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Organizations for Quality Control

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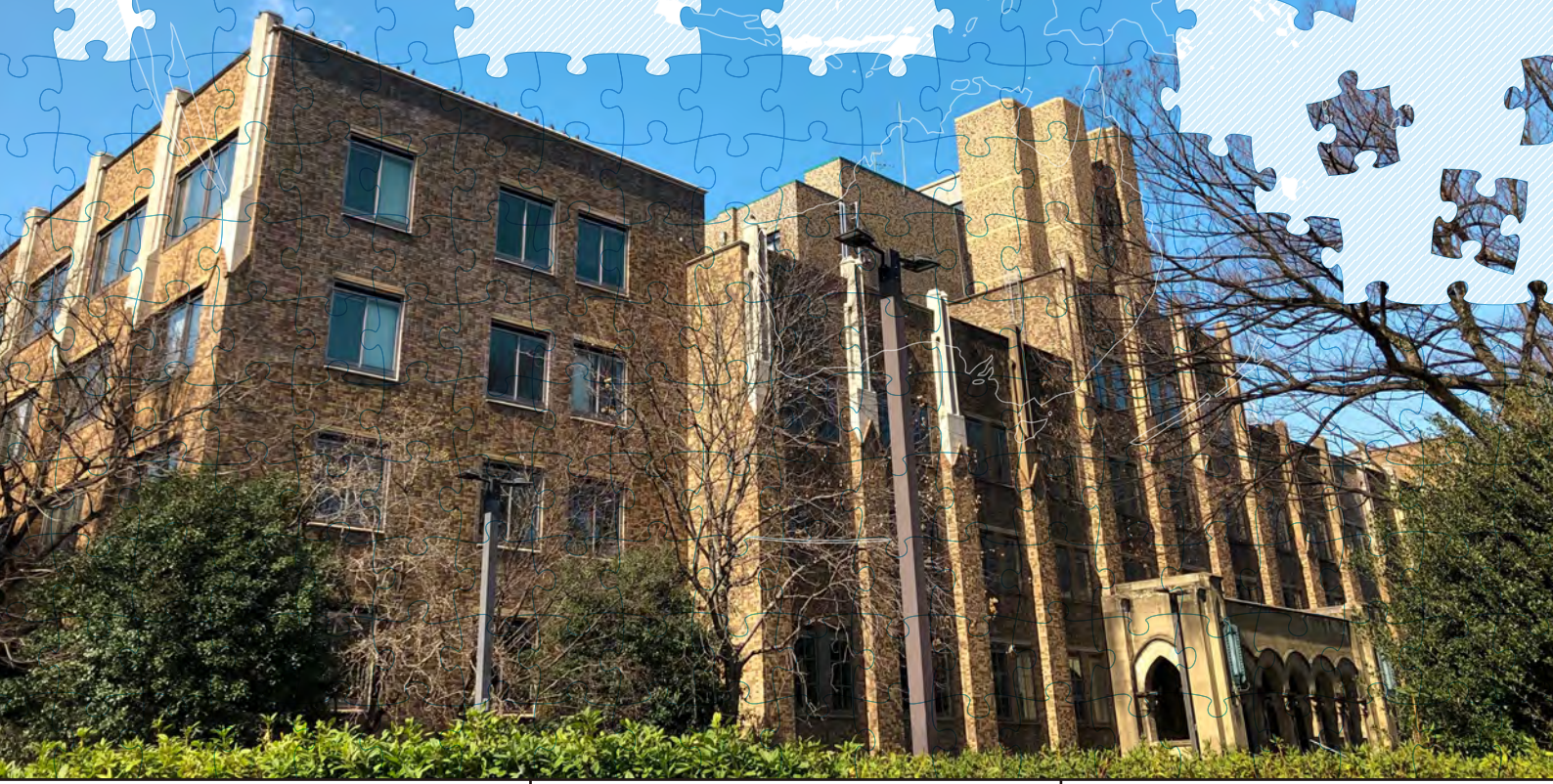

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Organizations for Quality Control

Branding in the Japanese Silk-Reeling Industry*

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Abstract

Transaction costs depend on the degree of information asymmetry. If sellers are motivated to reveal their products' quality, the cost accordingly decreases. If the quality information is strongly asymmetric, a device that guarantees commitment to a certain minimum quality could provide sellers with a quality premium. Such devices include quality inspection systems and brand reputation as established by either a merchant or a producer. In the market for raw silk, the largest export commodity of nineteenth-century Japan, Western trading companies dominated quality control by the mid-1880s. In the mid-1880s, Japanese manufacturers internalized the inspection and branding process, earned quality premiums, and began to grow rapidly. A higher reputation for quality led to a higher return and the growth of a company. In contrast, in Italy, quality was controlled by the region's chamber of commerce, and quality premiums were shared by the region's manufacturers. As a result, while Japan had enormous leading companies, the size of the companies in Italy remained small.

Key words: Institutions, asymmetric information of quality, branding, silk-reeling industry, Japan.
JEL: N35, L22, L23.

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1 Introduction

The transaction costs of impersonal trades, particularly the cost of using the price mechanism (Coase, 1937), depend on the degree of information asymmetry about the items to be traded. If sellers are motivated to reveal product quality, the cost accordingly decreases. If the quality information is strongly asymmetric and there is no trade, the worst equilibrium is a possible outcome.

There are two potential remedies. One is the third-party qualification. The governance of trade by a state court could maintain this function, but another kind of organization, such as a trade association or chamber of commerce, could also work. While a state court is supposed to be equipped with the ability to verify and enforce a relevant contract, the responsibility for verification has also been historically taken on by private organizations; alternatively, as in the case of the commercial court in France, the state court sometimes explicitly delegates the function to a specific organization (Lemercier, 2003).

The other potential outcome is relational contracting, or a firm organization in which trading partners are fixed and pricing shielded from the market such that inside prices do not necessarily synchronize with the market prices on a real-time basis (Coase, 1937, Williamson, 1985). With an increasing probability of the current trade continuing in the next term, relational transactions provide both parties, who maximize long-term streams of revenue, with incentives for honest trades.

A ramification of such devices for relational contracting is branding, which signals commitment to a certain level of quality for repeat customers. While buyers might feel impersonal to the seller, they can observe the history of the brand, which provides the seller with incentives to commit to a certain quality to earn a quality premium (Klein and Leffler, 1981). From production to consumption, multiple agents can be involved in trades. It is efficient for one to establish a brand if she/he can know the quality, control

it, and signal this quality to customers at the lowest cost. The agent who minimizes the cost might be either a manufacturer or a trader. On the one hand, manufacturers can assess and control the quality at lower costs. On the other hand, given some fixed cost and thus increasing returns to scale on establishment of a brand, a trader might be able to signal a certain quality through smaller marginal costs. Depending on which effect dominates the other, either the manufacturer or a trader establishes a brand, such as a "mis en bouteille au chateau (bottled at the chateau)" brand or a "négociant (merchant)" brand of Bordeaux wines.

Modern silk-reeling was industry the largest export industry of Japan from the 1880s to the 1920s and was the first modern East Asian manufacturing industry to dominate international markets. Heterogeneity both in technology and in organizations for quality control is a significant feature of the silk-reeling industry from the late nineteenth century to the early twentieth century. The governance of market trade was accordingly diverse. In Italy, third-party inspection managed by the regional chamber of commerce guaranteed the quality of the raw silk, and small- to medium-sized factories remained dominant. In China, trading companies' brands were dominant. In Japan, although Western trading companies' brands dominated the export market until the early 1880s, manufacturer brands gradually replaced them beginning in the mid-1880s, and firms that established their own brands grew to be the world's largest . This paper focuses on the internalization of branding from trading companies to cooperatives of silk-reeling manufacturers and ultimately to individual manufacturers.

Section 2 addresses the internal organizational changes in silk-reeling manufacturers during the internalization process. Section 3 describes the Japanese combination of market institutions and firm organizations. Section 4 presents a theoretical prediction to explain the choice whether to integrate or separate branding vertically from the viewpoint of upstream maximizing manufacturing firm profit. Section 5 compares Japanese

institutions with Italian institutions motivated by the theoretical prediction. Section 6 draws conclusions.

