Imposed Efficiency of the Treaty Port
Japanese Industrialization and Western Imperialist Institutions*

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Abstract

An intrinsic feature of a pre-modern society is its diversity of industries and segregated markets. Segregated markets more likely fail in coordination for development. However, if a concentrated market is exogenously formed and the market could provide the only price to local markets, the market can work as a pivot of coordination for economic growth. Treaty port markets imposed on nineteenth century Japan worked as the pivot and ignited Japan's industrialization. This work examines the silk-reeling industry, which was the major exporter and led Japanese industrialization, and the role of the treaty port for its development. While there is a consensus about the positive impact on economic growth of free trade forced on East Asia in the nineteenth century, the critical role of the concession market has not gained proper attention. This paper focuses on this market.

Key words: economic institutions, economic openness, treaty port, empire effect
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1 Introduction

1.1 Key role of treaty port outside of Western empires

The expansion of impersonal market trades has been the driving force of modern economic growth. Third party governance formed in Western states has thus far been the only institutional arrangement to have stimulated this type of development (North and Thomas (1973), North (2005)). Indeed, Westernization of non-Western countries has generally accelerated the growth of economies in the long term(Parente and Prescott (1994, 1999), Hall and Jones (1999), Acemoglu and Robinson (2000), Acemoglu, Johnson and Robinson (2001)). A successfully Westernized economy has grown faster than a non-Westernized economy. This statement is persuasive in itself. The question then arises as to how some economies have been Westernized while others have not.

Efficient types of institutions invented in the North Atlantic spread across the world in the late nineteenth century under the imperialist integration of the global economy. The nexus of these institutions, represented by the free trade and the international financial system, functioned as world-wide "public goods,"[1] and fostered global economic growth. Via international trades during the globalization process, the entire world was exposed to Westernized and standardized practices. By the early twentieth century, almost every economy had been incorporated into the global free trade regime and the well-standardized international financial market centered at London. As the empirical results of Faber and Gerritse (2012) indicate, the free trade with exposure to more efficient institutions is presumed to have prompted changes in local institutions.[2]

Between potentially interactive or endogenous causalities between trade openness and institutional changes, the causality from implanted institutions to growth of trade has been recently emphasized. Regions annexed by empires or under the control of imperialist power greatly enjoyed the benefits of increased trade volume in the market integrated under efficient institutions.[3] On the other hand, the other causality suggested by Faber and Gerritse (2012), from the trade openness to institutional changes, is less often addressed, especially for the "first age" of globalization in the 19th century. Japan maintained independence from the Western empires, was forced to join the free trade before institutional modernization, and finally accomplished institutional changes and industrialization, providing an appropriate example.

Pre-modern economies often consist of diverse and segregated markets, each of which is governed by a specific institution. In such a context, country-wide coordination failure might be expected. For economies in which the coordination failed, the outcome was not simply something that had yet to happen. Domestic commodity and factor markets governed by domestic institutions, which were often characterized by the personal and relational governance mechanism, could work together as stubborn "barriers" to the Westernization of governance. The social cost of development to overwhelm the barriers was also significant also for Japan.[4]

[1] See O'Brien (2002), pp. 4-64.

[2] Faber and Gerritse (2012), pp. 59-61.

[3] SeeMitchener and Weidenmier (2005), pp. 663-679; Ferguson and Schularick (2006), pp. 295-302; and Mitchener and Weidenmier (2008), pp. 1811-1818.

[4] See White (1989), pp. 240-245.

However, if a concentrated market is exogenously formed, and if the market provides "the" price information to local markets, the market could serve as a pivot for the coordination of local and diverse markets into an integrated market. East Asia in the late nineteenth century provides such an example. In East Asia from the late nineteenth to the early twentieth centuries, international commodity trade was governed by Western imperialism, and domestic trade was governed by the independent states. East Asian countries that faced military threats from the British or the Americans were forced to open several ports as "treaty ports," to allow Western merchants to settle, to admit consular jurisdiction, and to commit to free trades under third-party enforcement by the consul within treaty ports from the mid-nineteenth century. As a result, in several treaty ports, such as Yokohama in Japan and Shanghai in China, there wa a large influx of exports from the inland areas. In addition, the ports were connected to international telegraph networks through Western trading companies and to financial markets through Western banks. While treaty ports then grew as extremely concentrated commodity markets, where information about foreign markets was rapidly shared, the inland— outside of the treaty ports—belonged under the sovereignty of the domestic states in Japan and China, neither of which was colonized. The domestic commodity and factor markets in both countries were still under the governance of the domestic states and not of the civilized Western states.

Significant differences exist between the "first age" of globalization in the nineteenth century and the subsequent "second age," which began in the 1980s and has obviously driven by the international capital market (Clemens and Williamson (2004), Ferguson and Schularick (2006)). In the first age, compared with the second age, capital exports from the developed economies to the private sector of poor countries were smaller and less responsive to economic conditions,[5] and the market for government bonds of emerging economies was less integrated.[6] Thus the commodity market therefore had a larger relative importance. The efficient commodity market, instead of the capital market, was the driving force behind the world-wide economic growth during the first globalization. Furthermore, the stipulations of the treaties between Japan or China and Western countries enhanced the relative importance of efficiency in the commodity market of treaty ports. While both Japan and China opened treaty ports for the free trade of commodities, neither officially allowed foreigners to engage in any business outside of the treaty ports. It implied that the financial claims of foreign businesses inland were not protected by the domestic court. Thus the treaty port played a critical role as the center of businesses.

1.2 Japan's industrialization in the first age of globalization

Currently Japan is one of the most successfully "Westernized" non-Western economies. In 1859, Japan was incorporated into the global market by the imposed free trade and began to show clear signs of modern economic growth in the mid-1880s. Responding to the free trade regime, relative prices drastically changed in favor of exports, inducing the reallocation

[5] See Clemens and Williamson (2004), pp. 317-324.

[6] See Mauro, Sussman and Yafeh (2002), pp. 710-721.

of resources to industries with comparative advantages and fostering the growth.[7] While it took 40 years for Japan to fully modernize its legal system from the 1860s to the 1890s, international free trades increased Japan's growth as soon as it opened its ports to foreign trade. A driving force behind Japan's industrialization was the silk-reeling industry. Raw silk threads are reeled from cocoon of silkworms. Farmers raised silkworms and had them cocoon. Then they hand-reeled raw silk threads from cocoon. This is traditional silk reeling. On the other hand, in the mid-19th century, reeling process was separated and mechanized first in Italy and France, which was the rise of the modern silk-reeling industry.

