CIRJE-F-563

Industrial Policy Cuts Two Ways: Evidence from Cotton Spinning Firms in Japan, 1956-1964

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May 2008; Revised in January and April 2009

April 15, 2009

Industrial Policy Cuts Two Ways: Evidence from Cotton Spinning Firms in Japan, 1956-1964 [*]

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Abstract

A number of studies have revealed that the effect of industrial policy on productivity growth is negative. Is this because industrial policy fails to control the activities of firms, or because it can effectively control them? This paper attempts to answer these questions, using firm-level data from the cotton spinning industry in Japan for the period 1956-64. It has been determined that industrial policy cut two ways during this period. Industrial policy effectively controlled the output of cotton spinning firms, which contributed to the establishment of a stable market structure during the period. On the flip side, such policy constrained the reallocation of resources from less productive large firms to more productive small firms. Combined with the negative productivity growth of large firms during this period, industrial policy resulted in negative industry productivity growth.

JEL classification: D21 (Firm Behavior), D4 (Market Structure and Pricing), L5 (Regulation and Industrial Policy), N0 (Economic History), K2 (Regulation and Business Law)

Keywords: Industrial Policy; Regulation; Reallocation; Productivity Growth; Endogeneity

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[*] Kozo Kiyota gratefully acknowledges the financial support received from the Japan Society for the Promotion of Science (JSPS) 2006 Postdoctoral Fellowship for Research Abroad. The usual disclaimers apply.

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1. Introduction

Whether industrial policy contributes to productivity growth is an important question in the fields of industrial organization, law and economics, and development economics.[1] Among industrial policies applied in various periods and countries, one of the most controversial policies is the Japanese industrial policy during the postwar period.[2] This controversy arises because the "success" of some Japanese industrial policies has been used to justify "targeting" policies in other countries, including the United States.[3] Because of this, several studies have investigated the effects of Japanese industrial policy.[4] An important lesson from previous studies is that while Japanese industrial policy may have contributed to the growth of labor productivity, it did not contribute to the growth of total factor productivity (TFP). For example, Beason and Weinstein (1996) examined the effects of industrial policy on industry-level TFP growth in Japan. They revealed that industrial policy did not have a significant positive effect on productivity growth. Kiyota and Okazaki (2005) utilized firm-level data in Japan. They found that industrial policy had a positive effect on labor productivity, but not on TFP.

While these previous studies were insightful, there is not yet a clear answer on why industrial policy produced a negative effect on TFP. This uncertainty is a result of two contrasting interpretations of the results. The first is that industrial policy failed to

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[1] For a comprehensive survey of the literature on this issue, see Noland and Pack (2003) and Rodrick (2007, Chapter 4).

[2] The Japanese government implemented industrial policy to control international trade, investment, technology imports and foreign exchange (Noland and Pack, 2003, pp. 23-37).

[3] "In fact, it is the success of Japanese targeting that is often used as the justification for targeting in the United States" (Beason and Weinstein, 1996, p. 286). Note that whether or not Japanese industrial policy was a "success" is still controversial, because TFP would have fallen more without industrial policy. In this paper, the focus is on mechanisms behind the negative relationships between industrial policy and industry productivity growth. A thorough evaluation of industrial policy is beyond the scope of this paper.

[4] For a review of the literature, see Kiyota and Okazaki (2005).

control the activities of firms and, therefore, lowered industry productivity growth. The second is that the government was able to control the activities of firms and, therefore, lowered industry productivity growth. The former interpretation implies that the problem lies in implementation, rather than in policy design, while the latter explanation implies that the problem lies in the policy design itself. Without clarifying these differences, it is difficult to accurately assess the effects of industrial policy.

To answer this question, the ways in how industrial policy affects the activities of firms need to be examined. However, most of the previous studies that have dealt with productivity have focused on the correlation between industrial policy measures and productivity growth, without focusing on specific changes in a firm's activities. Moreover, previous studies on the effect of industrial policy on productivity have paid little attention to the legal framework and historical background of the time-period, which makes it difficult to identify which activities were truly controlled by industrial policy. Indeed, adequate discussion on the effect of industrial policy on a firm's activities is missing from this literature strand.[5]

This paper examines the effect of industrial policy on industry productivity growth. One of the major contributions of this paper is to provide a missing element in this discussion by presenting an explanation of how industrial policy affects a firm's activities, and why industrial policy lowers industry productivity growth. This paper also attempts to address explicitly the possible endogeneity between industrial policy and firm characteristics, which has not yet been explored in the literature on industrial

[5] On the other hand, a number of historical studies have provided a detailed examination of the institutional and historical background to industrial policy, many of them focusing on the cotton spinning industry (Korenaga 2000, 2002, 2004 and 2005; Peck, Levin and Goto 1987; Saxonhouse 1979; Yamazawa 1978, 1981). However, these studies are basically descriptive and their scope does not extend to a discussion of the link between industrial policy and productivity growth.

policy. The focus is on the cotton spinning industry in Japan in the period 1956-64, an industry in which a key legal framework was implemented to control the output of cotton spinning firms during this time-frame.

This paper also contributes to the literature that examines the effects of policy change on productivity. In international trade literature, on one hand, a number of studies such as Bernard and Jensen (1999), and Kimura and Kiyota (2006), has estimated productivity at the firm level, has found productivity differences across firms within the same industry (i.e., firm heterogeneity), and attempted to link the difference to firm characteristics such as exporting activities. Although many theoretical models (e.g., Melitz, 2003), that motivate these examinations have in mind some exogenous policy shocks such as trade liberalization that affects firms differently, most of the empirical studies do not actually identify particular policy shocks. In industrial policy literature, on the other hand, a number of studies have examined the effects of particular industrial policies as noted. However, only a few studies utilize firm-level data. This paper covers the shortcomings of the previous studies, utilizing firm-level data and identifying a particular policy change.

Focusing on the cotton spinning industry in Japan provides at least four advantages. First, the data cover almost all firms in the industry, which provides the opportunity to examine the effects on both small firms and large firms. Second, detailed information on physical inputs and outputs are available. This study thus avoids some of the potential problems in using money-term variables as proxies for inputs or outputs.[6] Third, precise information on industrial policy is also available

[6] For example, Klette and Griliches (1996) pointed out that the use of deflated firm-level sales as a proxy for firm-level output can be biased when used to estimate the coefficients of the production function.

from the literature from economic history and historical records. Finally, the lessons drawn from industrial policy in Japan have implications for industrial policy in other countries, particularly developing countries (e.g., Noland and Pack, 2003).