2 Free trade imposed on two East Asian giants

Due to their defeat in the Opium War in 1842, the Qing dynasty of China was forced to abandon state control over international trade and to open five ports, including Shanghai, under the Treaty of Nanking with the United Kingdom. The Treaty of the Bogue in 1843 finalized a legal structure of forced free trades; China was to allow its Western counterparts consular jurisdiction within concessions in the five treaty ports specified in the treaties and a unilaterally applied most-favored nation status and it was also expected to abandon tariff autonomy. Forced free trade unleashed the potential of the Chinese traditional silk-reeling industry. The export of hand-reeled raw silk from China to Europe surged in France, the primary market in Europe, reaching more than 50 percent in the mid-1880s. Combined with machine-reeled raw silk, also known as filature, produced in the Shanghai region, Chinese dominance in France lasted until the 1920s. Chinese raw silk production is estimated to have grown from 12,000 tons in 1880 to 16,950 tons in 1920, more than a 40 percent increase, while Italian raw silk production is estimated to have been 2,820 tons and 3,620 tons in the same years, or less than a 30 percent increase.[1]

The treaty port regime designed by the Treaty of the Bogue in 1843 became a standard for imposing free trade in East Asia. Conceding to a U.S. military presence, Japan also accepted the open trade regime in treaties with Western counterparts in 1858, with efficacy in 1859. Since Japan began trading freely with Western countries in 1859, it has exported hand-reeled raw silk to France. In the early 1870s, the price

[1]See Nakabayashi (2003), 480–483 (the original source is Direction Generale des Douanes et des Contributions Indirects, *Tableau general du commerce de la France avec ses colonies et les puissances etrangeres*, Paris: Impriemerie Nationale/Imprimerie Impriale); and Federico (1997), 203.

of raw silk dropped, as did that of other commodities, and continued to decrease until the middle 1890s. During this market-wide downturn, the Japanese traditional raw silk industry lost a competitive advantage over its Chinese rival in export markets. While exports of Chinese raw silk to France increased during a period of worldwide decrease in commodity prices, Japanese exports of raw silk diminished. The French silk market largely stagnated for a few years after the recession in 1882, severely damaging those artisans engaged in sericulture and hand-reeling. Similarly, machine silk-reeling factories, introduced to Japan in the middle 1870s, found diminished export opportunities for their machine-reeled filature owing to the French recession (Nakabayashi, 2014).

2.1 The rise of the modern American fabric industry

The American silk fabric industry began to develop after the late 1870s, accelerating in the 1880s The differences in institutional details between the U.S. and French markets explain the different experiences of the industries serving different markets. In Lyon, the silk fabric industry maintained "flexible specialization" as a luxury industry using hand looms until the 1900s, during which time, they produced various kinds of raw silk in demand, from hand-reeled raw silk with non-uniform threads to machine-reeled filature (Duran (1913), 72–77; Rawlley (1919), 66–73; Federico (1997), 77; and Cottereau (1997)). Moreover, in the American silk fabric industry, a factory system was established, and power throwing machines and power looms prevailed rapidly in the 1880s. Unlike its French competitor, the American industry developed by concentrating on medium- to low-grade fabrics for mass consumption. Accordingly, the American market demanded inexpensive filature with non-uniform threads in large lots, raw silk suitable for mass production by power looms.

With this change in the international market, the modern silk-reeling industry in Japan significantly rose. This developing industry was led by silk-reeling manufacturers

in Suwa County of Nagano Prefecture in Central Japan. Cooperatives of silk-reeling manufacturers, the largest of which was called *Kaimeisha*, formed an organization that incorporated inspection and branding processes and shared inspection results to improve member factories' production lines. Led by newly established manufacturers' brands, the Japanese share of the United States silk fabric market reached 50 percent by the end of the 1880s, 70 percent through the 1910s, and 80 percent in the 1920s. This successful expansion was the first Japanese experience of economic development produced by exports, and this pathway has since been followed by various Japanese manufacturing industries. With increasing U.S. demand, the output of Japanese raw silk is estimated to have grown from 1,297 tons in 1873 to 25,335 tons in 1923, or approximately twenty times its original size (Federico, 1997, 204–205). This growth was achieved not only by expansion but also by a rapid increase in labor productivity, which was naturally accompanied by rapid growth in real wages in Suwa County (Figure 1). The development of Japanese silk-reeling was not an expansion of a cottage industry without improvements in labor productivity but rather a salient modernization of the industry.

Figure 1: Productivity and real wages of the modern silk-reeling industry in Suwa County, Nagano, 1877–1919.

Source: Nakabayashi (2003), 468–469, 489–490.

Notes: Productivity: Average in the Village of Hirano, Suwa County, Nagano Prefecture. Wages in 1880–1888: Average daily wages of the Kaimeisha manufacturers. Wages in 1889–1919: Average daily wages of Miyasaka Seinojou Factory.

This paper will first address the organization of the Kaimeisha, the first cooperative to succeed in establishing its brand through the rereeling and inspection techniques. There are two important points to consider when analyzing an organization. First, the

price of raw silk, like that of all other commodities, is determined by multiple factors of quality. The pricing of raw silk in the market involves mapping multidimensional factors of quality to an amount of money; thus, price is a multidimensional function of multidimensional quality. Second, the internalization of quality control and signaling quality as part of an organization is, by definition, partial replacement of a function of the price mechanism, under which multidimensional valuation occurs. By this integration, or internalization, manufacturers acquire more detailed information about consumers' multidimensional preferences by watching the price movement of their own brand (Thomas, 1995). In the case of silk-reeling cooperatives, they established quality inspection organizations to certify their own brands, replacing inspections previously conducted by Western trading companies in the treaty port of Yokohama. That is, it incorporated a previously external transaction in the market. This successful incorporation of market transactions, with the purpose of acquiring information on the multidimensional price function of the market, was one of the principle efforts of silk manufacturers in Suwa County.

3 Internalized qualification

3.1 Internalization by manufacturers' cooperatives

In the 1880s, given their capital constraints, Japanese factories were equipped with only dozens of basins and initially produced amounts too small to meet the large lots with a standard level of denier uniformity demanded by the U.S. market.[2] As a consequence, this new industry established cooperatives for rereeling. Rereeling was literally reeling the filaments again after initially reeling silk from each cocoon to dry the raw silk.[3]

[2] "Denier" is the unit for thickness of threads. 1 denier is 0.05311 grams per 476 meters.

[3] The reeling process involves drawing silk threads from boiled cocoons and winding them. While wound silk could be taken off the reel and shipped immediately in Italy, Japan's high humidity levels

After rereeling, the raw silk from factories was shipped cooperatively. By cooperative rereeling and shipment, small manufacturers could increase their shipment lots jointly and improve the uniformity of the raw silk in the same lot. Thus, one important reason for their success was this technological advantage. However, the pioneering firms that first introduced the technology into Japan in the late 1870s or early 1880s did not become dominant. An association of silk manufacturers in Suwa County, the Kaimeisha, introduced a rereeling system and constructed an innovative organization in 1884. Silk manufacturers in Suwa County, specifically, and then, in Japan more broadly, adopted the rereeling technique.

The Kaimeisha was established in 1879 for cooperative shipment by silk-reeling manufacturers. The manufacturers gathered the raw silk produced by small member factories and shipped the product to a commissioned wholesale merchant in Yokohama. The wholesaler then sold the raw silk to Western trading companies. After the raw silk was bought from wholesalers, the Western trading company classified the raw silk from No. 1 to No. 3, repacked it, and put its own chop (trademark) on it. These trading companies then exported the raw silk under their own private brands to Europe.

However, in 1882, Japanese silk manufacturers faced a recession in France. By this recession, the Kaimeisha also faced losses and so sought to redirect its exports to the U.S. silk fabric market (Nakabayashi, 2003, 169). Although exports to the U.S. market required manufacturers to meet the higher standard of denier uniformity demanded in that market, many of the procedures at Yokohama remained the same; the raw silk was inspected, classified, priced by Western trading companies, and then exported to the U.S. under trading companies' brands, which were called "private chops" in the New York market (Duran, 1913, 105–106).

By establishing a brand, the seller can acquire information about marginal increases

raised the possibility that once-reeled threads would stick to each other. Accordingly, Japanese raw silk had to be wound again on a second, larger reel for drying and conditioning.

in price due to marginal improvements in quality in a direction in the multidimensional quality space and can earn quality premiums accompanied by a commitment to certain qualities. Thus, the seller has both the necessary information and the incentives to improve and commit to a level of quality (Thomas, 1995). This kind of seller, in this case, was a Western trading company. Manufacturers in the hinterland thus lacked both the information and the incentives to improve quality in the correct direction in the multidimensional quality space, guided by the price function in New York. This asymmetry was strongly felt by the manufacturers of the Kaimeisha before 1884. Letters with shipments from the Kaimeisha to the wholesaler at Yokohama, Ryohei Tomura, record this point.[4]

> [Letter with the 1st shipment. from the Kaimeisha to Ryohei Tomura, July 19, 1879]
>
> For classification of raw silk of individual manufacturers when sold [to Western trading companies], a card is inserted to each unit [2.2 kilograms], and so, when inspected [by Western trading companies], for No. 1, No. 2 and 3, please pull out each card, and bundle cards of No. 1 together and seal them, please do the same for No. 2 and No. 3 and please send them to us. Even when raw silk was rejected [by the Western trading companies], please do the same for classification into No. 1, No. 2, and No. 3, seal them and send them to us, but, if foreigners [Western trading companies] did not classify raw silk, we would like you to classify it, quote price differences for No. 1 and No. 2, and send them to us.