Also in Japan, responding to the demand from the treaty port market, the modern silk-reeling industry developed. In the late nineteenth century, when rayon was not yet commercially viable, silk was a major textile in the world and the international market of raw silk was well-integrated.[8] The role of the treaty port in Japan's rapid development was critical, especially for the raw silk trade, which accounted for approximately 30 percent or more of the total Japanese exports from the 1860s to the 1920s. This paper focuses on this role of the treaty port in the raw silk trade. Most trade of raw silk for export was concentrated at the Yokohama treaty port in Japan. This implies the treaty port market gave "the" prices of the major export that reflected the demand and prices in foreign markets. As will be discussed below, the prices at the port reflected those in large foreign markets such as the New York market with sufficient speed.

When Japan began to trade with Western countries under the commercial treaties in 1859, traditional hand-reeled raw silk, "hanks," was exported to Europe, especially to France.[9] Hanks were produced by farmers who were engaged in cocoon cropping. However, this trade suffered a decrease in demand due to a depression in France in the mid-1880s. In contrast, the development of the modern American silk fabric industry from the late 1870s created new international demand. The change in the structure of international demand—with an increase in the modern American fabric industry's demand for machine-reeled raw silk, "filature," as raw material—pushed the Japanese silk-reeling industry toward modernization.

The Japanese modern silk-reeling industry emerged as a factory industry in the mid-1880s, and thereafter, the exports of raw silk to the US rose dramatically. The Japanese share in the US raw silk market rose from 30 percent to 50 percent during the 1880s, 60 percent in the late 1900s, 70 percent in the 1910s, and 80 percent in the 1920s.[10] The development of the modern silk-reeling industry constituted a rapid shift from a traditional cottage industry to a factory industry that employed 300-500 employees at the largest establishments, and it provided Japan with its first experience with a strong export industry driving its economic development, a pattern that was eventually followed by other manufacturing industries.

Meanwhile, the development of the modern silk-reeling industry required a well-functioning market for large trades of cocoons, the raw material. Railway lines and telegraph networks were constructed in Eastern Japan where sericulture prevailed from the 1880s, and this new

[7] See Huber (1971), pp. 621-627; Bernhofen and Brown (2004), pp.54-64; and Bernhofen and Brown (2005), pp. 216-221.

[8] See Ma (1996), pp.345-352.

[9] See Nakabayashi (2003), pp. 478-483, Appendix: Table 6-1, 6-2.

[10] See Nakabayashi (2003), pp. 473-477, Appendix: Table 5-1, 5-2.

infrastructure promoted the convergence of local cocoon markets. Furthermore, the modern banking system introduced by the government from the 1870s to the 1880s financed the purchases of cocoons by silk-reeling manufacturers. This market convergence led to the reorganization of sericulture. Farmers, who had been engaged both in sericulture and in the hand-reeling of raw silk, decreased production of the latter and began to supply cocoons to the modern silk-reeling manufacturers.

Intriguingly, the reorganization of sericulture continued in the mid-1880s, coinciding with the international demand shifted from France to the US. Reflecting the structural change of the international market, the relative price of filature in New York to hanks in Lyon rose. The Yokohama market immediately followed suit, and the silk-reeling manufacturers responded to this shift. As per the stipulation of the treaty, all trade with foreign countries was to be conducted within the treaty ports, which were physically small. Hence, any order within the port was immediately reflected in the prices. As Western trading companies at the port placed orders in response to the prices of the New York market, the Lyon market, the Shanghai market, and other major markets, which were reported by the telegraph networks, any public information about foreign trade was reflected in the prices at the Yokohama market. The best response of silk-reeling manufacturers was obvious: simply watch and follow the prices at the efficient treaty port market of Yokohama.

Responding to the increase in the relative price of filature to hanks at Yokohama, Japanese manufacturers changed their production line to increase the supply production of raw silk suitable to the US market, and their rapid action provided them with the opportunity to earn higher-than-normal, or excessive, returns in the mid-1880s, while other supplier countries failed to meet the rapid growth of the US demand. The excessive returns stimulated the growth of modern silk reeling and the reorganization of sericulture, and they paved the path to dominance in the international market. The efficient treaty port market of Yokohama served as the pivotal junction for the coordinated change.

1.3 Data and informational efficiency of price formation

The literature from Huber (1971) to Bernhofen and Brown (2005) has clarified that incorporation of Japan into the free trade market rapidly changed the relative price of tradable goods and had a positive impact on Japan's growth and industrialization. A remaining issue is to determine how the relative price change of tradable goods was transmitted to the resource reallocation in the inland and led to the growth of a factory industry. A study of this question must evaluate the performance at a micro-level institutional setting, the treaty port, and for such an empirical work, it is essential to utilize the indices of price and inventory at high frequencies. Then this research focuses on the modernization process of the modern silk-reeling industry that gained the comparative advantage, and the major part of this research effort has been devoted to building new price and inventory data series based on primary sources. The obvious cost of this approach is the potential oversimplification by considering the most successful case representative, but the benefit is a close examination the industry's response to the international market and analysis of the gaps in the existing literature.

In the following sections, this paper uses the weekly series of price and inventory of raw

silk at the Yokohama treaty port market and the monthly price series of the New York market as constructed by the author.[11] Price indices of high frequency enable us to directly evaluate the responsiveness of the Yokohama market to the international market. Then, high frequency indices of inventory are expected to show the inland producers' response to the prices at Yokohama. We focus specifically on the potentially different responses of machine-reeling manufacturers and hand-reeling farmers. While existent works, represented by Huber (1971) and Bernhofen and Brown (2004, 2005), have studied the aggregated outcome of Japan's joining the free trade market, the responses of producers with a relative advantage over the international market has not been delineated. This research examines the role of the treaty port market, which quickly reflected international market prices, in the provision of incentives to producers.

Raw silk prices at Yokohama and New York, and the exchange rates have unit roots ad are $I(1)$ processes (**Appendix A.1**), indicating these prices are random walk (Phillips (1987)). This implies that these prices they were efficiently formed such that public information were reflected within the term of data frequency, one week at Yokohama and one month at New York, satisfying the weak-form efficiency (Fama (1970)). None is $I()1$ in the first-order difference, and thus vector auto-regression later is performed on the first-order differences in the common logarithmic expressions.