This paper is organized as follows. Section 2 reviews industrial policy in the cotton spinning industry in Japan. Section 3 explains the empirical model and data. Section 4 presents the estimation results. The conclusions are presented in Section 5.

2. Industrial Policy and the Cotton Spinning Industry: A Historical Review of the Legal Framework

Until trade liberalization in the 1960s, foreign exchange allocation was a basic tool for industrial policy in Japan. The Foreign Exchange and Foreign Trade Administration Law of 1949 prescribed that foreign exchange should be concentrated in the government and that the government should draw up a foreign exchange budget to allocate foreign exchange quotas. The basic purpose of this system was to maintain a balance of payments by saving foreign exchanges, however, it was utilized for industrial policy purposes by the government, specifically the Ministry of International Trade and Industry (MITI).

For example, for industries which depended upon imported raw materials, MITI could virtually control the production of each firm through foreign exchange allocations, which, in turn, supported the administrative guidance by MITI. In addition, foreign exchange for some raw material imports was allocated according to the export performance of each firm that used them (the export link system). This system was a powerful tool for the promotion of exports.

However, as the Japanese economy recovered from the damage caused by WWII, and increased its presence in the world economy, foreign countries, in particular the United States, increased pressure on the Japanese government to liberalize trade. In 1959, at the General Meeting of General Agreement on Tariffs and Trade (GATT) in Tokyo, the United States representative requested that the Japanese government remove import protections. To cope with this pressure from abroad, the Japanese cabinet decided on an action plan for trade liberalization in 1960 and in practice, trade liberalization proceeded rapidly in the early 1960s (Fukao, 1989; Nakakita, 1993).

The cotton spinning industry, the focus of this paper, was deeply involved in this foreign exchange allocation system. Its raw materials (input), raw cotton, as well as its products (output), cotton yarn, were classified as goods which could not be imported without foreign exchange allocation by MITI. In other words, the cotton spinning industry was not only protected from international competition through foreign exchange allocations for cotton yarn, but domestic competition was also regulated by MITI through foreign exchange allocations for raw cotton (Japan Spinners' Association, 1962, pp. 226-270; Korenaga, 2000). In the early 1960s, as part of a general policy change, the cotton spinning industry experienced trade liberalization. In April 1961, import of raw cotton was liberalized and government intervention in the cotton spinning industry by means of foreign exchange allocations was discontinued.

Meanwhile, production and equipment in the cotton spinning industry rapidly increased. When World War II ended in 1945, the ten largest firms dominated the cotton spinning industry, which came to be called "judai-bo." After the war, many smaller firms entered the industry, which were called "shin-bo" and "shinshin-bo." These smaller firms, as well as "judai-bo", contributed to the expansion of the industry, in the areas of both production and equipment.

Consequently, from the mid-1950s, the cotton spinning industry was faced with an excess of capacity. To deal with this problem, an equipment registration system was introduced in 1956 through the Law on Temporary Measures for Textile Industry Equipment (Sen'i Kogyo Setsubi Rinji Sochi Ho). This law required that all firms had to register their cotton spinning equipment with the government, as equipment to be used in specific categories of products, and that those products should only be produced using the registered equipment.

Every year, the government could approve new registrations if the capacity of registered equipment was likely to be insufficient to meet the forecasted, anticipated demand of the following year. If the capacity of registered equipment was likely to exceed anticipated demand in the following year, the government could instruct the firms to cooperate by suspending the use of excess equipment. In reality, no new registrations were approved, and hence the number of registered spindles did not increase after 1957 (Japan Spinners' Association, various half year issues).

In April 1959, the government decided that 1.28 million spindles were in excess and instructed the firms to suspend them, in accordance with the Law on Temporary Measures for Textile Industry Equipment. The suspension rate was defined as a percentage of the registered spindles, and was 7.5% for the firms whose registered spindles were 7,000 or less. Concerning the firms with more than 7,000 registered spindles, 7.5% for the spindles up to 7,000 and 15% for the spindles over 7,000 (Japan Spinners' Association, 1962, p.100). This means that the operable spindles for each firm beginning in 1959 were reduced by 7.5% or more, depending on the number of the spindles they had registered. The suspension rate was reduced in October 1961. The new suspension rate was 6% for the firms whose registered spindles were 7,000 or less.

Concerning the firms with more than 7,000 registered spindles, 6% for the spindles up to 7,000 and 12% for the spindles over 7,000.[7]

The role of the equipment controls increased after trade liberalization, because in the past, the government could effectively regulate the production of each firm through foreign exchange allocations for raw cotton (Japan Spinners' Association, 1962, pp. 100-101). Hence, in 1959, the Japan Spinners' Association put forward a proposal requesting that a new "industrial order" be prepared to replace the foreign exchange allocation system, which had been "the central pillar for the regulation of the cotton industry" (Japan Spinners' Association, 1962, pp. 84-85).

This proposal was reflected in the July 1960 amendments to the Law on Temporary Measures for Textile Industry Equipment. Two major reforms were implemented in this revision. First, the government was given the authority to order firms to suspend the use of their equipment to allow for short-term adjustments in production, in addition to making long-term adjustments. Second, fines were implemented to deal with firms that did not comply with these new government directives. (Japan Spinners' Association, 1962, pp. 88-94).

In October 1964, the amended law was replaced by the New Law on Temporary Measures for Textile Industry Equipment. The New Law was proposed as a step towards deregulation of the cotton spinning industry. First, the clause on short-term production adjustments was deleted. Short-term production adjustments were left to the "depression cartel" provisions contained in the Anti-monopoly Law, which required Fair Trade Committee approval. Second, a new "scrap and build" clause was added. This allowed firms that disposed of suspended equipment to register new equipment up

[7] *Nihon Bouseki Geppou* (*Montyly Report of Japan Spinners' Association*) 178, pp.43-44.

to half the value of the disposed. This clause targeted the promotion of rapid modernization of equipment to enhance the international competitiveness of the industry. The cotton spinning industry was expected to have become internationally competitive and fully deregulated by the time the New Law expired four years later in 1968 (Japan Spinners' Association, 1979, pp. 57-64). As it was, after a two-year extension, the New Law was abolished in June 1970 (ibid p. 106 and p. 149).[8]

One may be concerned that focusing on this industrial policy is the examination of an unusual case. However, it is indeed in line with the literature. For example, from the Schumpeterian view, industrial policy could provide greater incentives to invest in new technology and processes, subsidizing technology development. This in turn stimulates competition among firms and could lead to rapid growth in productivity.[9] On the flip side, if industrial policy forces firms to reduce capital stocks by taking spindles out of operation, industrial policy will discourage firms to invest in new technologies and thus can cause a negative effect on productivity.[10] In the following sections, this issue is explored in more detail.