Thus, the Kaimeisha depended entirely on inspections by Western trading companies for quality control and for the distribution of proceeds between member manufacturers.

[4]"Oguchi Keiko Ke monjo (Archives of Keiko Oguchi)", held by Yokohama Archives of History.

> [Letter with 11th shipment, from the Kaimeisha to Ryohei Tomura, November 4, 1879]
>
> The other day, ..., while all boxes[5] were sold as No. 1, member manufacturers complain that there should be good or bad raw silk which should be differentiated into No. 1 or 2 in the boxes sold, by which managerial manufacturers are troubled, and therefore, hereafter, when selling in such a way, we would like you to roughly classify raw silk into No. 1 and 2, stamp classes on cards, and send them to us. There were no classification for 1st, 2nd and 3rd shipment, which naturally induced [a change in] quality [for the] worse, and thus, though we understand it is costly to you, please classify raw silk into as many classes as possible, then member manufacturers should make effort to improve quality. We would like you to accept this and handle it.

A few important points are reported in this letter. First, the classification of raw silk was directly linked to quality control as an incentive through the distribution of proceeds, which depended on the classification by Western trading companies. Second, the classification was still completely managed by Western trading companies; otherwise, manufacturers requested that the wholesaler at Yokohama approximate Western trading companies' classification. Third, without having their own brand, manufacturers could not recognize how the quality they produced was valued in the market.

After 4 years of business operations under information opacity, to increase the denier uniformity of the raw silk produced by member factories, the Kaimeisha organized a cooperative finishing system in 1884. The finishing process consisted of cooperative rereeling and cooperative inspection. In cooperative rereeling, traditional silk-reeling farmers in Gunma Prefecture sought to enter the U.S. market in the late 1870s.[6] Once it became clear that cooperative rereeling was useful in producing the kind of uniform raw

[5] 1 box of raw silk is 37.5 kilograms.

[6] See Kato et al. (1987), 145–199 and Federico (1997), 120.

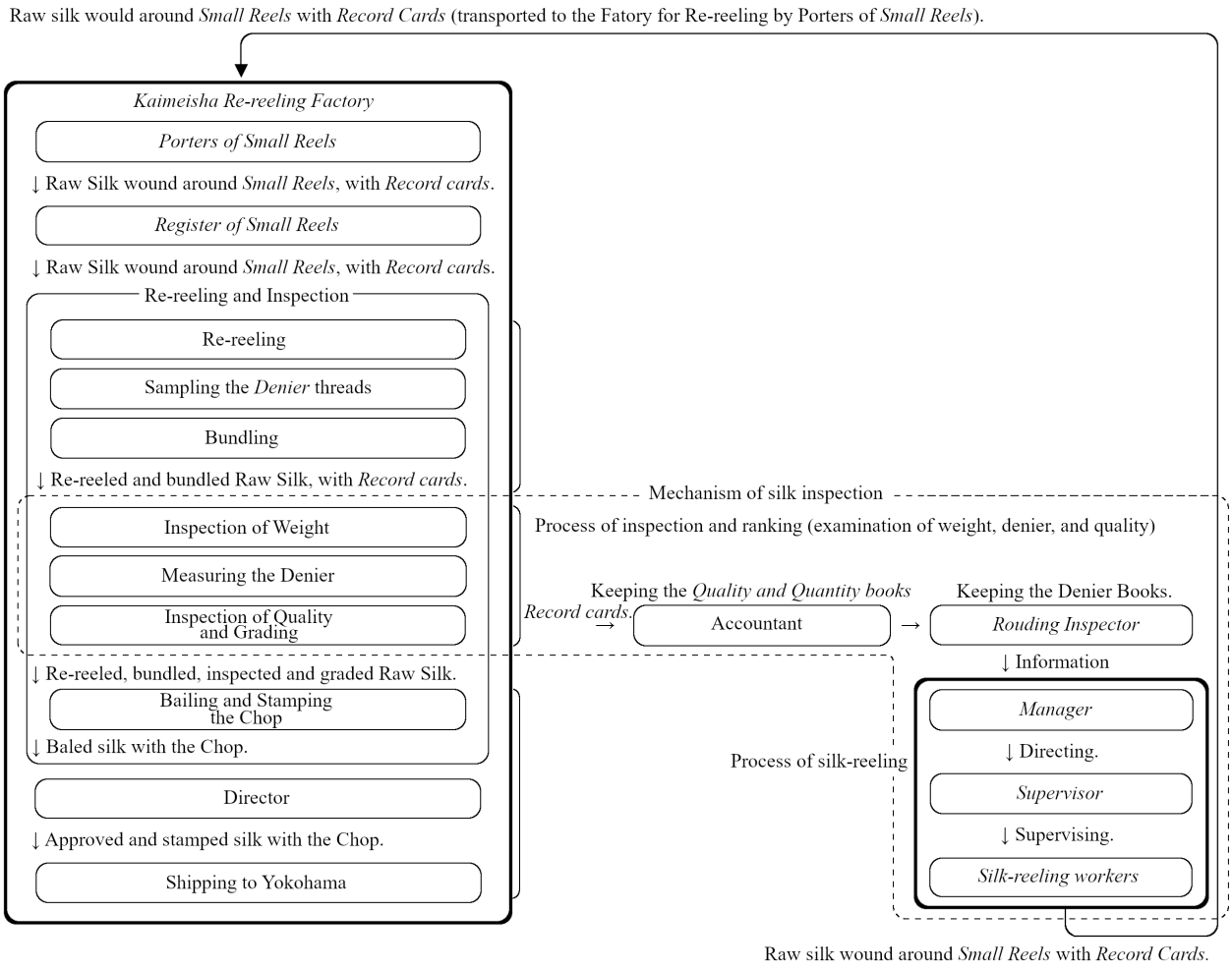
silk demanded in the U.S., machine-reeling manufacturers hastened to adopt the practice. Indeed, this cooperative technique was technologically helpful for improving the denier uniformity of raw silk threads.[7] Thus, cooperative rereeling was not a breakthrough in technology. Advancement was rather organizational, particularly in the inspection process, and the distribution of proceeds was strictly linked to the results of cooperative inspection.

The member manufacturers were supposed to transfer every single reel of raw silk with signs of which factory and reeling workers were in charge. Inspectors sampled the silk thread to measure the denier. The weight of each bundle and the denier of the thread were measured and entered into the record card. The bundle of raw silk then underwent a final quality inspection, receiving a grade of 1, 2, 3, or substandard, according to denier uniformity and luster. It was then baled, imprinted with the chop of its grade and shipped to a wholesale merchant in Yokohama. Then, the wholesale merchant sent market information by telegram to the Kaimeisha and received the sale order from the Kaimeisha in response.

The record cards, on the other hand, were sent to the Kaimeisha accountant, who entered the date, denier, quality, and quantity under the name of the worker in charge of the reel in a section of the "Raw Silk Detailed Record". The "Detailed Record" was passed to a rounding inspector, who transferred the information into each female employee's section in the "Denier Book" (Figure 2).

[7]Mostly because, in the 1880s, factories were too small to maintain uniform quality in large lots and partly because hand-powered reeling machines were still in use in a number of factories in the 1880s, it was difficult to maintain the constant speed necessary for producing uniform thread. To partially offset this problem, rereeling wheels were generally operated with waterpower. In 1892, there were twenty member factories in the Kaimeisha and a total of 1,590 basins. In the same year, eight factories, accounting for 328 basins, were hand driven. Nou Shoumu Shou Noumu Kyoku (1895).

Figure 2: Rereeling and inspection system of the Kaimeisha after 1884.



Source: "Hashizume ke shiryou (Archives of Hashizume)," held by the Okaya Silk Museum.

Importantly, the "Detailed Record" and the "Denier Book", which logged the daily performance of individual workers at their factories, were used as the means to control

the incentives for the different manufacturers by providing the information necessary to improve quality. After the raw silk was sold, the proceeds of the sales were distributed according to the grade recorded by the inspectors of the Kaimeisha. Thus, the higher quality that a manufacturer realized, the more money the manufacturer received. The rounding inspectors guided the factories by passing on the information about quality that accumulated in the "Detailed Record". With the guidance of the "Detailed Record", the manufacturers knew about the different dimensions of quality to be improved.