Section 2 presents an overview of the structural change in the international silk market and the rise of the modern silk-reeling industry in Japan. **Section 3** first shows that the raw silk price series led foreign exchange rate series in terms of Grenger causality in the 1880s, indicating that the Yokohama raw silk market was embedded in the globally integrated commodity market. The efficiency of the Yokohama raw silk market is then described. The efficiency, compared with the Italian markets, on which the efficient Anglo-Saxon model was unfortunately not imposed, is presented by checking the Granger causality among the relevant price series. **Section 4** shows that silk-reeling manufacturers responded to the prices at Yokohama with sufficient speed to capitalize on opportunities to earn excessive returns in the international market. The result will be established primarily by performing vector auto regressions of prices, inventories, and the shipment of raw silk to the Yokohama market. In **Section 5**, we will return to the discussion on the historical role of treaty port, in terms of "imposed efficiency."

[11] For the Yokohama market, the main data source is a weekly journal, *Tokyo Keizai Zasshi (Tokyo Economic Journal)*, Tokyo: Keizai Zasshi sha, and a newspaper, *Chugai Bukka Shimpo (Domestic and foreign prices mail)*, Tokyo: Bukka Shimporsha, is used to fill several gaps. For the New York market, the main source is a monthly journal, *The American Silk Journal*, New York: The Silk Association of America, and Treasury Department of the United States, *Annual report and statements of the Chief of the Bureau of Statistics on the foreign commerce and navigation, immigration, and tonnage of the United States*, Washington DC: Government Printing Office, is used to fill some gaps.

2 International market and the rise of the silk-reeling industry

2.1 Japanese silk-reeling industry in the changing international market

The shogunate strictly controlled international trades before 1859 when Japan was forced to join the free trade regime, and raw silk produced in Eastern Japan was shipped to Yedo, renamed to Tokyo in 1868, and to Kyoto, the largest consumer cities. These domestic trades were governed by the guilds authorized by the shogunate. However, once the free trade began 1859, sericultural farmers found that export of hand-reeled raw silk was further more profitable and thus switched their shipment to Yokohama. The traditional governance of raw silk trade collapsed.

Before the mid-1880s, most of the Japanese raw silk was exported to France. Japanese exports of hand-reeled raw silk increased in the early 1860s and then stagnated since the 1870s.[12] However, exports from China to France sharply increased through the 1870s. The competitive advantage of Japanese traditional raw silk over the Chinese product was lost during the 1870s as the international raw silk prices decreased.[13] Specifically, the decrease in prices and the subsequent stagnation for several years after 1882 severely affected the sericultural farmers who were engaged in the hand-reeling of raw silk.[14]

Meanwhile, in the 1880s, the price of Japanese machine-reeled raw silk, filature, in the New York market rose relative to that of Japanese hand-reeled raw silk, hanks, in the Lyon market because the demand from the American silk fabric industry for filature had exhibited a strong growth (**Figure 1**).

The silk fabric industry in Lyon flourished from the early nineteenth century to the mid nineteenth century, and its propensity for using hand-reeled raw silk as a raw material was maintained until the 1900s by the sustained demand for hand-loomed fabric that was used in the luxurious fashions of the times.[15] Because even coarse raw silk could be processed by skilled hand-throwers, France imported various types of raw silk as raw material for the silk fabric industry; this raw silk ranged from high-quality Italian filature to low-quality Asian hand-reeled raw silk.

In contrast, in the late 1870s, the American fabric industry began to produce goods for mass consumption in earnest. As the use of power-throwing machines and power looms rapidly prevailed, the factory system for mass production was established.[16] As a result, the

[12] See Nakabayashi (2003), pp. 470-473, Appendix; Table 4-1, 4-2. With regard to the statistics of production and export of raw silk, see Nakabayashi (2003), pp. 461-463, Appendix: Table 1, and Nakabayashi (2006), pp. 183-191. An overview is also given by Hunter (2003), pp. 31-49, and Ma (1996), pp. 335-343.

[13] See Nakabayashi (2006), p. 184.

[14] See Nakabayashi (2003), pp. 88-93. The financial crisis in 1882 heavily affected the trade of raw silk in Europe ("Commercial history and review of 1882." *The Economist*, no. 2,061, Feb 24, 1883, p. 26.), and then the French economy entered a recession until 1886 (Levy-Leboyer and Bourguignon (1990), pp. 1-13.).

[15] See Duran (1913), pp. 72-77; Rawlley (1919), pp. 66-73; Cottereau (1997); and Federico (1997), p. 77.

[16] See Wyckoff (1879), pp. 8, 29-30. In the US, there were 5,321 power looms and 3,153 hand looms in 1880 and 44,257 power looms and 173 hand looms in 1900. The Department of the Interior, *Report on the manufacturers in the United States at the tenth Census (June 1, 1880)*, Washington DC: Government Printing

American silk fabric manufacturers did not value hand-reeled hanks, with their uneven threads that rendered the hanks unsuitable for power throwing machines and power looms, and instead actively sought filature, with even threads, as the primary raw material,[17] while at the same time demanding a relatively small amount of improved hand-reeled raw silk, "re-reels" from Japan and re-reeled "tsatlee" from China. In the early 1880s, the dominant supplier of filature in the US was Italy.

2.2 Rise of modern silk-reeling

Responding to the increase in demand for filature, machine-silk reeling was gradually dispersed from the end of the 1870s in Japan. In the early 1880s, however, Japanese manufacturers failed to supply filature with even threads. Western trading companies at Yokohama bought filature of uneven threads from Japanese exporters, inspected the raw silk, classified the raw silk, added its own trademark—"chop"—, and exported the raw silk as its own brand to France and the US. Quality premium,[18] from relevant classification belonged to Western trading companies.

Several years later, a cooperative of silk-reeling manufacturers in Suwa county of Nagano prefecture in Central Japan, Kaimeisha, formed a new organization and adopted a new strategy. From 1884, the cooperative established a facility for jointly finishing and inspecting raw silk produced by member manufacturers, strictly inspected and classified produced raw silk, put its own trademark on only the product that satisfied the standard, and exported the raw silk with its own brand name to the US. American silk fabric manufacturers preferred "original chops" by manufacturers to "private chops" by trading companies and did not hesitate to pay a "premium" for original chops of good quality.[19] The Kameisha's original chop succeeded in acquiring a large demand and earning a considerable premium.