3. Empirical Model and Data

3.1. Estimation of Production Function and Productivity

The econometric analysis on the dynamic framework is based upon firm profit-

[8] Government intervention with the textile equipment continued until the early 1980s, for the purpose of structural improvement of the industry. In August 1967, the Law on Temporary Measures for Structural Improvement of Specific Textile Industries was enacted. The main objectives of this law were 1) to dispose of excess equipment, 2) to increase firm scale, and 3) to update equipment. This law was followed by the Law on Temporary Measures for Structural Improvement of Textile Industries in 1974. For more details, see Korenaga (2002).
[9] For a theoretical model, see, for example, Aghion, Dewartripont, and Rey (1997).
[10] This type of policy came to be widely applied in Japan in the 1970s and 1980s, when many industries were faced with over capacity under the decline of economic growth and sharp rise of oil price (Bureau of Industrial Policy, Ministry of International Trade and Industry ed. 1983, 1988).

maximizing behavior developed by Olley and Pakes (1996) (OP) and extended by Levinsohn and Petrin (2003) (LP). This empirical model is summarized as follows.

Suppose that firm n has a production function with a Cobb-Douglas form:

$$y_{nt} = \beta_0 + \beta_k k_{nt} + \beta_l l_{nt} + \beta_e e_{nt} + \beta_m m_{nt} + \varepsilon_{nt}, \quad (1)$$

where y_{nt}, k_{nt}, l_{nt}, e_{nt} and m_{nt} are the natural logs of output, capital stock, employment, energy and materials used in year t, respectively; ε_{nt} consists of two components: one being productivity level ω_{nt} and the other being an error term η_{nt}. Assume that ω_{nt} follows a first-order Markov process: $\omega_{nt} = E[\omega_{nt} \mid \omega_{nt-1}] + \xi_{nt}$, where ξ_{nt} is an innovation in productivity over last period's expectation. Suppose that η_{nt} is not observed, either by the firm or by the researchers, while ω_{nt} is observed by the firm in year t. In other words, ω_{nt} is a state variable, and thus affects the choice of inputs, while η_{nt} has no effect on the firm's choice.

A firm maximizes the expected value of its current and future profits. A firm can easily adjust labor and energy inputs. However, capital is a quasi-fixed input.[11] Capital in use in year t is assumed to be known at the beginning of the year, and thus capital is another state variable. The correlation between the choice of inputs and productivity causes a simultaneity problem, as pointed out in Marschak and Andrews (1944). The question, therefore, is how consistent estimates for β_0, β_k, β_l, β_e and β_m can be obtained.

To resolve this problem, LP introduced the assumption linking the current (the natural log of) material input m_{nt}, with productivity ω_{nt}: with more productive firms using more intermediate inputs. Let the demand function for materials be $m_{nt} = m_{nt}(\omega_{nt}, k_{nt})$, and the inverse of the optimal function with respect to ω_{nt} be

[11] Note that this assumption is consistent with historical review in Section 2 because the Japanese government partly controlled some of the equipment.

$\omega_{nt} = \omega_{nt}(m_{nt}, k_{nt})$. This implies that

$$y_{nt} = \beta_l l_{nt} + \beta_e e_{nt} + \phi_{nt}(m_{nt}, k_{nt}) + \eta_{nt}, \tag{2}$$

where

$$\phi_{nt}(m_{nt}, k_{nt}) = \beta_0 + \beta_k k_{nt} + \beta_m m_{nt} + \omega_{nt}(m_{nt}, k_{nt}) \tag{3}$$

The LP estimations of (2) and (3) are decomposed into two stages. In the first stage, β_l and β_e are estimated. Assume that $\phi_{nt}(m_{nt}, k_{nt})$ can be approximated by a third-order polynomial, using the natural logs of capital and material:

$$y_{nt} = \delta_0 + \beta_l l_{nt} + \beta_e e_{nt} + \sum_{i=0}^{3}\sum_{j=0}^{3-i} \delta_{hj} k_{nt}^i m_{nt}^j + \eta_{nt}. \tag{4}$$

The consistent estimators for δ_0, β_l and β_e are obtained by applying OLS to (4).[12]

In the second stage, β_k and β_m are estimated. From the estimation result of (4), obtain the estimated value of $\hat{\phi}_{nt}$:

$$\hat{\phi}_{nt} = \hat{y}_t - \hat{\beta}_l l_{nt} - \hat{\beta}_e e_{nt} = \hat{\delta}_0 + \sum_{i=0}^{3}\sum_{j=0}^{3-i} \hat{\delta}_{hj} k_{nt}^i m_{nt}^j. \tag{5}$$

Let β_k^* and β_m^* denote candidate values of β_k and β_m, respectively. From (3) and (5), $\hat{\omega}_{nt} = \hat{\phi}_{nt} - \beta_k^* k_{nt} - \beta_m^* m_{nt}$. Let $E[\omega_{nt} \mid \omega_{nt-1}]$ be the predicted value of the following regression:

$$\hat{\omega}_{nt-1} = \gamma_0 + \gamma_1 \omega_{nt-1} + \gamma_2 \omega_{nt-1}^2 + \gamma_3 \omega_{nt-1}^3 + \varepsilon_{nt}. \tag{6}$$

The residual of the production function for (β_k^*, β_m^*) is then computed as:

$$\eta_{nt} \hat{+} \xi_{nt} = y_{nt} - \hat{\beta}_l l_{nt} - \hat{\beta}_e e_{nt} - \beta_k^* k_{nt} - \beta_m^* m_{nt} - E[\omega_{nt} \mid \omega_{nt-1}]. \tag{7}$$

To identify both β_k and β_m, the residual must interact with at least two instruments. Note that capital stock is a quasi-fixed input, and therefore, determined

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[12] Note that β_0 is not separately identified from the intercept from $\phi_{nt}(m_{nt}, k_{nt})$.

by the previous period's investment decisions. This implies that the capital stock in year t does not respond to the productivity innovation in year t. The following moment condition is thus produced:

$$E[\eta_{nt} + \xi_{nt} \mid k_{nt}] = 0. \tag{8}$$

Note also that the productivity innovation in year t can be correlated with the material usage in year t, but should be uncorrelated with the material usage in year $t-1$, because firms choose m_{nt-1} before either product innovations or errors in year t are realized. The following additional moment condition is thus produced:

$$E[\eta_{nt} + \xi_{nt} \mid m_{nt-1}] = 0. \tag{9}$$

Using moment conditions (8) and (9), the consistent estimators of β_k and β_m can be obtained by minimizing the following GMM criterion function:

$$\min_{(\beta_k^*, \beta_m^*)} \sum_t \left\{ (\eta_{nt} \hat{+} \xi_{nt}) k_{nt} + (\eta_{nt} \hat{+} \xi_{nt}) m_{nt-1} \right\}^2. \tag{10}$$

Note that the estimators obtained from the LP estimation are used more than once. However, an analytic estimate of the standard error of the estimators is too difficult. Therefore, bootstrap estimates of the standard errors are calculated and reported.