Member silk-reeling manufacturers were thus given concrete information about quality and financial incentives to control it. Under this scheme, it became substantially more likely for member manufacturers to increase their proceeds by improving quality. Thus, sustaining quality became more compatible with the incentives for member manufacturers, as advised by the cooperative rounding inspectors, because quality control to meet market demand was less costly when the information was transmitted by rounding inspectors, and improved quality was rewarded by preshipment inspection and the distribution of proceeds.[8] The Kaimeisha thus incorporated a part of the pricing function that took place in the market into its organization.

As shown in the example above, to motivate manufacturers to improve production efficiency, it was necessary that the product be evaluated accurately and receive an appropriately high price at final sale. Importantly, this quality premium could not end up with a trading company or a wholesale merchant but had to be transmitted to the manufacturer to provide the incentive to improve quality. The certification of

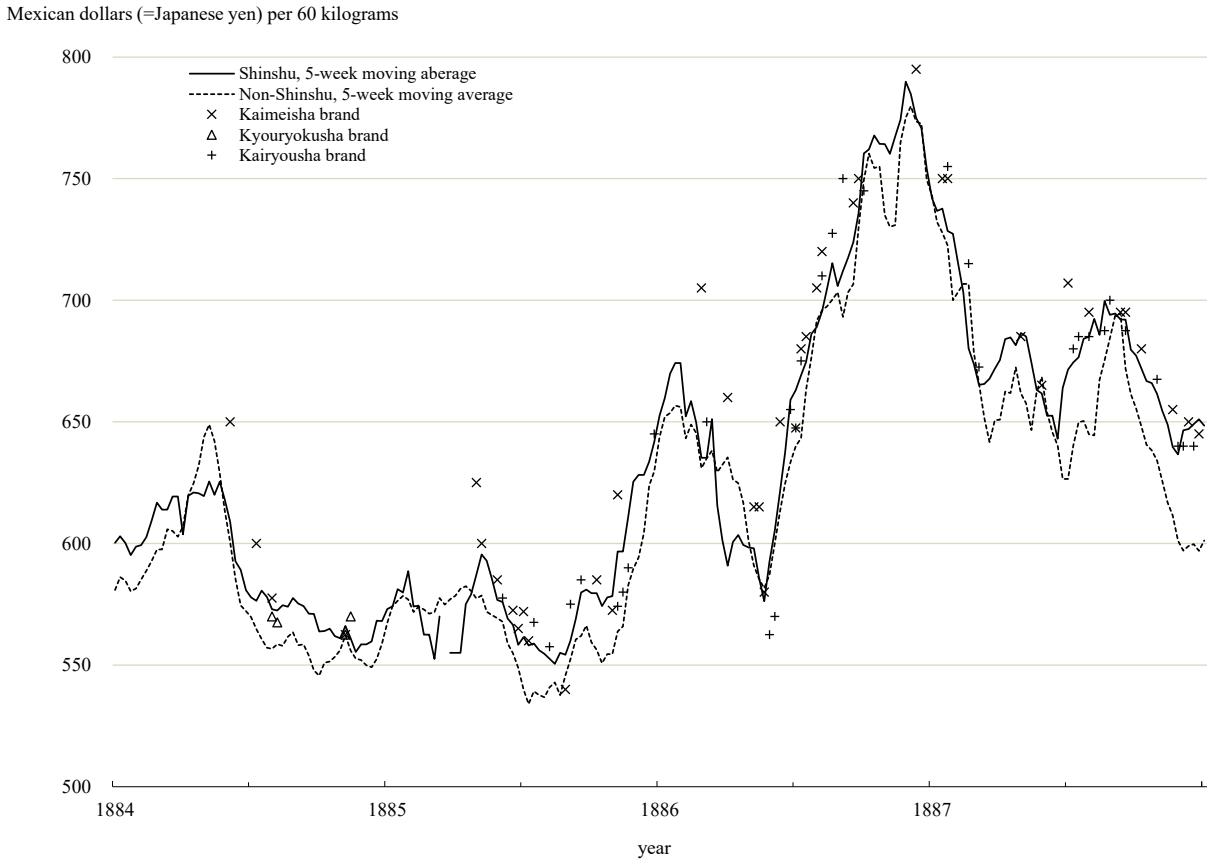
[8]High-quality production costs more than low-quality production, and the amount of the cost increase is determined by the manufacturer's level of efficiency. Therefore, high-quality production may not mean that profit is maximized for a manufacturer who was less efficient. The Kaimeisha organization provided little incentive to less efficient factories to improve their quality. In fact, it prohibited factories that could not achieve the Kaimeisha average in quality from becoming members; this cutoff in fact stood at 80 percent of the Kaimeisha average in productivity (Article 7 of Rules, 1884). The continuity of membership was also important for quality control: most of the original members remained in the Kaimeisha until at least the late 1890s. By contrast, associations with fluid membership could not sufficiently control product quality even by introducing cooperative re-reeling.

quality by silk-reeling manufacturers' chops was a device for realizing such organizational coordination.

The Kaimeisha set the design for its chop in its 1884 Rules, and its 1888 Rules further prescribed strict control over the brand quality. The raw silk was classified into three groups. Group 1, the best , was recognized as the Kaimeisha brand, within which there were three numbered ranks. Group 2 was sold with another name, the Souseigumi brand. Group 3, for sale only in the domestic market, was sold without a brand name. According to the 1888 Agreement, the Kaimeisha No. 1 brand accounted for approximately 70 percent of the total production of the Kaimeisha. By the late 1880s, trading companies in Yokohama had received orders from New York that specified the Kaimeisha brand. The Kaimeisha brand thus seems to have become trusted in New York by the end of the decade. The Kaimeisha brand clearly gained a quality premium beginning in 1884 (Figures 3, 4, and 5), and the cooperating member factories of the Kaimeisha developed rapidly.[9]

[9]The Shinshū (Nagano prefecture) filature (machine-reeled raw silk) brands were appreciated, especially after 1884. "July [1884]: About the middle of the month Shinshu Silks came in to some extent, and gave evidence of excellent quality. The price of Hanks [hand-reeled and non-re-reeled raw silk] weakened continually, but towards the close, filatures were decidedly strong, the good quality apparently making them prime favorites for the American Market', "The silk trade of Japan", taken from Messrs. Griffin & Co.'s Half-yearly Silk report, *The Japan Weekly Mail*, April 18, 1885, 373. Messrs. Griffin & Co is a trading company in Yokohama. There were 1,624 basins in Suwa County in 1884, of which 691 were affiliated with the Kaimeisha. In 1890, a total of 1,310 basins were affiliated with the Kaimeisha.

Figure 3: Filature (machine-reeled raw silk) prices at the Yokohama market, weekly, 1884–1887.