The Kameisha's success was rapidly followed and shared by other manufacturers. In 1884, Japanese exports of raw silk to the US exceeded those to France, and since, the production and exports of filature rapidly increased. Filature amounted to 31 percent of the total export of raw silk in 1880, and 50 percent in 1889. Meanwhile, the Japanese share of the US raw silk market reached over 50 percent in 1887.[20]

The rapid dispersion of the new production organization and the rapid growth of machine-reeling prompted by the organization was a direct response to the international market. Increased demand for filature of even threads led to a sharp rise in its relative price in the international market in 1885 and 886 (**Figure 1**). This shows that there was a tentative gap between the sharply increasing demand and supply, which provided suppliers with an opportunity to

Office, 1883, pp. 928-929. The Department of the Interior, Census Office, *Twelfth Census of the United States, taken in the year 1900, manufacturers part 3, special reports on selected industries*, Washington DC: Government Printing Office, 1902, p. 206.

[17]See Wyckoff (1879), pp. 25-27; and Wyckoff (1883), p. 18.

[18]When the quality of a product is private information, suppliers have incentives to cheat purchasers, and therefore, the suppliers who established their own brands and commit to certain quality can earn premium price paid by the purchasers who want assured quality. See Klein and Leffler (1981), pp. 618-625.

[19]See Duran (1913), pp. 105-109.

[20]See Nakabayashi (2003), pp.161-182, 474; and Nakabayashi (2006), pp.184-197.

acquire excessive returns by taking prompt action. This gap was evident in the Yokohama market. Reflecting a steep rise of the relative price of filature to hanks in the international market, the price of filature relative to hanks in the Yokohama market rose accordingly in 1885 and 886 (**Figure 2**). The opportunity to earn excessive returns provided incentives to adopt the new organization and the rapid growth in the modern silk-reeling industry.

From cocoon cropping to silk-reeling, nexus of supply chain consisted of complementary production functions at each stage. If the transmitted shock were smaller, it might not have shaken the older equilibrium that supported hand-reeling. The quickly rising relative price of filature and the accompanying excessive return had enough impact that cocoon cropping farmers left hand-reeling and silk-reeling manufacturers rapidly increased their production capacity toward the new equilibrium of modern silk-reeling.

2.3 Reorganization of sericulture and integration of cocoon markets

At the same time, sericultural farmers who engaged in hand-reeling suffered from the French recession and the deflationary policy of the Japanese government in the mid-1880s.[21] Farmers then decreased hand-reeling production and began to supply cocoons as raw materials for the modern silk-reeling industry. A noteworthy phenomenon was that a considerable portion of the returns from the increased demand for filature was also shared by sericultural farmers. In the mid-1880s, the supply of cocoons became more profitable than the supply of hand-reeled raw silk, and the gap in profits between the supply of cocoons and hand-reeling became significant enough to attract considerable attention from about 1885 to 1886 (**Figure 3**). This increase in returns encouraged sericultural farmers to promptly switch. The development of the modern silk-reeling industry coincided with the reorganization of sericulture.

This reorganization appears to have been accelerated by the rise of the relative price of filature to hanks in the international market, which was immediately reflected in the Yokohama market. Otherwise, the Japanese silk-reeling manufacturers and sericultural farmers would have recognized the structural change of the international market much later and would have failed to acquire the excessive returns from this change, leading to much smaller incentives for the rapid modernization of silk-reeling. The reorganization would have also been delayed.

The rise of the modern silk-reeling industry entailed the integration of the cocoon markets. After the late 1880s, local cocoon markets of sericultural regions in Eastern Japan converged at a remarkable speed (**Figure 4**). This development was related to a unique aspect of Japanese sericulture and silk-reeling. In Italy, silk-reeling factories were dispersed and the silk-reeling manufacturers procured cocoons from nearby local markets. In contrast, in Japan, silk-reeling factories were concentrated in areas such as Suwa, while sericulture prevailed across the whole of Eastern Japan. In other words, the Japanese silk-reeling industry was based on the mass procurement of material and on the mass production of raw silk, whereas the Italian industry retained the characteristics of a more moderately scaled rural industry.[22] This type of devel-

[21]The Japanese government had adopted a deflationary policy, that is, decreasing base money and increasing tax, and this policy resulted in the transfer of income to the government sector, exacerbating the recession, given that a land tax imposed on farmers was designated by a fixed nominal amount. See Patrick (1965), pp. 202-205.

[22]See Federico (1997), pp. 146-151.

opment had become the norm in Japan from the late 1880s.

At that time, a necessary condition for the integration of the local cocoon markets was the construction of trunk lines by the Japan Railways Company, a state-subsidized company, and the government-run National Railway Agency. The local cocoon markets were linked to the silk-reeling districts by the railways, and the links to Suwa County of Nagano Prefecture were especially important.[23]

These distribution channels shaped the geographical network of the cocoon market. In the early 1880s, owing to the recession in France, there was a decrease in the production of cocoons and raw silk in all areas of East Japan. From the mid-1880s, however, an increase in the production of raw silk had exceeded that of cocoons in Nagano Prefecture, while an increase in the production of cocoons had surpassed that of raw silk in terms of growth in the other areas, indicating the transition from hand-reeling to the provision of cocoons with the machine-reeling manufacturers.[24]

3 Efficient pricing of raw silk at Yokohama

3.1 Structure of the treaty port

The treaties of friendship and commerce with the US, the UK, France, Russia, and the Netherlands prescribed that Japan open Yokohama and four other ports as treaty ports, where free trade was guaranteed, and give the Western parties consular jurisdiction in these ports. These extraterritorial privileges effective until 1899, when the new treaties with the Western countries came into effect. Impersonal trade in the price mechanism governed by the Western legal system was thus introduced in the treaty ports before the practice developed endogenously in the inland areas. Almost all of the raw silk exports were traded at one of the five ports, Yokohama.