3.2. Data

The major source of data is *Statistics on the Japanese Cotton Spinning Industry* (*Menshi Boseki Jijo Sankosho*), published on a biannual basis by the Japan Spinners' Association (various half year issues).[13] The strength of these statistics is their wide sample coverage and reliability, as well as the comprehensiveness of the information they provide. These statistics cover the majority of cotton spinning firms in Japan.

[13] The Japan Spinners' Association changed its name from the All Japan Cotton Spinners' Association in 1964.

At the same time, they include quantitative information such as output, labor input, material input, energy usage and capital stock figures. However, information on sales and investment is not available.

Using these statistics a longitudinal (panel) data set was constructed for the years 1956 to 1964. This covers the entire period of when the Law on Temporary Measures for Textile Industry Equipment was enforced, hence, the consistent data on equipment available from *Statistics on the Japanese Cotton Spinning Industry*. Firms for which output or input information is not available, or is not positive, have been excluded. Firms that existed for only one year have also been excluded. The total number of sample firms exceeded 120 for every year. The numbers of workers covered in the dataset are 92,430 in 1956, and 76,405 in 1964, which are 71% and 68% of all the regular workers in the cotton spinning industry in Japan.[14]

Output is defined as the weighted average of 12 output commodities.[15] Weight is defined as the sales share of each commodity. As mentioned above, sales data are not available from *Statistics on the Japanese Cotton Spinning Industry*. Unit price data has been obtained from the Bank of Japan (1956-1964) to calculate sales.[16] Inputs are defined as labor, capital stock, material input and energy usage. Labor is defined as

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[14] The total number of regular workers was 129,738 in 1956 and 111,549 in 1964 (MITI, 1958, 1966).

[15] The 12 commodities are 1) cotton yarn, 2) blended spinning cotton yarn, 3) spun rayon yarn, 4) waste cotton yarn, 5) blended waste cotton yarn, 6) tokubo, 7) viscose staple yarn, 8) mixed spun rayon yarn, 9) blended synthetic yarn, 10) synthetic yarn, 11) cotton waste and 12) rayon staple waste.

[16] Note that unit price depends on a "count," which is a unit that indicates the thickness of yarn. The higher the count, the thinner the yarn. Thinner yarn was regarded as being of higher quality and, therefore, a higher count means a higher unit price. Although unit price is available only for 20-count yarn in *Statistics on the Japanese Cotton Spinning Industry*, the conversion rate (the relationship between unit price and count) is available for cotton yarn and spun rayon yarn (Fujino, Fujino and Ono, 1979). The unit prices for cotton yarn and spun rayon yarn have been adjusted, based on this conversion rate. This means that the unit price differs across different firms. For the conversion rate, see Table A1.

the sum of production workers and white collar workers. Since data on white collar workers are not available for the periods before 1958, the number of white collar workers was estimated using a proportion of white collar workers to the total number of workers in 1959. Capital stock is defined as the number of operating spindles.[17] Material input is defined as the weighted average of the eight materials.[18] Weight is defined as the share of material costs. Energy usage is defined as the weighted average of the three energy inputs.[19] The cost of energy is used for the weight. Unit price data for the material inputs have been obtained from the Bank of Japan (1956-1964), as have unit price data for energy usage (Bank of Japan, 1964).[20]

Figure 1 presents the output share of the 10 largest firms, namely "judai-bo," for 1956-1979. Except in 1964-65, when the New Law on Temporary Measures for Textile Industry Equipment was enacted, the share of "judai-bo" remained stable from the late 1960s. The cotton spinning industry maintained a stable market structure for two decades in the sense that the share of large these large firms remained almost constant throughout the period. Note that the coverage of the *Statistics* changed when the New Textile Law on Temporary Measures for Textile Industry Equipment was enacted in 1965.[21] To exclude this effect, the period prior to 1965 was focused upon.

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[17] The number of operating spindles refers to the average number of the spindles actually operated in a certain year. Its upper limit was the number of operable spindles: the registered spindles minus spindles that were not suspended or out of order. Note that whereas no additional registration was approved after 1957, the number of operating spindles could change within the limit.

[18] The eight inputs are 1) cotton, 2) rayon staple, 3) viscose staple, 4) waste cotton yarn, 5) polyester, 6) vinyl, 7) nylon and 8) acrylic.

[19] The three energy inputs are 1) coal, 2) electricity and 3) heavy oil.

[20] Unit price is available only at the industry level. For a more detailed description about the definition and the source of unit price data, see Table A1.

[21] Until 1964, the *Statistics* surveyed the equipment classified into that for cotton spinning by the Law on Temporary Measures for Textile Industry Equipment of 1956, and it also surveyed the outputs and inputs of that equipment. As the New Textile Law was enacted in October 1964 and the classification of equipment was changed, the *Statistics* expanded the coverage of the survey to equipments for other new outputs such as spun rayon yarn in 1965, when the coverage of the survey on outputs and inputs was expanded as well. That is why the output share of the large firms

=== Figure 1 ===

Table 1 reports the descriptive statistics for 1956-1964. To measure the effects of the New Law on Temporary Measures for Textile Industry Equipment (i.e., industrial policy), the ratio of suspended spindles was used, which is defined as the ratio of the suspended spindles to the total registered spindles.[22] Because the suspended spindles ratio was different across different firms, it allowed capture of the industrial policy effect at the firm level.

=== Table 1 ===

There are four major findings in this table. First, labor productivity grew steadily from 1956 to 1964. Labor productivity increased during the industrial policy period, increasing from 5.04 in 1959, to 5.86 in 1964. Second, the cotton spinning firms started using synthetic yarn as intermediate inputs from 1959. The ratio of synthetic yarn to material inputs increased from 0% in 1958, to 7% in 1968. This result may support an anecdote that the introduction of synthetic yarn improved the productivity of the cotton spinning firms.[23] Third, the industrial policy controlled the

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declined in 1965 (Figure 1). For more details, see the Japan Spinners' Association (1960, page I).