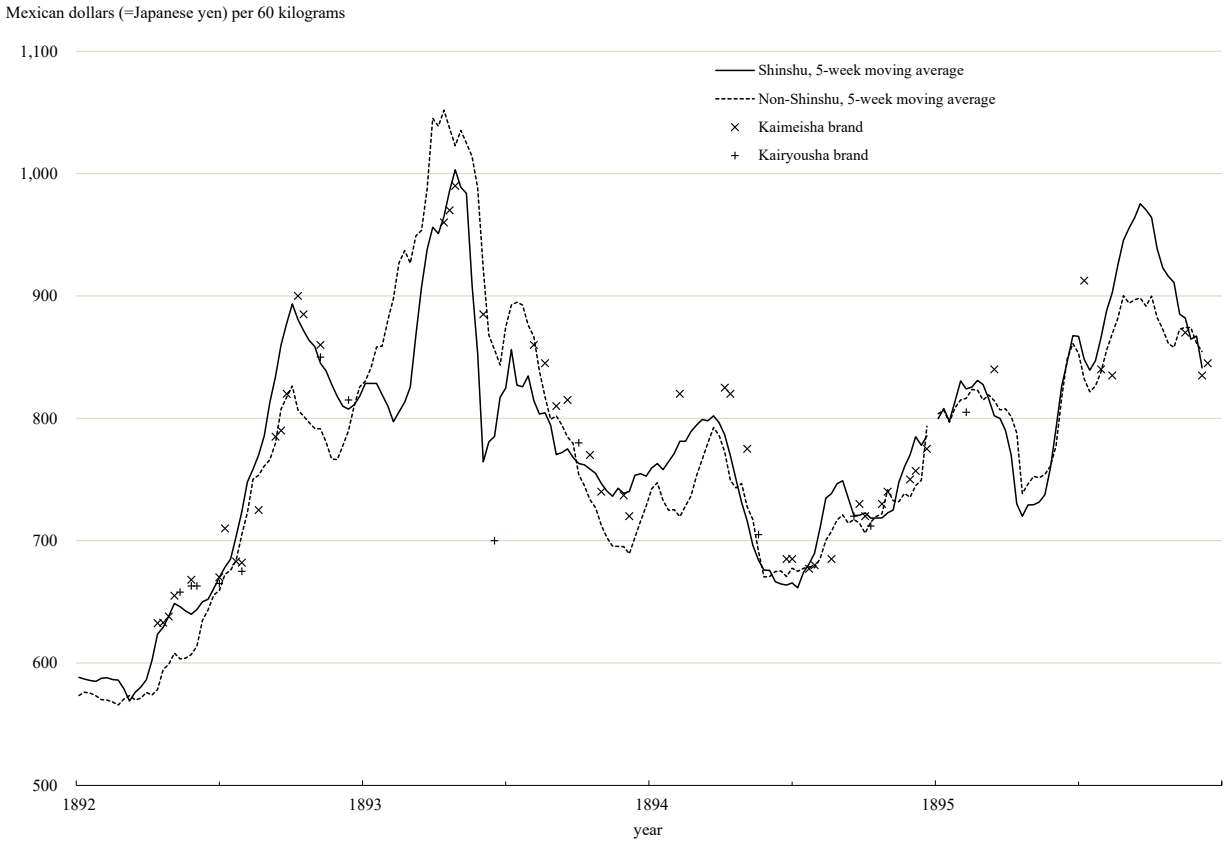


Source: Nakabayashi (2003), 178. The original source is the *Tokyo Keizai Zasshi (Tokyo Economic Journal)*.

Figure 4: Filature (machine-reeled raw silk) prices at the Yokohama market, weekly, 1888–1891.

Source Nakabayashi (2003), 178. The original source is *Tokyo Keizai Zasshi (Tokyo Economic Journal).*

Figure 5: Filature (machine-reeled raw silk) prices at the Yokohama market, weekly, 1892–1895.



Source Nakabayashi (2003), 178. The original source is *Tokyo Keizai Zasshi (Tokyo Economic Journal)*.

The outcome was straightforward. Figures 3 and 4 depict the weekly price series of filature produced in Shinshū, which is the old name for Nagano Prefecture, including Suwa County and other regions, on a five-week moving average and those of the Kaimeisha filature. After 1884, the Kaimeisha filature earned an obvious quality premium. The practice was followed by other cooperatives. A typical example is a coop-

erative in Suwa County, Kyouryoskusha, and Kairyousha, which was the new name of Kyouryokusha after 1885. Kyouryokusha was an organization for cooperative shipment. In 1885, member manufacturers copied the Kaimeisha method and renamed their own brand Kairyousha. Then, though smaller, the Kairyousha brand successfully earned a quality premium along with the Kaimeisha.

With other machine-reeling manufacturers following the Kaimeisha's lead, by the end of the 1880s, the total Japanese share of the U.S. market reached more than 50 percent. Recognizing that the growth in market share in the U.S. resulted from the consistent provision of a certified quality, the silk-reeling manufacturers that already obtained a quality premium had sufficient incentive to maintain that higher quality associated with their brand names.[10] With the rapid success of this production model, the organization of the Kaimeisha became a standard in the development of Japan's modern silk-reeling industry.

Earned premiums resulted in accelerated growth for member manufacturers of the Kaimeisha. The number of basins on which reeling workers operated rapidly increased from the mid-1880s to the early 1890s. This growth was accompanied by increased labor and productivity, which was shown as a growth in per-basin output (Table 1).

INSERT Table 1 HERE

[10] "In filatures and re-reels, some of the manufacturers who have a reputation to maintain have turned out good, worthy silk; while other chops, especially in the Medium Grades, have been non-uniform and unreliable as of old", "The silk trade of Japan", taken from Messrs. Griffin & Co.'s (trading company in Yokohama) half-yearly silk report, *The Japan weekly mail*, January 19, 1884, 68. In addition, silk fabric manufacturers were willing to pay quality "premium" for credible "original chops [manufacturer brands]" relative to "private chops [trading company brands]" in real business practice. See Duran (1913), 105, 109.

3.2 Development of the U.S. fabric industry and the challenge from Shanghai filature

However, the Japanese share of the U.S. market stopped increasing in the mid-1890s when Shanghai factories rapidly increased the production of Chinese filature for export to the United States. In the mid-1890s, productivity increased as the speed of throwing machines and power looms in the American silk fabric industry as increased. Through increased productivity in the American silk fabric industry, the real price of silk fabrics decreased, making silk more popular for mass consumption.[11] Moreover, the replacement of highly skilled male workers with low-skilled female workers, which began in the 1880s, progressed further in the production of medium- to low-grade cloth in the American silk fabric industry. The raw silk demanded in these increasingly capital-intensive factories was, above all, raw silk with more uniform threads because such silk was suited to the high-speed operation of power looms and made higher labor productivity possible.[12]

On the other hand, large factories equipped with 150-500 basins were established in Shanghai by Western trading companies from the 1880s to 1890s.[13] As the threads of Chinese machine-reeled silk were more uniform than those of their Japanese competitors, American silk fabric manufacturers changed from Japanese filature to Shanghai filature for the production of organzine.[14] This substitution of Chinese raw silk was clearly felt

[11] See Kumasaburo Tanabe, a staff member of the New York consulate, "Shika toki no gen-in narabini Beikoku ni okeru kinuorimono ryuko no keikyo (the cause of the rise of the silk price and the popularity of silk fabrics in the United States)", *Kanpou (The Official Gazette)*, 2,936, Apr 17, 1893. Matsui (1930), 149.

[12] "[T]he high-speed looms introduced between 1890 and 1900 are said to have caused a substitution of women for men because the ease in manipulation made the work suitable for women", Department of Labor, the United States (1910), 61. See also Clark (1929), 210–215; Scranton (1989), 195–197. On the wage difference between male and female workers in the U.S. silk industry in the 1900s, see Aldrich and Albelda (1980), 329–340. In Paterson, New Jersey, Italian immigrants rapidly became the main labor source for the industry after the recession of 1893-1894, surpassing British and French immigrants in number. See Brockett (1876), 119 and The Senate of the United States (1911), 17–20.

[13] See Nishikido (1897), 39-44, and Li (1981), 163–168.

[14] Both organzine and tram were silk threads made of twisted strands of raw silk. Organzine was mainly used as a warp thread and tram as a woof thread. When raw silk was processed to become organzine, the raw silk had to be more uniform than it was when processed to become tram because

in Japan, reflected by the stagnation of the Japanese share of the U.S. market.

This market shift was also reflected in the decreased quality premium earned by the Kaimeisha brand in the Yokohama market. In the mid-1890s, the quality premium for the Kaimeisha and other Nagano brands diminished and finally disappeared (Figure 5).

3.3 Independent production organizations

Moreover, in the mid-1890s, many of the chops of Japanese raw silk became jumbled as competing silk-reeling manufacturers responded to their individual incentives (United States Tariff Commission, 1926, 50). While major manufacturers aimed to make the quality premium permanent, minor manufacturers tried to make short-term profits by cheating buyers with sales of low-quality silk with a highly reputed chop. Overall, however, the major silk-reeling manufacturers, led by the Suwa-based businesses, maintained confidence in their brands, leading to further development of the Japanese silk-reeling industry.[15]

At the same time, the capital restraint of the silk-reeling manufacturers in Suwa County was loosened by their large profits in the late 1880s. The growth of individual member factories also enabled leading factories to satisfy the optimal technological scale

a more uniform warp was strongly needed for increased productivity. See the report of Iwajiro Honda, a technical official with Noshomusho, *Dai Nihon Sanshi Kaiho*, No. 52, October 1896, 34–38. If the warp threads were non-uniform, the threads became tangled in the loom, and the worker had to stop the loom to remove them. In addition, looms needed to be adjusted by skilled male workers. See (Chittick, 1913), 16–17; United States Tariff Commission (1926), 51; Department of Labor, the United States (1911), 34; and Matsui (1930), 138; Federico (1997), 214; A report from B. Richardson, president of the American silk association, *Dai Nihon Sanshi Kaiho (Journal of the Sericultural Association of Japan)*, 19, January 1894, 27-34; reports from the New York branch of Yokohama Kiito Gomei Kaisha, *Dai Nihon Sanshi Kaiho*, 29, November 1894, 34–35; 32, February 1895, 42–43; 44, February 1896, 45; and 46, April 1896, 24–25. The American silk fabric industry stagnated during the mid-1890s when manufacturers struggled to increase productivity (Scranton, 1989, 112–227). Organzine was used as warp threads in the fabric, and the warp had to be more uniform than the weft for use on power looms.