In addition, the treaties prohibited foreigners from practicing business outside the concessions. Therefore they traded with the Japanese merchants specialized in the trade of exports and imports within the concessions of treaty ports. These Japanese exporters and importers had access to the domestic markets of Japan. All of the Western trading companies, Japanese exporters, and Japanese importers gathered in a very small enclosed space inside the concession of Yokohama, where all the trade transactions were conducted. Silk-reeling manufacturers shipped and consigned their products to Japanese exporters, and the Japanese exporters in turn sold them to Western trading companies on the behalf of silk-reeling manufacturers. The price of exported raw silk was determined by the negotiations finalized between the Japanese exporters and the Western trading companies in the confined space at Yokohama.

Thus, the place where all players gathered to trade products was very small, they accounted for most of the raw silk exports from Japan, and all the transactions were spot traded under the Western legal system. These factors made the place a nearly perfect market from the standpoint of informational symmetry because any information about raw silk trades was quickly

[23] See Nakabayashi (2003), pp. 124-134.

[24] See Nakabayashi (2003), pp. 87-121; and Nakabayashi (2006), pp. 187-191.

shared among all the players. This efficient market mechanism played a significant role in the trade of raw silk.

3.2 Efficient commodity market and the following foreign exchange market

Before moving to the gold standard in October 1897, Japan was under the silver standard. With Western countries leaving the silver standard and joining the gold standard, the silver price in the international market was volatile and tended to go down in the late nineteenth century. This tendency implied that the exchange rate of the Japanese Yen against Western currencies was also volatile (**Figure 5**).

The Yokohama raw silk market rapidly adjusted to this volatile exchange rate. A rough drop of the exchange rate, for instance from 1884 to 1886, was perfectly adjusted for by the rapid rise of raw silk price at Yokohama, which is observed from the weekly basis. A regression of the weekly series of filature prices ($YPJF$) at Yokohama to the weekly series of the exchange rate at Yokohama, in terms of dollars per 100 yen ($YEXUSD$), shows that filature price was adjusted to changes in the exchange rate within a week.[25]

$$\log[YPJF_t] = \underset{(26.177^{**})}{12.161} - \underset{(-12.374^{**})}{1.297} \log[YEXUSD_t] \tag{1}$$

This rapid adjustment for less than a week itself shows the efficiency of Yokohama silk market. Furthermore, the raw silk price significantly led the exchange rate in terms of Grenger causality thorough the 1880s, as **Table 1** shows. The raw silk market more quickly predicts the volatility of the exchange market, and the prediction was inflected in the raw silk prices. The driving force of global integration then was the commodity market.

It is thus shown that the changes in the exchange rate at the Yokohama market had only a negligible effect on Japanese filature prices at the New York market ($NPJF$) in terms of the monthly series. Inserting the prices of Italian filature at the New York market ($NPIF$) as a regressor to determine the changes in the international raw silk prices independent of changes in the exchange rates between the gold standard currencies and the silver standard currencies, we have,[26]

$$\log[NPJF_t] = \underset{-3.025^{**}}{-2.556} + \underset{19.761^{**}}{0.849} \log[NPIF_t] + \underset{3.119^{**}}{0.090} \log[YEXUSD_t]. \tag{2}$$

Generally, the Yokohama commodity market was so efficient that it responded to the turbulence of the foreign exchange market with rapid adjustments. This rapid response suggests

[25]Term: from January 1884 to December 1886. Data frequency: weekly. Number of observations: 156. Estimation: OLS. Adjusted R^2 : 0.495. F-static: 153.128^{**}. Numbers within parentheses in the equation are the *t*-statistics, and $**$ denotes significance at the 1 percent level.

[26]Term: from January 1880 to September 1897. Data frequency: monthly. Number of observations: 179. Estimation: OLS. Adjusted R^2: 0.866. F-statistic: 577.653^{**}.

that we can reasonably neglect the effect of changes in the exchange rate when analyzing the movements of raw silk prices at the Yokohama and New York markets.

This response also implies that, instead of allowing a decrease in the relative price of Japanese commodities in international markets, the efficient Yokohama market, facing decreasing foreign exchange rates, immediately caused an export-led inflation in the Japanese domestic market. The Japanese economy experienced inflation due to a decrease in the exchange rate in the late nineteenth century until October 1897, when Japan switched to the gold standard, and the price of filature led consumer prices with a lag of several years. This export-led inflation increased the real income of silk manufacturers and cocoon-growing farmers, thus accelerating the mobilization of resources into the sector.[27]

Japan moved to the gold standard primarily in an attempt avoid the risk premium accompanied by fluctuating silver prices that was to be reflected in yields of the Japanese government bonds when resuming the issuance of the government bonds in the international market, which had been suspended to stave off the threat of potential colonization. Indeed, after joining the gold standard, the spread with the British government bonds shrank.[28] In the international financial market as a whole, regional shocks, including those in Japan, were well absorbed,[29] and sovereign debt spreads were globally harmonized.[30] While such a switch motivated by a bond issuance with lower premiums was a part of the dominant trend heading for the gold standard in the international market,[31] convergence to the gold standard is thought to have had a positive impact on the country's own volume of trade with lag of several years, by removing the volatility of the exchange rate.[32] Before the First World War, most foreign exchange trades were made to meet the real demand from trades of real goods, and an effect of stabilizing the exchange rate was thus important for the real economy. It then turns out that, before switching to the gold standard, the efficient commodity market quickly adjusting volatile exchange rates did affect the expansion of international trades in Japan.

3.3 A faster synchronization to the New York market

The efficient Yokohama market functioned as a channel through which the trades could catch up to the opportunities to earn excessive returns in international markets. From 1882 to 1903, Italian filature and Japanese filature were actively traded in the New York market, and hence the complete price series for both goods are available at the monthly basis.

[27] See Nakabayashi (2003), pp. 102-115; and Nakabayashi (2006), pp. 187-191. Policy makers in those days correctly recognized that the decreasing exchange rate caused the increase of real income for the silk-reeling manufacturers and sericultural farmers. Noshomusho (Ministry of Agriculture and Commerce), "Hon nen no kiito soba ni jikka kyoka no betsu ari" (There is a difference between real price and nominal price in the raw silk quotations of this year), *Noshoko Koho (Bulletin on Agriculture, Commerce, and Manufacturing)*, no. 18, August 15, 1886, pp. 682-684.

[28] See Sussman and Yafeh (2000), pp.449-451; and Nakabayashi (forthcoming).