[22] The data on the suspended spindles for the end of 1964 are not available in the second half year of 1964 issue of *Menshi Boseki Jijo Sankosho*, reflecting the change of the legal framework in October 1964. Hence, for 1964, we use the number of the suspended spindles at the end of June 1964, available in the first half year of 1964 issue of *Boseki Jijo Sankosho*. The ratio of suspended spindles should be between 0.075 and 0.15 for 1959-1960 and between 0.06 and 0.12 for 1961-1964. However, some firm-years whose ratio is outside these ranges were found. Because it is impossible to identify whether firms mistakenly reported these figures or broke the law, the analysis was conducted assuming that these figures were reported correctly.

[23] For example, Nagahama (1965, pp.5-6) stated that the synthetic yarn enabled the cotton spinning

equipment of firms after 1959. On average, the ratio of suspended spindles is 6.8-8.6% after the suspension of spindles started in 1959. Finally, the correlation between the suspended spindles ratio and firm size (measured by the capital stock) ranges between 0.40 and 0.48. This implies that the suspended spindles ratio is not just a proxy for the firm size, but may share some relationships with it.

These results seem to suggest that, through the regulation on equipment, industrial policy made a significant contribution to raising labor productivity, while also controlling firm output to maintain a stable market structure. Indeed, the growth in labor productivity and the maintenance of a stable market structure are surprising, despite the fact that the spinning industry was faced with a substantial change in the technological environment. An example of these changes is the widespread adoption of synthetic fiber as an intermediate input, given that the Japanese economy experienced rapid growth during the 1960s, and a severe recession in the early 1970s. Note, however, that labor productivity may not be a good indicator of productivity, because labor productivity increases not through an increase in the efficiency of workers, but through an increase of other types of inputs, such as capital or energy. To control the effects of the other factors, the next section estimates TFP.[24]

4. Results

4.1. Firm-Level Productivity

Table 2 presents the estimates of the input coefficients from the production

firms to control the quality of staple more easily, which improved the productivity of firms. However, none of the previous studies have statistically examined the relationship between the use of the synthetic yarn and the productivity of firm. Section 4.2 addresses this issue in more detail.

[24] As noted, investment data are not available from this data source. The LP estimation method is applied to estimate TFP.

function. The production function was estimated using all cotton spinning firms included in the source data for 1956-64 (unbalanced panel), based on the OLS and LP estimation.[25] The estimates of the coefficient derived from the LP estimation are significantly different from those derived from the OLS. While the OLS results reject the null hypothesis that the production function has constant returns to scale, the LP estimation results do not reject the null hypothesis. This implies that the coefficients are biased downwards in the OLS estimation and, therefore, the LP estimation successfully eliminates the simultaneity bias. These results also suggest that the Japanese government does not necessarily target the increasing returns to scale sector.

=== Table 2 ===

Table 3 presents the (un-weighted) annual average level, growth in labor productivity, and TFP between 1956 and 1964. TFP is obtained from the LP estimation. TFP level is defined as $\exp(\omega_{nt})$. Table 3 also reports levels and growth for both large and small firms.[26] In Section 2, the year identified was when the industrial policy was enacted (i.e., year 1959). The productivity growth was compared before and during the times the industrial policy was enacted, to assess the productivity implications of industrial policy.

=== Table 3 ===

[25] Table A2 presents entry and exit patterns.

[26] To simplify the discussion, large firms are known as judai-bo, and shin-bo and shinshin-bo are small firms.

Three findings stand out from this table. First, labor productivity rapidly grew, even after industrial policy was enacted. The annual average growth rate was 5.6% for 1956-59, and 2.8% for 1959-64. Second, by contrast, TFP did not show significant growth. The annual average rate of TFP growth was 0.6% and 0.2% for the years 1956-59 and 1959-64, respectively. As noted in the introduction, these results are consistent with the findings of previous studies, such as Beason and Weinstein (1996), and Kiyota and Okazaki (2005).

Finally, both labor productivity and TFP growth rates for large firms were consistently lower than for small firms. For example, the TFP growth rate for small firms was 0.7% for 1956-59, while the rate for large firms was 0.0%. Moreover, the TFP growth rate for large firms for 1959-64 was -0.7%. This result is surprising when combined with the knowledge that large firms maintained around 48% market share between 1957 and 1964 (Figure 1 and Table 1), despite the fact that their productivity decreased during this period. In addition, it is also interesting to note that the difference of TFP growth between large and small firms is not necessarily attributable to the catch-up process of small firms. This is because on average, the TFP level of small firms is greater than that of large firms, throughout this period.

Note that Table 3 simply presents the difference of the productivity growth before and during industrial policy. Hence, it is not clear whether industrial policy has created significant negative effects on the efficiency of the cotton spinning firms. The results clearly confirm that the output share of large firms was not supported by either efficiency or by an unobservable effort that would have been captured by TFP. This result implies that industrial policy effectively controlled a firm's activities. The next section examines in more detail the implications of these findings for industry productivity growth.

4.2. Productivity and Industrial Policy

To examine the effects of industrial policy on productivity, the methodology that is used to examine the effects of trade liberalization on productivity were employed. Similar to Pavcnik (2002), and Amiti and Konings (2007), the possible links between industrial policy and firm-level productivity were specified as follows:

$$\omega_{nt} = \gamma_0 + \chi_i + \chi_t + \gamma_1 (\textit{suspended spindles ratio})_{nt} + \gamma_2 (\textit{synthetic yarn})_{nt} + \upsilon_{nt}, \qquad (11)$$

where χ_i denotes firm-specific fixed effects that captures unobserved firm-level heterogeneity; χ_t denotes year-fixed effects that controls for industry-level shocks over time (e.g., demand shocks); *suspended spindles ratio* denotes the ratio of suspended spindles that captures the effects of industrial policy; and υ_{nt} denotes error term. As a control variable, a synthetic yarn-material input ratio *synthetic yarn* to control was included for the effects of synthetic fiber introduction. The suspended spindles ratio and the synthetic yarn ratios are the same as those used in Table 1.

Table 4 presents the regression results. Columns (1) and (2) indicate the results of the fixed-effect and random-effect models, respectively. The synthetic yarn-material ratio shows significantly positive coefficients, which is consistent with the anecdotal evidence discussed in Section 3.2. On the other hand, the suspended spindles ratio does not show a significant sign. Note, however, that the suspended spindles ratio could be endogenous as Section 2 found that the suspension rate was different by the number of registered spindles. Another regression was run in order to address the possible endogeneity of industrial policy. The ratio of suspended spindles is treated as an endogenous variable, while capital stock and other exogenous variables are instrumental variables (IV).[27]

=== Table 4 ===

Column (3) presents the two-step efficient GMM estimator. Firm-specific fixed effects are included to control for the unobservable heterogeneity of firms.[28] Endogenous (GMM distance) test statistic rejects the null that the suspended spindles ratio can be treated as exogenous at the 95% level. In the first stage regression results, the Kleibergen-Paap underidentification LM test rejects the null hypothesis that the equation is underidentified at the 99% level. The weak identification Wald *F* statistic exceeds 10, "the rule of thumb" of Staiger and Stock (1997). The null hypothesis that the instrument is weak is rejected at the significant critical value.

