	27
Total		30	24	54	13	67

Table 9 Change of organizational form, 1920–1925

		1925			Exit	Total
		Survive				
1920		Integrated	Non-integ	Total		
Firms existing in 1920	Integrated	23	0	23	7	30
	Non-integrated	3	9	12	12	24
	Total	26	9	35	19	54
Newcomers		13	2	15	0	15
Total		39	11	50	19	69

Table 10 Change of organizational form, 1925–1930

1925		1930			Exit	Total
		Survive		Total		
		Integrated	Non-integrated		Total	
Firms existing in 1925	Integrated	35	2	37	2	39
	Non-integrated	2	7	9	2	11
	Total	38	8	46	4	50
Newcomers		8	6	14	0	15
Total		46	14	60	4	64

Table 11 Change of organizational form, 1930–1935

		1935			Exit	Total
		Survive				
1930		Integrated	Non-integ	Total		
Firms existing in 1930	Integrated	39	2	41	4	45
	Non-integrated	1	12	13	2	15
	Total	40	14	54	6	60
Newcomers		1	7	8	0	8
Total		41	21	62	6	68

Table 12 Decomposition of the change in the proportion of integrated firms: Production

%

	1905-1910	1910-1915	1915-1920	1920-1925	1925-1930	1930-1935
Total change	16.8	11.3	11.4	6.3	-1.3	-3.8
Contribution						
Death rate	4.5	-2.5	0.0	1.9	0.5	0.2
Birth rate	1.1	-2.0	-0.9	0.4	-2.1	-3.4
Growth rate	4.3	-1.6	-1.0	-4.0	-1.4	0.7
Conversion	5.9	20.1	14.0	11.8	1.4	-1.6

Table 13 Parameters of selection and imitation: Production

	1905-1910	1910-1915	1915-1920	1920-1925	1925-1930	1930-1935
b_i	0.122	0.108	0.080	0.088	0.064	0.038
b_n	0.067	0.278	0.120	0.038	0.295	0.532
d_i	0.119	0.256	0.164	0.027	0.011	0.103
d_n	0.296	0.110	0.163	0.232	0.092	0.128
c_i	0.000	0.000	0.000	0.000	0.009	0.031
c_n	0.152	0.517	0.558	0.593	0.298	0.092
g_{ii}	1.617	1.769	1.017	1.445	0.857	1.579
g_{nn}	1.322	1.986	1.119	2.754	1.004	1.430
g_{in}					1.593	1.472
g_{ni}	1.100	1.652	0.785	1.513	0.737	1.233

Appendix Table 1 Change of organizational form in terms of production, 1905–1910

		Sales in 1905			Sales in 1910			case
		Survive	Exit	Total	Survive			
					Integrated	Non-integrated	Total	
Firms existing in 1905	Integrated	179,245	24,101	203,346	289,900	0	289,900	
	Non-integrated	175,789	73,961	249,750	29,448	196,950	226,398	
	Total	355,034	98,062	453,095	319,348	196,950	516,298	
Newcomers		0	0	0	24,767	16,705	41,471	
Total		355,034	98,062	453,095	344,114	213,655	557,769	

Appendix Table 2 Change of organizational form in terms of production, 1910–1915

		Sales in 1910			Sales in 1915			case
		Survive	Exit	Total	Survive			
					Integrated	Non-integrated	Total	
Firms existing in 1910	Integrated	256,141	87,974	344,114	453,107	0	453,107	
	Non-integrated	199,034	14,621	213,655	183,387	182,537	365,924	
	Total	455,175	102,594	557,769	636,494	182,537	819,031	
Newcomers					15,991	59,388	75,379	
Total		455,175	102,594	557,769	652,485	241,925	894,410	

Appendix Table 3 Change of organizational form in terms of production, 1915–1920

		Sales in 1915			Sales in 1920			case
		Survive	Exit	Total	Survive			
						Integrated	Non-integrated	Total
Firms existing in 1915	Integrated	555,237	106,931	662,168	554,614	0	554,614	
	Non-integrated	202,409	39,516	241,925	88,644	100,173	188,817	
	Total	757,646	146,447	904,093	643,258	100,173	743,431	
Newcomers					52,488	29,122	81,610	
Total		757,646	146,447	904,093	695,746	129,295	825,040	

Appendix Table 4 Change of organizational form in terms of production, 1920–1925

		case					
		Sales in 1920			Sales in 1925		
		Survive	Exit	Total	Survive		
					Integrated	Non-integrated	Total
Firms existing in 1920	Integrated	662,273	33,473	695,746	946,467	0	946,467
	Non-integrated	99,238	30,057	129,295	88,986	111,375	200,361
	Total	761,511	63,529	825,040	1,035,452	111,375	1,146,827
Newcomers					92,527	4,958	97,485
Total		761,511	63,529	825,040	1,127,979	116,333	1,244,312

Appendix Table 5 Change of organizational form in terms of production, 1925–1930

		Sales in 1925			Sales in 1930		
		Survive	Exit	Total	Survive		
					Integrated	Non-integrated	Total
Firms existing in 1925	Integrated	1,115,334	12,645	1,127,979	947,763	15,289	963,052
	Non-integrated	105,688	10,645	116,333	23,238	74,448	97,686
	Total	1,221,022	23,290	1,244,312	971,001	89,737	1,060,738
Newcomers					72,003	34,338	106,341
Total		1,221,022	23,290	1,244,312	1,043,004	124,075	1,167,078

Appendix Table 6 Change of organizational form in terms of production, 1930–1935

		case					
		Sales in 1930			Sales in 1935		
		Survive	Exit	Total	Survive		
					Integrated	Non-integrated	Total
Firms existing in 1930	Integrated	935,525	107,479	1,043,004	1,431,640	42,317	1,473,957
	Non-integrated	106,865	17,209	124,074	13,378	139,492	152,870
	Total	1,042,390	124,688	1,167,078	1,445,018	181,809	1,626,827
Newcomers					39,673	71,790	111,463
Total		1,042,390	124,688	1,167,078	1,484,690	253,599	1,738,289