[29] See Chernyshoff and Jacks (2009), pp. 200-203.

[30] See Mauro et al. (2002), pp. 710-721.

[31] See Meissner (2005), pp. 394-401.

[32] See Estevadeordal, Frantz and Taylor (2003), pp. 388-390, 393-396; and López-Córdova and Meissner (2003), pp. 348-351.

Using the price indices, let us compare the behaviors of Japanese filature and Italian filature prices. Then **Table 2** shows that the Japanese filature price strongly led the Italian filature price in terms of Granger causality. Information publicly available in the New York market was reflected in the Japanese filature price faster than it was in the Italian filature price. Because Chinese filature, mainly Shanghai filature, came to be actively traded in the New York market in the mid-1880s, the Japanese and the Chinese were ahead of the Italians, while there was no significant lag between the Japanese and the Chinese (**Table 3**).

With respect to improved hand-reeled raw silk, re-reels of Japan and re-reeled tsatlee of China synchronized in the New York market, indicating that Japanese and Chinese local market participants enjoyed the efficiency of the treaty markets (**Table 4**).

As expected, the Yokohama prices and the New York prices of the Japanese filature were closely synchronized (**Table 5**). Therefore, the prices of exports from Japan and China, on both of which the efficient treaty port mechanism was fortunately imposed, efficiently transmitted information about the Western world to their home countries, while those from Italy, on which the efficient system was not imposed, moved at a slower pace. This system obviously afforded opportunities to earn excessive returns to Japanese manufacturers and farmers.

Furthermore, another remarkable aspect of the Yokohama market was that not only the prices of machine-reeled filature but also those of re-reels produced by farmers were efficiently transmitted from New York to Yokohama (**Table 6**). It is noteworthy that the Yokohama market transmitted the necessary information about the international market to farmers and local merchants as well as to silk-reeling manufacturers. Indeed, there was no lead-lag relation in terms of Granger between filature and re-reels at Yokohama (**Table 7**). The Yokohama market efficiently transmitted the relevant information about the relative prices of filature and re-reels such that both the silk-reeling manufacturers and farmers could rationally respond to the international market.

4 Rapid industrialization as a benefit from efficient market

4.1 Dynamic response of manufacturers to prices

Even if the prices at Yokohama reflected the opportunities at New York with sufficient promptness, unless the production and shipment also quickly responded to the prices, the efficiently formed prices would not themselves have provided the Japanese silk-reeling industry with any real opportunities. Focusing on this effect, we here examine the arrivals from the inland to the Yokohama market.

The lead-lag relation among the arrivals of filature ($YAJF$), price of filature ($YPJF$), and stock of filature ($YSJF$) at Yokohama shows that the arrivals of filature at Yokohama followed not only the stock but also the prices at Yokohama in Granger's terms (**Table 8**), indicating that the silk-reeling manufacturers responded not only to the stock at Yokohama but also to the prices. The impulse response of ($YAJF$) to a factored shock in ($YPJF$) indicates that silk-reeling manufacturers responded to a sudden rise in prices with a shipment within 2 weeks (**Figure 6**). Silk-reeling manufacturers, who depended heavily on bank loans for the purchases of cocoons, did not generally hold large inventory of their products and

shipped the filature as soon as it was produced. The increase in shipments as a response to a price increase seems to suggest an increase in production, which took several weeks.

4.2 Response of farmers and local merchants

However, any similar response is not observed in the shipment of re-reels, raw silk hand-reeled by farmers. The arrivals of re-reels to the Yokohama market ($YAJR$) responded only to a shock in the stock at Yokohama ($YSJR$), but not to that in the price at Yokohama ($YPJR$) (**Table 9**). A considerable portion of re-reels was shipped to Yokohama through intermediary local merchants who had bought them from farmers, and they held some inventory because these merchants were less indebted than the silk-reeling manufacturers. While the impulse response appears to indicate that the arrival of re-reels to Yokohama ($YAJR$) responded to the price ($YPJR$) rather promptly because an adjustment with the inventory required no lead-time (**Figure 7**), this partial adjustment had only a statistically negligible effect on the whole movement of arrivals at Yokohama. Alternatively, it is more precise to state that farmers and merchants who produced and traded in re-reels responded to the opportunities reflected in the Yokohama prices following the New York prices only by shipping inventory and not by increasing production, whereas machine-reeling manufacturers did so by rapidly increased production.

This observation is consistent with the inference that the silk-reeling manufacturers responded to the prices at Yokohama by increasing the purchase of cocoons and the production of raw silk, and farmers responded by selling more cocoons to manufacturers, not by producing more hand-reeled re-reels. The sales of cocoons acted as a means to take the opportunity of earning excessive returns provided by the efficient pricing at Yokohama. The findings and inference suggest that the close link between the treaty port market and the inland cocoon market particularly had a positive impact on growth of modern silk-reeling, followed by organizational change of the sericulture.

4.3 Domestic financial market

In the mid-1880s, because of the strong demand for filature in the US, and because the world silk-reeling industry did not immediately adjust to the rapidly changing condition, there was an opportunity to earn some excessive returns by producing this. This opportunity was exploited by the Japanese manufacturers, who could capitalize on the extremely efficient market at the treaty port where prices provided the relevant information about international markets (**Figure 1** and **Figure 2**). The sooner they acquired the information, the more returns they could earn. Such information was efficiently processed in this market and was transmitted to manufacturers. Indeed, the supply of filature changed quickly in response to the prices in Yokohama that reflected information in New York. The manufacturers successfully availed themselves of the opportunities.