These results suggest that the instruments have some validity. Regression results indicate that once the endogeneity is controlled for industrial policy, the coefficient of the suspended spindles ratio turns out to be significantly negative. The result implies that industrial policy produced negative effects on TFP. The coefficients of the OLS fixed- and random-effect models are biased because of the endogeneity.[29]

4.3. Industry Productivity Growth

Figure 1 and Table 1 indicate that industrial policy effectively controlled the

[27] Other exogenous variables are the synthetic yarn-material ratio and year dummies.

[28] The time-invariant "judai-bo" (i.e., large firms) specific effects are wiped out by the firm-specific fixed effects.

[29] One may concern that the results come from the firms whose suspended spindles ratio is outside the ranges (Footnote 23). An alternative ratio was constructed that takes the upper limit value (0.15 for 1959-1960 and 0.12 for 1961-1964) if the ratio exceeds the upper limit value and takes the lower limit value (0.075 for 1959-1960 and 0.06 for 1961-1964) if the ratio becomes smaller than the lower limit. A regression was then run, replacing the suspended spindles ratio to this alternative ratio. It was found that the regression results were qualitatively similar to each other.

output of cotton spinning firms. Table 3 shows that TFP growth in large firms was negative during this period, while Table 4 indicates that industrial policy produced significant negative effects on the productivity of large firms. These figures are derived from an (un-weighted) arithmetic average of firm-level productivity. To assess the implications for industry productivity growth, the analysis is extended as a measure of growth.

As in OP, the aggregate productivity level is defined as the weighted average of firm-level productivity, with the share of industry output defined as the weight:

$$\omega_t \equiv \sum_n s_{nt}\omega_{nt}, \tag{12}$$

where s_{nt} is the share of firm n's output in the cotton spinning industry in year t. Note that aggregate productivity growth is driven not only by continuing firms, but also by entering/exiting firms. To incorporate the effect of entry/exit into the aggregate productivity growth, the aggregate productivity growth was decomposed using a modified version of Baily, Hulten, and Campbell (1992):[30]

$$\begin{aligned}\Delta\omega_t \cong &\sum_{n\in C} s_{nt-1}\Delta\omega_{nt} + \sum_{n\in C}(\omega_{nt-1} - \omega_{t-1})\Delta s_{nt} + \nu\rho_{\Delta s\Delta\omega} \\ &+ \sum_{n\in N} s_{nt}(\omega_{nt} - \omega_{t-1}) - \sum_{n\in X} s_{nt-1}(\omega_{nt-1} - \omega_{t-1}),\end{aligned} \tag{13}$$

where $\nu = \left\{\sqrt{\sum_{n\in C}\Delta s_{nt}^2}\right\}\left\{\sqrt{\sum_{n\in C}\Delta\omega_{nt}^2}\right\}(>0)$; $\rho_{\Delta s\Delta\omega}$ is the correlation between increases in the firm's output share, and its productivity growth; and C, N and X represent the set of continuing firms, entering firms and exiting firms, respectively.

The first term indicates each firm's own productivity growth, weighted by the industry share of each firm in year $t-1$. This is sometimes called the "within" effect. The second term represents the changes in the shares, weighted by the deviation of the

[30] For more details, see Foster, Haltiwanger, and Krizan (2001).

productivity level from the industry average level in year $t-1$. The second term captures the changes in the shares, which is sometimes called the "between" effect, or alternatively, the "reallocation" effect. The third term captures the correlation between the changes in the shares and the productivity growth, which is called the "covariance" effect. The fourth and last terms represent the effects of entry and exit, respectively. To examine the difference in the productivity growth between large and small firms, the within and between effects were further decomposed for large and small firms, respectively.[31]

Table 5 presents the decomposition of the industry productivity growth based on Equation (14). The major findings are threefold. First, the industry productivity growth was positive between 1956 and 1959, but turned negative between 1959 and 1964. In addition, the aggregate industry growth moved in tandem with the within effect. This finding suggests that the industry productivity growth can be attributed to each firm's own productivity growth. Second, the large firms demonstrated a lower within effect than the small firms. The within effects of the large firms were -0.01% for 1956-59, and -0.44%t for 1959-64. The within effects of the small firms were 0.35% and 0.04% for 1956-59 and 1959-64, respectively.

=== Table 5 ===

Third, the between effect did not contribute to industry productivity growth, especially after 1959. This result implies that the reallocation of resources from the less productive large firms to the more productive small firms was ineffective during

[31] A similar decomposition exercise can be found in Baily, Halten, and Campbell (1992).

this period. Industrial policy effectively controlled the output of the firms. Simultaneously, however, this control also restricted the reallocation of resources across these same firms. Combined with the negative TFP growth of the large firms, industrial policy resulted in overall negative industry productivity growth.

5. Conclusion

This paper has examined the effect of industrial policy on industry productivity growth. A detailed historical review of the industrial policies within the cotton spinning industry was first provided, in which the government introduced a major legal framework: the suspension of equipment after 1959. This measure was designed to indirectly control the output of cotton spinning firms.

Using firm-level data from the cotton spinning industry for 1956-64, estimations were then made on the productivity of firms, and the industry as a whole, both before and during the industrial regulation period. The major findings are summarized as follows. First, industrial policy effectively controlled the output of cotton spinning firms. The output share of the ten largest firms, which are called "judai-bo," remained stable from the late 1950s, after the Law on Temporary Measures for Textile Industry Equipment was enacted. The market share of these large firms remained almost constant throughout this period.

Second, cotton spinning firms experienced low total factor productivity (TFP) growth from 1956 to 1964. The annual average growth rate was 0.3%. The TFP growth rate for large firms was consistently lower than the rate for small firms. The annual average TFP growth rate for large firms for 1959-64 was -0.7%, while the rate for small firms was 0.4%. Third, industrial policy had negative effects on the productivity of firm. Besides, as a consequence of industrial policy, the reallocation effect did not work during this period. Combined with the negative TFP growth rates of the large firms, industrial policy resulted in overall negative productivity growth in the cotton spinning industry.

One important policy implication that can be drawn from this analysis is that industrial policy often cuts two ways. Industrial policy may be effective in controlling a firm's activities, such as output levels. This control, however, implies that the industrial policy also constrains the reallocation of resources across the firms. This type of policy will be effective when large firms achieve high rates of productivity growth. Otherwise, the policy will fail. Policymakers should recognize that industrial policy can be a two-edged sword.