[15]Several studies have emphasized that some Japanese machine-reeled silk brands were not trusted and that trading companies or wholesale merchants had to participate in quality control (Ishii (1972), 70–71, 208–209, Federico (1997), 162–164). Although this observation describes the conditions of the early 1880s, it does not apply to the leading silk-reeling manufacturers after the middle years of that decade.

of production for manufacturers' brands. Therefore, as the heterogeneity of member factories increased, the loss of efficiency from a suboptimal level of quality became increasingly serious. The increased heterogeneity was indeed observed at the Kaimeisha. As the organization grew rapidly in the early 1890s, the variation in production scale also increased, which made cooperation more technically difficult (Table 1). This inference is not just a theoretical hindsight but rather an issue explicitly recognized as reality by contemporary manufacturers.

> It is totally impossible for current organizations of silk-reeling manufacturers in Suwa County to specifically produce high-quality raw silk, ..., even if you alone produce high-quality raw silk taking any necessary cost and hand the raw silk to a cooperative re-reeling factory, after [it is] packed, you can get no [price] effect due [to the high-quality silk] being mixed with low-quality raw silk, ..., therefore, if you try to alone produce high-quality raw silk, you definitely need to carefully select cocoons, ..., to carefully re-reel, to strictly inspect disconnection, denier, and shine, and to carefully choose boiling water on your own.[16]

Consequently, leading manufacturers established large factories equipped with several hundred to a thousand basins outside of cooperatives in the mid-1890s. A typical case was Kanetarou Katakura, the chief manager of the Kaimeisha. While his founding factory was a member of the Kaimeisha, he established a factory equipped with 300 basins outside the Kaimeisha, independently conducted quality inspections and shipped its products under a different brand name. Katakura later increased the number of factories, each of which shipped its product under different brand names, and grew to become the world's largest silk-reeling company.

[16]"Suwa seishika keiken dan (Story of silk-reeling manufacturers' experience in Suwa)", *Shinano Mainichi Shimbun (Shinano Daily)*, December 1, 1895.

Another typical case was the Goushi Okaya Seishi Gaisha (Okaya Silk-Reeling & Company). Otojirou Oguchi, Unokichi Hashizume, and Gen-emon Yokouchi, all of whom were smaller members of the Kaimeisha, understood the necessity of transforming the organization, withdrew from the Kaimeisha, jointly formed a company, and established a factory equipped with 400 basins to achieve the "standardization of raw material, boiling water, and management" under "one large factory" run by one integrated management.[17] The factory was expanded to 794 basins in 1899 and more than 1,000 basins in the early 1900s. In the early 1900s, the Okaya Silk-Reeling & Company was the largest standalone factory whose products were shipped under the same brand name. Its brand, "White Chicken", was recognized as the standard bearer for "Japanese Filature No. 1" in the New York Market.[18] The factory increased productivity during growth, and profitability became stable (Table 2). Rapid expansion to a production scale of 1,000 basins is consistent with the idea that improving quality and recognition in the market will also expand the optimal size of production for the same brand.

INSERT Table 2 HERE

One important advantage of such large independent factories was, again, in their technological assets. The production of raw silk with uniform threads required a constant speed from the machine-powered reels and a consistent temperature of steam from boilers since the reeling process involves boiling cocoons in steam, both of which were factory requirements with high fixed costs. Another advantage was organizational in setting the quality level to maximize profits responding to the market prices directly, beyond the technologically optimal quality. Both of these advantages were associated with the withdrawal from cooperative rereeling.

[17] Memorandum by Otojirou Oguchi, 1903. "Hashizume Ke Shiryo (Archives of Hashizume)", held by the Okaya Silk Museum.

[18] "Classification of raw silks", *The American Silk Journal*, 27(7), July 1908, 23.

One of the significant changes in organization accompanying the transition of factories from cooperative members to independent large companies was the internalization of the inspection process and the establishment of individual brands. If the level of efficiency was the same for all the factories included in an association, the optimal level of quality, which was the level of quality that maximized their profit, was also the same. However, if the level of efficiency differed among factories, the optimal level of quality itself could be different. Such differences in efficiency could be most pronounced when a higher level of quality was required, as any cooperative with less efficient factories could impose losses on the more efficient factory. In such a case, a larger and more efficient manufacturer could be better off by withdrawing from the association, incorporating the inspection process into its own factory, and establishing its own brand. Thus, in response to these incentives, manufacturers' "original chops" for large independent firms were established as credible brands in the New York market between the late 1890s and the early 1900s.

With this organizational change, silk-reeling manufacturers came to acquire information about the multidimensional quality vector in the New York market and more efficiently connected it to the operation of silk-reeling. Indeed, this learning process became one of the factors contributing to a growing advantage over the Shanghai silk-reeling factories. While Japanese filature production began to grow and increase its share of the U.S. market again, the growth of the silk-reeling industry in Shanghai became considerably slower in the 1900s. There were several reasons for this loss of advantage by the Shanghai factories. Among the faults of the Chinese silk-reeling industry was its firm organization. In most Chinese silk-reeling factories, the owner and the manager of a factory were different people, with managers usually contracting the use of a factory on an annual basis. The managers, who controlled the production process, had weaker incentives to pursue long-term profit given the probability that their contracts might

not be renewed. This organizational structure therefore implied a weaker incentive for factories to expand production and establish their own brand.[19] In contrast, the silk-reeling manufacturers in Suwa County had a strong incentive to maintain long-term profits and thus used the information acquired through the price earned by their own chop to control the optimal process of production.

Furthermore, information acquired through brand establishment was effectively utilized to motivate workers to balance quantity and quality of output at the level that maximized profit. In the cooperative rereeling system, the inspection process was incorporated in the rereeling factory, meaning that all information about workers' performance in the reeling factories was collectively accumulated in the cooperative rereeling factory and not acquired by the individual reeling factories. With the extraction from the cooperative system, individual factories acquired this information directly.

The devolution of information acquisition resulted in drastic changes to the wage system of employed workers. From the late 1880s, silk-reeling manufacturers in Suwa County had adopted a relative wage system, under which the wages of workers were determined by relative evaluation among workers. By the late 1890s, with separate production and inspection under cooperative rereeling and inspection systems, however, firms monitored almost only a quantitative measure of labor productivity because feasibility and cost concerns limited observation in different reeling factories to this amount measure alone. A lack of oversight in a multidimensional productive actions of workers and a room of opportunistic behavior ensured that workers devoted increasing effort to raise output amount at the expense of product quality. To avoid such multitask moral hazard, it would have been helpful to monitor other dimensions of work, includ-

[19] See Lieu (1933), 39–47; Lieu (1940), 96–102; Li (1981), 171–173; and Eng (1986), 70–79. While Federico (1997) contradicts this argument because some Shanghai silk was of high quality (Federico, 1997, 24), the important issue is whether management was oriented to brand consolidation. Notably, after the 1900s, the Japanese silk-reeling industry, in which management was generally oriented to maintaining brand reputation and quality premiums, boosted its share of the U.S. market again.

ing quality (Holmstrom and Milgrom, 1991). Nevertheless, information about aspects of performance, including the quality of the raw silk reeled, was collected in the cooperative rereeling factory.

With the establishment of large independent factories, this information came to be accumulated in individual factories. Therefore, large manufacturers introduced a new wage system in the 1900s. This new wage system utilized a four-dimensional wage function composed of labor productivity, material productivity, denier uniformity of raw silk threads, and luster of threads as independent variables. By inducing incentives through this wage function, workers essentially were simultaneously maximizing factory profits through their own choices to maximize earnings. Indeed, vectors of workers' effort became better coordinated with such a wage system in the 1900s (Nakabayashi, 2006, 200–203).