It must be noted, at the same time, that the prompt response to price changes on the part of the silk-reeling manufacturers would not be sufficient. This response needed to be accompanied by an integrated cocoon market and a functional financial market. Once prices

at Yokohama rose, the manufacturers borrowed large amounts of money and subsequently went to purchase the material from the cocoon markets linked by the railways. By the early 1880s, the modern financial market had been developed under governmental support, and the modern silk-reeling industry was one of the industries that aggressively capitalized on the newly created modern financial market. The active purchases of cocoons brought some profits to sericultural farmers and stimulated cocoon cropping. Thus, the governmental effort was well-coordinated with the manufacturers' rapid response to Yokohama prices.[33]

5 Discussion: Imposed efficiency

The rise of Japanese manufacturing, led by the silk-reeling industry, was not accompanied by an increase in labor productivity relative to Western countries. Broadberry (1994) tentatively attributes the success to flexibility of the Japanese manufacturing dating back to its craftsmanship.[34] This emphasis on flexibility is correct. The critical component of flexibility was the prompt adjustment to the international market. Our evidence does not necessarily reject Broadberry's evaluation favorable to Japanese, but strongly support a hypothesis that the flexibility was imposed and imbedded by the Western powers from the 1860s. In the 1900s, the level of wages of silk-reeling workers in Suwa of Nagano, Japan was roughly similar to that in Messina of Sicily in Italy,[35] a region which produced filature of good quality and had a much longer tradition of craftsmanship in the industry. We cannot ascribe the reason that the Japanese silk-reeling industry was more flexible to the market than was the Italian silk-reeling industry to the Japanese tradition of craftsmanship. Indeed, the most of Japan's advance can be attributed to the rapid introduction of modern technology instead of to its tradition of sericulture.[36] Our evidence consistently shows that strong relationship between local markets and the treaty port was critical to induce cocoon cropping farmers to leave hand-reeling and to supply cocoons as raw material to silk-reeling manufacturers.

Then, we could further state that the modernization effort of the Japanese government was well-coordinated with that of the silk-reeling manufacturers and sericultural farmers through the treaty port, imposed by the West. No endogenous miracle existed there. The efficient treaty port market established by Western powers accelerated the modernization of Japan's silk-reeling industry, marking the beginning of the industrialization of Japan, with infrastructures such as trunk roads, railroads, and telecommunications constructed by the government as well as with the efficient financial market. Yokohama prices quickly reflected New York price information with sufficient speed. The price at Yokohama thus presented the silk-reeling manufacturers with the relevant information in the international market, and they were able to exploit the opportunities to earn excessive returns by capitalizing on the shortage of filature in the US. The trading of cocoons was supported by the infrastructure and the financial system. Such trading resulted in a reorganization of the sericulture that progressed rapidly in the 1880s

[33] See Nakabayashi (2003), pp. 333-405, and Nakabayashi (2006), pp. 205-208.
[34] See Broadberry (1994), pp. 292-294, 299-300.
[35] See Nakabayashi (2003), p. 203.
[36] See Ma (2004), pp. 373-386.

with a strong US demand for machine-reeled filature. The treaty port played a pivotal role as the gateway of "empire effect" (Ferguson and Schularick (2006), Mitchener and Weidenmier (2008)) to Japan, which was not annexed by Western countries, and through the gateway, the trade openness stimulated changes in local institutions (Faber and Gerritse (2012)).

All events discussed above, such as the rise of the modern silk-reeling industry, the sericulture reorganization, and the integration of local cocoon markets, occurred during the mid-1880s, coinciding with the major changes in the structure of the international market. None of the events is necessarily striking in itself, but that their simultaneous development was well-coordinated is impressive. For this development to take place, excellent processing of information in the treaty market—the pivotal junction of raw silk trade—appears to be critical.

The market in the real world is always imperfect, and opportunities for excessive returns thus exist everywhere, even in the modern economy. Indeed, behavior to earn excessive returns always determines the direction of development, not only in unsuccessful economies but also in successful ones. The difference between the two kinds of economies lies in that the incentives for excessive returns are properly coordinated in the latter.[37] In other words, in order to avoid a resource-coordination failure, there should be a system whereby excessive returns are efficiently allocated. In the case of late nineteenth century Japan, the institution of the treaty port played this role. The opportunity generated by the demand shock for filature was accurately reflected in the relative price at Yokohama, and silk-reeling manufacturers and sericultural farmers responded to the changes. Then reorganization of sericulture proceeded at a speed that made it possible for these manufacturers to extract some excessive returns.

However, reaping such returns was not the only possible outcome. Along with Japan, China was also forced to accept the institutional framework of treaty ports. In China, mainly because of the problems with the political system, the government's efforts to develop inland trade were insufficient, the "self-government" like "the law merchant of medieval Europe" was still dominant in the late nineteenth century,[38] and the international opportunities were not effectively connected with the inland development. Instead, Chinese merchants utilized treaty ports to establish an intra-Asian trading network. They interlinked those treaty ports in East Asia, formed strong networks among them, and dominated the local and regional trades.[39] Together with the industrial development in Japan, mercantile development in China seems to be another important outcome of the settlement of treaty ports in East Asia in the nineteenth century. An inquiry into this Chinese development should be our future agenda.

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[37] See Aoki (2001), pp. 1-27.

[38] Reinsch (1900), pp. 95-96.

[39] See Hao (1970), pp. 48-59; Motono (2000), pp. 167-170; and Furuta (2005), pp. 25-42.