Future research should include a more thorough investigation of the validity of the Levinsohn-Petrin (LP) estimation in analyzing the effects of policies, as an important extension. The LP estimation assumes perfectly competitive input markets. However, various policies such as industrial policy and trade policy could distort the input markets and generate some imperfectly competitive environments. This may cause biases in the LP estimator. In this connection, in order to estimate the productivity of firms more precisely, it is also important to control for the quality of the inputs, such as the difference between high- and low-quality capital stocks. Further investigation on the endogeneity of industrial policy is another important extension. To conduct such analysis, it is imperative that the quality and coverage of the firm-level data and policy variables be improved and expanded.

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Figure 1. Output Share of the Top 10 Largest Firms (Judai-bo), 1956-1979

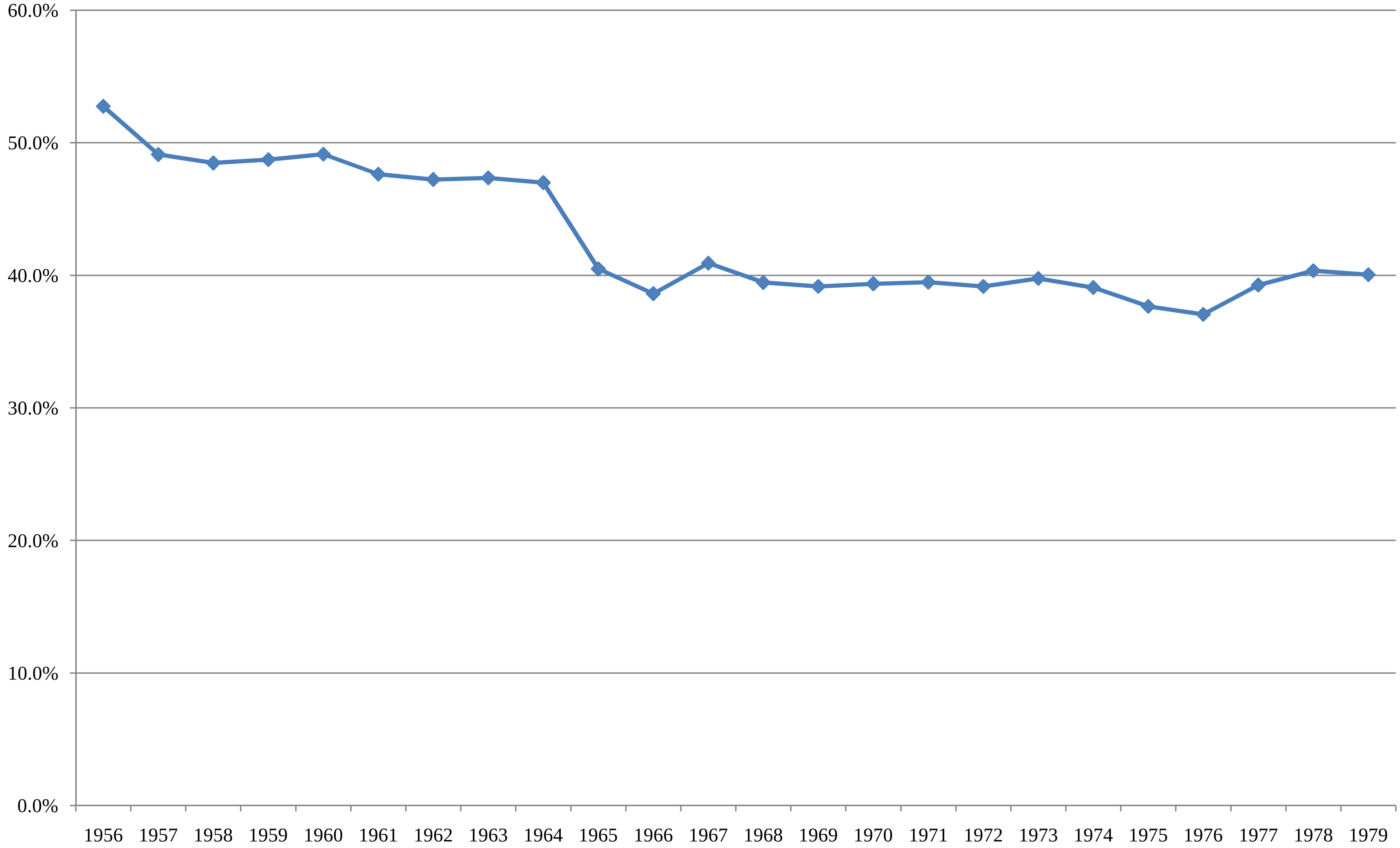

Table 1. Descriptive Statistics

	Output share of the top 10 largest firms (judai-bo)	Arithmetic average of all firms							Correlation between the suspended ratio and capital stock
		Labor productivity	Output-capital ratio	Output-energy ratio	Output-material ratio	Capital-labor ratio	Synthetic yarn-material input ratio	Suspended spindles ratio	
1956	0.53	4.50	0.08	0.55	0.87	62.80	0.00	0	n.a.
1957	0.49	4.79	0.08	0.54	0.87	66.66	0.00	0	n.a.
1958	0.48	4.65	0.08	0.51	0.88	64.10	0.00	0	n.a.
1959	0.49	5.04	0.09	0.52	0.89	64.05	0.01	0.08	0.44
1960	0.49	5.30	0.09	0.51	0.90	65.66	0.02	0.09	0.48
1961	0.48	5.74	0.09	0.51	0.89	68.64	0.01	0.07	0.40
1962	0.47	5.52	0.10	0.49	0.90	63.71	0.02	0.07	0.44
1963	0.47	5.62	0.09	0.46	0.90	66.24	0.04	0.07	0.48
1964	0.47	5.86	0.09	0.46	0.92	71.03	0.07	0.07	0.48

Note: n.a. stands for not available.

Source: See main text.

Table 2. Estimation Results of Production Function

	OLS			LP estimation		
	Dependent variable: gross output			Dependent variable: gross output		
Independent variables	Coefficient	Standard error	Significance level	Coefficient	Standard error	Significance level
Capital stock	-0.003	0.009	0.754	0.085	0.167	0.612
Labor	0.033	0.011	0.003	0.022	0.029	0.452
Energy	0.063	0.016	0.000	0.071	0.037	0.055
Material inputs	0.893	0.012	0.000	0.815	0.178	0.000
Test of constant returns to scale						
	F-test: *F*-statistic = 22.5 (*p*-value = 0.000)			Wald test: Chi-squared = 0.03 (*p*-value = 0.859)		
Number of observations	1181			1181		

Note: All standard errors are bootstrapped using 1,000 replications.