Therefore, the incorporation of market pricing into production processes occurred on the shop floor, with individual workers organizing their operations along with streamlined information that flowed from the market through feedback in the inspection process back to production, revealing the price of the brand in the market and providing multidimensional incentives to firm workers in the 1900s. In the 1880s, the inspection process, which had been a market transaction, was first incorporated into associations for cooperative rereeling. With the resulting establishment of brands differentiated by quality, associations could acquire information on the multidimensional aspects of the price function and could use this information to control the incentives of member manufacturers through the distribution of proceeds. In the mid-1890s, a similar change occurred in the organization of the silk-reeling industry. The inspection process was disaggregated from the cooperative to the individual factories, leading to their individual brands. Manufacturers used information about the multidimensional price function acquired through their own brands to control the incentives of workers directly through the multidimensional

wage function. At this point, information about the multidimensional quality vector required by foreign export markets and reflected by the multidimensional price function, was then efficiently connected to the incentives of factory workers. This organizational change made the advantage of Japanese machine-reeled silk robust. Commencing with the growth period during the first decade of the 1900s, the Japanese share of the U.S. market continuously increased until the end of the 1920s.

4 A theoretical prediction

A distinctive characteristic of Japanese and European institutions in raw silk markets was vertical integration and separation. In Japan, manufacturer brands, notably those of leading companies prevailed as business institutions, i.e., the vertical integration of branding, while classification by regional chambers of commerce, i.e., vertical separation of branding, became dominant in Europe.

A tractable model can explain these two equilibria. Suppose that upstream manufacturers decide whether to vertically integrate branding through negotiations with downstream merchants. Then, we obtain the following theoretical prediction (Nakabayashi, 2023).

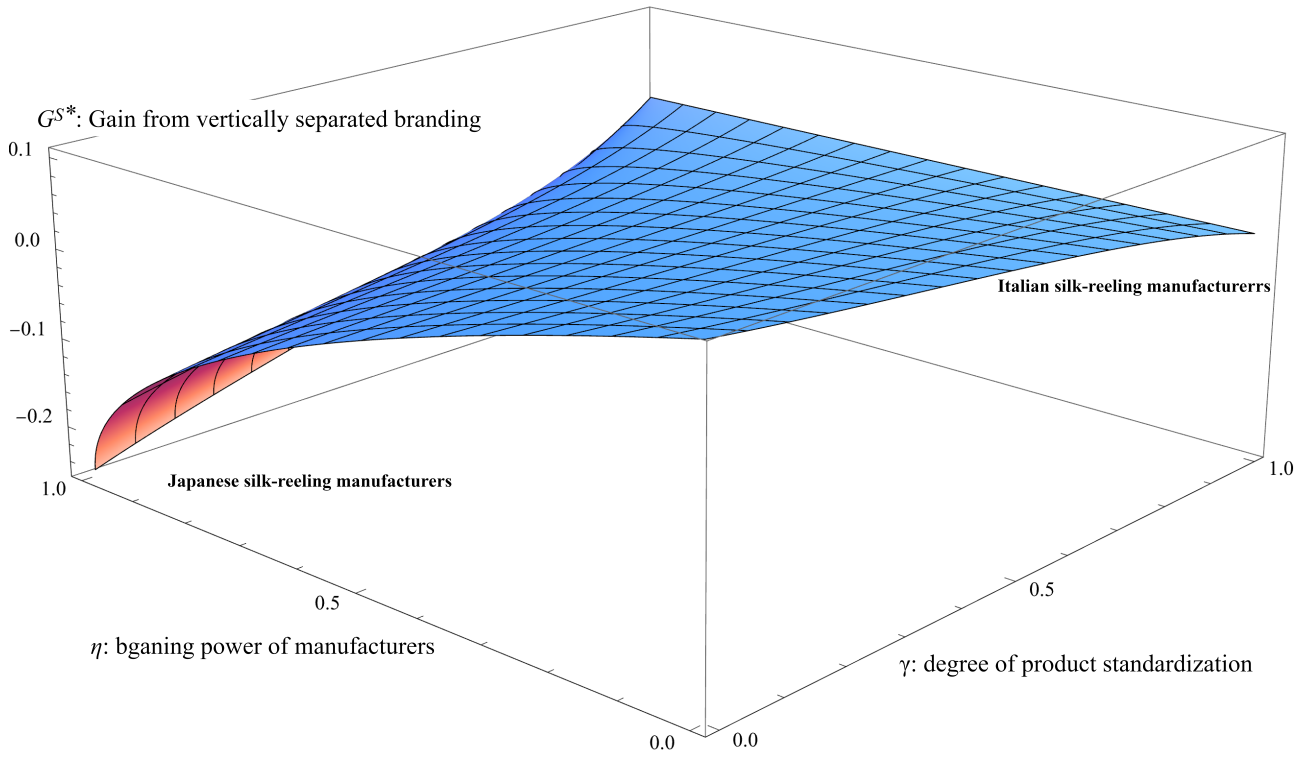
Prediction 1. *Vertical integration dominates if and only if the upstream firm's bargaining power is higher than a certain threshold, and the upstream firm's gain from vertical separation decreases with the upstream firm's own bargaining power. Furthermore, the upstream gain from vertical integration increases with the degree of product differentiation, and vice versa.*

In summary, in the case of the Japanese silk-reeling industry, where leading silk-reeling manufacturers built strong bargaining power by establishing brand names that were accepted in the U.S. market and continuing to differentiate their products by im-

provements in quality, the vertical integration of branding was optimal for profit maximization.

Let G^{S^*} denote the gain from vertical separation, γ denote the degree of product commoditization, i.e., $1/\gamma$ denote the degree of product differentiation, and η denote the bargaining power of the upstream manufacturing firm. A numerical example is presented in Figure 6. In the figure, Japanese silk-reeling manufacturers whose products were differentiated and whose size gave them strong bargaining power are located in the bottom-corner of the northwest. If they had moved from there, it is implied that they would have lost profit. By contrast, Italian silk-reeling manufacturers whose products were standardized by regional chambers of commerce and whose size was small in general are located in the up-corner of the northeast. Deviation from the equilibrium would not have increased manufacturers' profits.

Figure 6: Gain from vertical separation G^{S*}.



5 Two institutions

5.1 Branding or classification?

Signaling by brands is a means of engaging in relational contracting to overwhelm manufacturers' possible opportunistic behaviors and to realize a better equilibrium. The modern Japanese silk-reeling industry developed under this mechanism of governing trade. Moreover, not every original manufacturer chop was credible. Rather, the chops of large manufacturers received a persistent quality premium because the chops of other manufacturers were not credible. Silk fabric manufacturers in the U.S. purchased credible chops at a quality premium or unreliable chops for a significantly diminished price.

Therefore, in the 1910s, several American silk fabric manufacturers requested the introduction of another institution to govern trade: a third party to conduct inspection and classification without exception.

There was an informal classification in the Yokohama market. Before major manufacturers established manufacturers' brands, trading companies classified raw silk into levels No. 1 to No. 3 and put their "private chops" on them. After major manufacturers established manufacturers' brands, their credible manufacturer "original chops" became the means of classifying the chops of minor manufacturers. That is, small manufacturers' brands were classified into ranks of major manufacturers' brands. Chops of minor manufacturers and their classifications, however, were often unreliable. Thus, American silk fabric manufacturers came to request a third-party classification procedure. This specific demand became a major issue between American silk fabric manufacturers and Japanese silk-reeling manufacturers in the 1910s.[20]

5.2 Institution in Europe

Obviously, American manufacturers were considering a different institution as their model for the governance of trade, the institution in Europe. In the 1830s, a modern inspection method for raw silk was established by the Silk Conditioning House of Lyons (la Condition de soie de Lyon), which was called the Talabot system. The Talabot system was introduced as the official measure of quality inspection by the Chamber of Commerce of Lyons (la Chambre de Commerce de Lyons), and raw silk was inspected by this method. By the late 19th century, the Talabot system (le systeme Talabot), or the modified version, the Talabot-Persoz-Roget system, had been introduced by almost all commercial communities in markets in France and Italy and by primary markets in

[20]See "The American manufacturers' viewpoint", *Silk*, 11(9), September 1918, 33–40.

Germany, Switzerland and the U.K.[21] In the late 1880s, when Japan started to export raw silk to the U.S., the system of classifying quality by a third party had prevailed in Southern Europe; thus, the classification of Italian machine-reeled silk from the Milan market was credible (Tolaini, 1996, 205). Indeed, Italian filature could be traded according to the classification used in the Milan market, so the effectiveness of the third-party classification and certification procedure mitigated the need for firms to individually differentiate their product from others with a distinct brand; in fact, few such brands existed for Italian filatures during this period (Duran, 1913, 144–166).