Source: See main text.

Table 3. Productivity Level and Growth

(Annual average)

Level	Labor productivity All firms	Large firms	Small firms	TFP All firms	Large firms	Small firms
1956-59	4.83	4.89	4.82	0.75	0.73	0.75
1959-64	5.61	5.21	5.64	0.77	0.72	0.78
Growth (%)	**Labor productivity All firms**	**Large firms**	**Small firms**	**TFP All firms**	**Large firms**	**Small firms**
1956-59	5.59	-0.85	6.14	0.65	-0.01	0.70
1959-64	2.76	0.68	2.93	0.27	-0.72	0.35

Notes: Unweighted arithmetic annual average is reported. Large firms are the top 10 largest firms (judai-bo) while small firms are other firms.

Source: See main text.

Table 4. Effects of Industrial Policy on Productivity

	OLS			IV
Dependent variable: ln(TFP_{it})	(1)	(2)		(3)
Suspended spindles ratio	0.120	-0.054	Suspended spindles ratio	-0.799*
	[0.107]	[0.094]		[0.445]
Synthetic yarn-material ratio	0.187*	0.219**	Synthetic yarn-material ratio	0.212**
	[0.104]	[0.099]		[0.105]
Observations	1181	1181	Observations	1180
Year dummies	Yes	Yes	Year dummies	Yes
Firm-specific effects	Fixed	Random	Endogeneity (GMM distance) test	4.31**
R-squared			Underidentification test	
overall	0.017	0.031	Kleibergen-Paap *rk* LM statistic	31.20***
within	0.041	0.038	Weak identification test	
between	0.041	0.126	Kleibergen-Paap Wald *rk F* statistic	64.01
Hasuman test statistic	11.79			

Note: Robust standard errors are in brackets. ***, **, and * indicate statistically significant levels at 1, 5, and 10 percent, respectively. The Hausman test tests the null hypothesis that the coefficients estimated by the random effects estimator are the same as the ones estimated by the fixed effects estimator. For IV estimation, suspension rate is treated as endogenous variable while capital stock and other exogenous variables are as instruments. Two-step GMM estimation is used for the second stage. In IV estimation, one observation is not used because of the singleton group.

Table 5. Decomposition of Industry TFP Growth

	[1] = [2] + [5] + [8] + [11]	[2] = [3] + [4]	[3]	[4]	[5] = [6] + [7]	[6]	[7]	[8] = [9] + [10]	[9]	[10]	[11]
	Overall productivity growth	Within effect	Large firms	Small firms	Between effect	Large firms	Small firms	Entry and exit effect	Entry	Exit	Covariance effect
1956-59	0.44	0.35	-0.01	0.35	-0.09	-0.01	-0.08	0.02	0.02	0.00	0.17
1959-64	-0.06	-0.40	-0.44	0.04	-0.26	-0.23	-0.03	0.00	0.02	-0.01	0.60

Note: Large firms are the top 10 largest firms (judai-bo) while small firms are other firms (shin-bo & shinshin-bo). Figure indicates annual average rate (percent).
Source: See main text.

Table A1. Price Data: Definition and Source

Output	Item	Definition	Source
p_{Y1}	Cotton yarn, adjusted by average count	exp(0.8739+0.0068*average count)$\times p_{Y1'}$	Fujino, Fujino and Ono (1979)
$p_{Y1'}$	Cotton yarn	Available from the source	Bank of Japan (1956-1964)
p_{Y2}	Blended spinning cotton yarn	$(P_{Y1}+P_{Y3})/2$	
p_{Y3}	Supun rayon yarn, adjusted by average count	exp(0.9390+0.0034*average count)$\times p_{Y3'}$	Fujino, Fujino and Ono (1979)
$p_{Y3'}$	Supun rayon yarn	Available from the source	Bank of Japan (1956-1964)
p_{Y4}	Waste cotton yarn	$P_{Y1}/P_{M1}\times P_{M6}$	
p_{Y5}	Blended waste cotton yarn	$(P_{Y4}+P_{Y3})/2$	
p_{Y6}	Tokubo	P_{Y3}	
p_{Y7}	Viscose staple yarn	P_{Y3}	
p_{Y8}	Mixed supun rayon yarn	$(P_{Y1}+P_{Y3})/2$	
p_{Y9}	Blended synthetic yarn	$(P_{Y1}+P_{Y10})/2$	
p_{Y10}	Synthetic yarn	$p_{Y10A}W_A+p_{Y10B}W_B+p_{Y10C}W_C+p_{Y10C}W_D$	Weight W_j is the share of material cost.
	p_{Y10A} Polyester	Available from the source	Bank of Japan (1956-1964)
	p_{Y10B} Vinylon	Available from the source	Bank of Japan (1956-1964)
	p_{Y10V} Nylon	Available from the source	Bank of Japan (1956-1964)
	p_{Y10D} Acrylic	Available from the source	Bank of Japan (1956-1964)
p_{Y11}	Cotton weesp	p_{M5}	
p_{Y12}	Rayon staple weesp	$P_{Y3}/P_{M1}\times P_{Y4}$	
Material inputs			
p_{M1}	Cotton	Available from the source	All Japan Cotton Spinners' Association (various years)
p_{M2}	Rayon staple	Available from the source	Bank of Japan (1956-1964)
p_{M3}	Viscose staple	P_{Y3}	
p_{M4}	Waste cotton yarn	Available from the source	Bank of Japan (1956-1964)
p_{M5}	Polyester	Available from the source	Bank of Japan (1956-1964)
p_{M6}	Vinylon	Available from the source	Bank of Japan (1956-1964)
p_{M7}	Nylon	Available from the source	Bank of Japan (1956-1964)
p_{M8}	Acrylic	Available from the source	Bank of Japan (1956-1964)
Energy use			
p_{E1}	Coal	Available from the source	Bank of Japan (1964)
p_{E2}	Electricity	Available from the source	Bank of Japan (1964)
p_{E3}	Heavy oil	Available from the source	Bank of Japan (1964)

Table A2. Number of Entry, Incumbent, and Exit

	Number of firms			
	Total	Entry	Incumbent	Exit
1956-57	132	11	121	0
1957-58	135	3	132	0
1958-59	139	4	131	5
1959-60	134	0	132	2
1960-61	133	1	130	2
1961-62	132	1	128	3
1962-63	130	1	124	5
1963-64	125	0	121	4

Source: See main text.