Different from manufacturer branding, where the optimal scale of production tends to be larger than in trader branding, the Italian system of signaling quality by regional associations did not require a large scale of production. This provided favorable conditions for small factories to survive. In contrast, the compulsory classification system was not introduced into business between Japan and the U.S., such that quality governance by brands was maintained, with predictable effects on the organization of silk-reeling production in Japan, emergence of large manufacturers.[22]

Furthermore, in a strategic environment, instead of a competitive market, the vertical separation of branding among manufacturers could weaken competition, increase the ease of creating a coalition, and enable them to make larger profits (Nakabayashi, 2023, Bonanno and Vickers, 1988). The Italian system, which used the chamber of commerce as a monopoly on brand associations in the region, was separated from any individual manufacturer and provided an environment favorable to creating a coalition instead of making competition stiffer. This approach is assumed to help medium- to small-sized

[21] There were 41 conditioning houses that had adapted the Talabot system in 1878, 17 of which were in France and 15 of which were in Italy, with another 9 in other regions. In 1888, there were 33 houses, 14 of which were in France and 11 of which were in Italy. See Vignon (1890), 187–196, 349–352; Tolaini (1996), 219–224.

[22] Akira Shito, the director of the Silk Conditioning House of Yokohama, thought that the quality guaranteed by the reputation of famous factories was credible; that is, he recognized the governance of trade by brands as credible. See Akira Shito, "The problem of classification of raw silk", *Silk*, 11(9) September, 1918, 29–31.

factories survive.

5.3 Organization of production and the institution of the market

The organization of production in the Japanese silk-reeling industry relied on the establishment of brands. Manufacturers completely inspected the multidimensional quality of their products and utilized their "original chops" to guarantee particular qualities. The example above indicates that this organizational choice itself could generate a relatively large optimal size of production, particularly for more efficient firms (Prediction 1). When these "original chops" were priced in the market, the manufacturers could acquire information about the multidimensional aspects of quality demanded in the market through the multidimensional price function. Manufacturers used this information to control the process of production and the incentives for workers. If their products were deemed to have a higher quality standard than their competitors, it was possible for these firms to earn a higher quality premium on their chops, providing strong incentives to improve the process of production and the control of workers. In other words, competitive firms were provided with incentives to pursue firm-specific innovations in technology and organization to acquire a premium. This brand-based approach to quality feedback was the Japanese system. Obviously, some efficient major manufacturers could receive a large quality premium. Indeed, a remarkable feature of the Japanese silk-reeling industry was that several large firms developed.

In contrast, under the system where quality classifications were conducted without exception by a third party, little surplus remained for the manufacturers that produced a higher-quality silk than other firms within the same class. Few winners were motivated to emerge. Indeed, there were no Italian firms as large as several existing in Japan (Federico, 1997, 22).

These empirical facts, therefore, indicate complementarity between the institutions of the market and organizations of production in the late-nineteenth to early-twentieth-century silk-reeling industry. The raw silk market was characterized by a significant and increasing premium for increases in quality in a costly procedure to inspect and ensure product quality. While different productive organizations were considered and used in the effort to earn the highest possible profit from their efforts, the Japanese silk-reeling industry developed multidimensional labor incentive schemes that were directly linked with their individual brands and not limited by compulsory third-party classification or restricted solely by the trading of regions' brands. This was the key development ensuring the persistent success of the Japanese silk-reeling industry over its global competitors in the export market.

6 Conclusion

This paper adds an important example of quality control through trade, linking market institutions for products and organizations of production. Under the governance of trade by brands, the multidimensional price function could directly and efficiently be connected to the multidimensional wage function. Such governance of trade would lead to the emergence of enormous firms, and the Japanese silk-reeling industry rose as the most successful. However, under the governance of trade by third-party classification, more diversified industrial organizations could emerge, such as those in the European markets governed by the chambers of commerce.

The construction or extension of an organization involves the incorporation of transactions from markets, often to acquire and process information about a multidimensional price function. This means that the construction or extension of an organization changes the field where players choose strategies that determine the structures of the

organization. Therefore, the complementarity between market institutions and different organizations involved in production should be considered consistently.

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Table 1 Growth of Kaimeisha manufacturers, 1884-1901.

			year	1884	1885	1886	1887	1888	1889	1890	1891	1892	1894	1895	1896	1897	1898	1899	1900	1901
Number	Kanetaro Katakura			90	90	90	90	125	160	160	160	160	160	160	160	160	160	160	160	160
of basins	Kurataro (Kunizo) Hayashi			64	64	64	64	80	80	130	130	180	180	300	300	300	340	540	540	476
	Kinzaemon Ozawa			50	50	51	70	100	100	150	150	200	200	200	200	200	200	200	200	200
	Sehei Hayashi			26	30	30	36	50	70	160	160	180	180	180	180	180	300	332	332	332
	Katsuzaemon Komatsu			23	28	28	28	34	40	50	50	80	100	106	106	106	106	106	106	168
	Keijiro Hayashi					22	22	28	40	51	52	60	60	100	100	100				
	Tatsunosuke (Kikujiro) Ozawa			40	40	40	34	34	48	70	70	100	100	100	100	100	100	100	100	100
	Seikichi Hayashi			26	26	26	26	26	40	60	60	100	100	100	100	100	100	100	100	100
	Otojiro Oguchi			42	42	42	42	42	62	62	62	62	62	62	62					
	Ikutaro Katakura			36	44	44	44	44	54	54	54	54	54	56	56	58	58	58	58	58
	Sakutaro Hanaoka			14	14	14	14	14	20	26	26	26	40	42	44	49	44	44		
	Yokichi Hayashi			12	25	25	25	25	30	34	34	34	42	42	42	42	52	52	52	64
	Risaburo Hayashi				20	20	20	30	35	40	40	40	40	40	40	40				
	Ichiju Hayashi			20	20	20	20	20	27	27	27	30	37	37	37	37	37	37		
	Kinzaemon Hayashi			20	20	20	20	20	32	32	32	32	32	35	35	35				
	Tamizo Hanaoka			14	14	14	14	19	20	20	20	20	32	32	32	32				
	Unokichi Hashizume			17	17	17	17	20	20	20	20	20	32	32	32					
	Gen-emon Yokouchi			27	30	30	30	30	30	30	30	30	30	30	30					
	Kakuzaemon Katakura			20	20	20	20	20	20	20	20	20	20	30	30	30	30	32		
	Genza-emon Hayashi			10	10	16	16	17	20	20	20	20	27	27	27	27	27	39	39	39
	Kamesaburo Yokouchi			14	14	14	14	19	20	20	25	25	25	25	25	25	25	25		68
	Senza-emon Hayashi			53	61	61	36	36	54	54	54	100	100	100						
	Kinroku Ozawa							20	20	20	20	21							32	
	Others			73	23	0	0	0	0	0	0	0	0	0	0	0	32	0	0	32
	Total			691	702	708	702	853	1,042	1,310	1,316	1,594	1,653	1,836	1,738	1,621	1,611	1,825	1,719	1,797
	Variation			0.66	0.63	0.61	0.62	0.76	0.73	0.82	0.81	0.85	0.76	0.85	0.88	0.84	0.91	1.11	0.99	0.84
Output	Total		tons	20.4	20.3	30.4	31.3	41.3	56.3	60.0	62.3	66.4	73.1	80.3	71.3	105.0	71.6	79.9	82.5	90.8
of raw silk	per basin		kilograms	29.5	28.8	42.9	44.6	48.4	54.0	45.8	47.3	41.6	44.2	43.7	41.0	64.8	44.5	43.8	48.0	50.5

Source : "Kamasū daichou (Number of basins)," "Kamasū sankaku (Number of basins and outpu)," edited by Kaimeisha. "Oguchi Keiko ke shozo monjo (Arhives of Keiko Oguchi)," (8), held by the Okaya Silk Museum.

Notes : There is no record for number of basins and ouput in 1894. "Others" are rented basins to outsiders. Variation ([standard deviation]/[average]) does not include "others."

Table 2 Facilities, outputs and profits of Okaya Silk Reeling and Company.

year	Number of basins	Output of raw silk		Assets and profit		
		Total	per basin	Asstes		Profit
	a	*b*	*b/a*	Total	Fixed	
		kilograms	kilograms	yens	yens	yens
1897	440			114,981	30,044	5,651
1898	440	24,435	56	179,972	35,260	-36,905
1899	794	36,180	46	355,889	55,153	18,540
1900	794	45,900	58	544,750	55,153	-14,701
1901	794	52,144	66	333,577	64,849	9,409
1902	931	60,008	64	364,780	72,801	22,686
1903	937	52,515	56	399,765	84,470	-12,847
1904	1,016	61,425	60	484,847	91,524	18,851
1905	979	53,704	55	457,330	103,701	-7,550
1906	1,010	73,508	73	647,340	108,198	76,053
1907	1,050	73,888	70	930,256	113,490	2,543

Source : Nakabayashi (2003), pp. 194-195.