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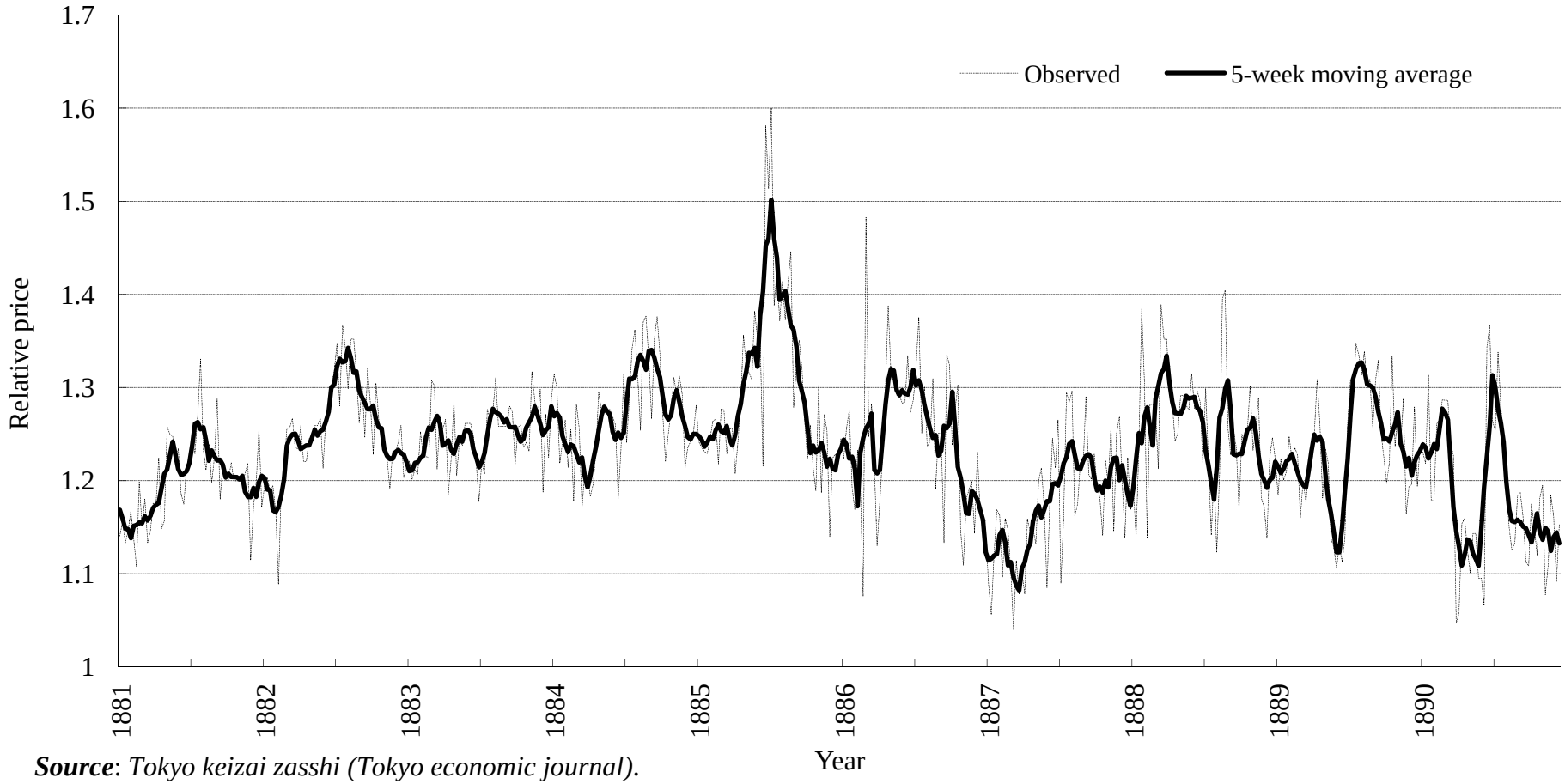
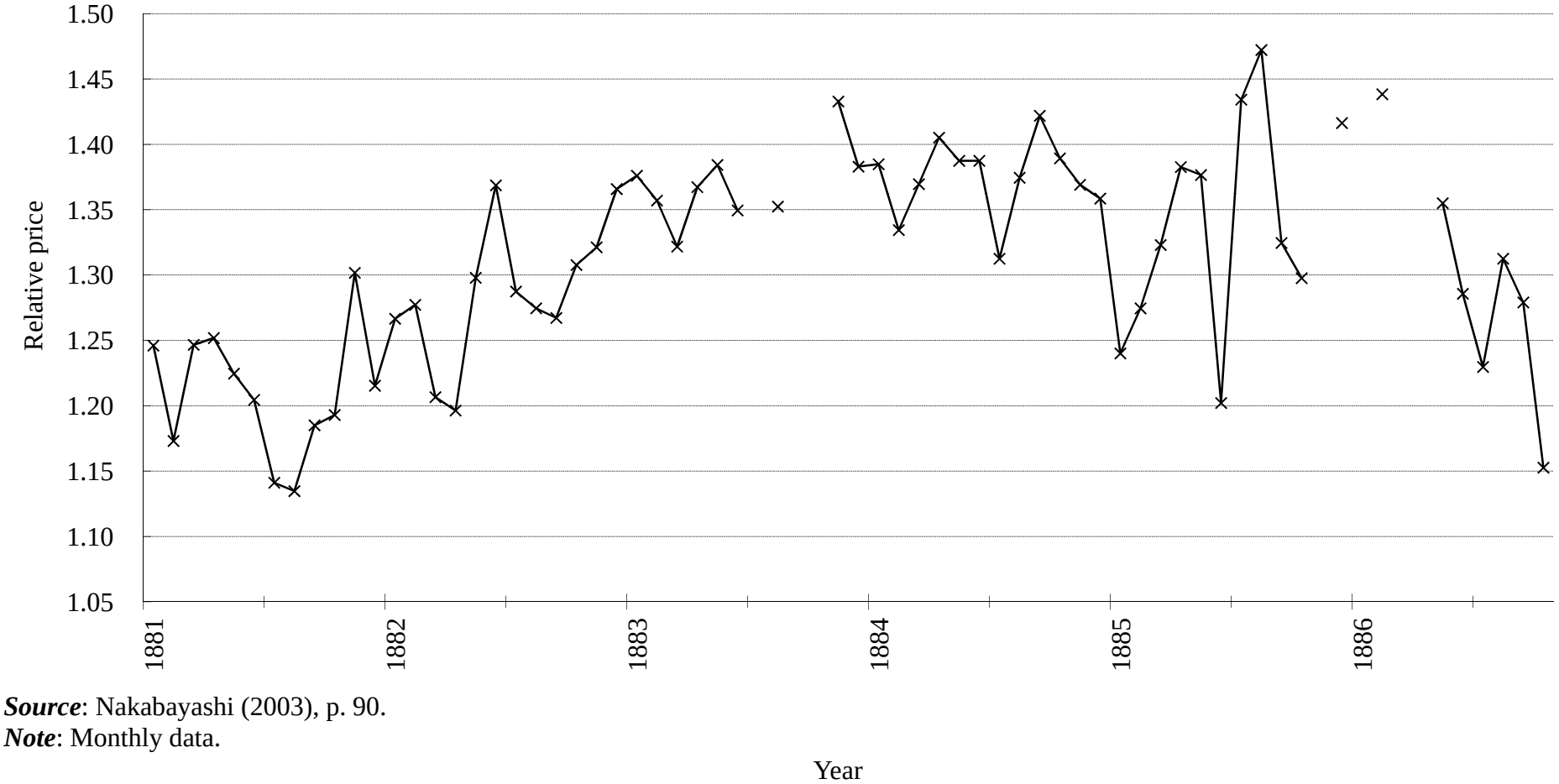
Figure 1. Relative price of Filature over Hanks at Yokohama: 1881-1890



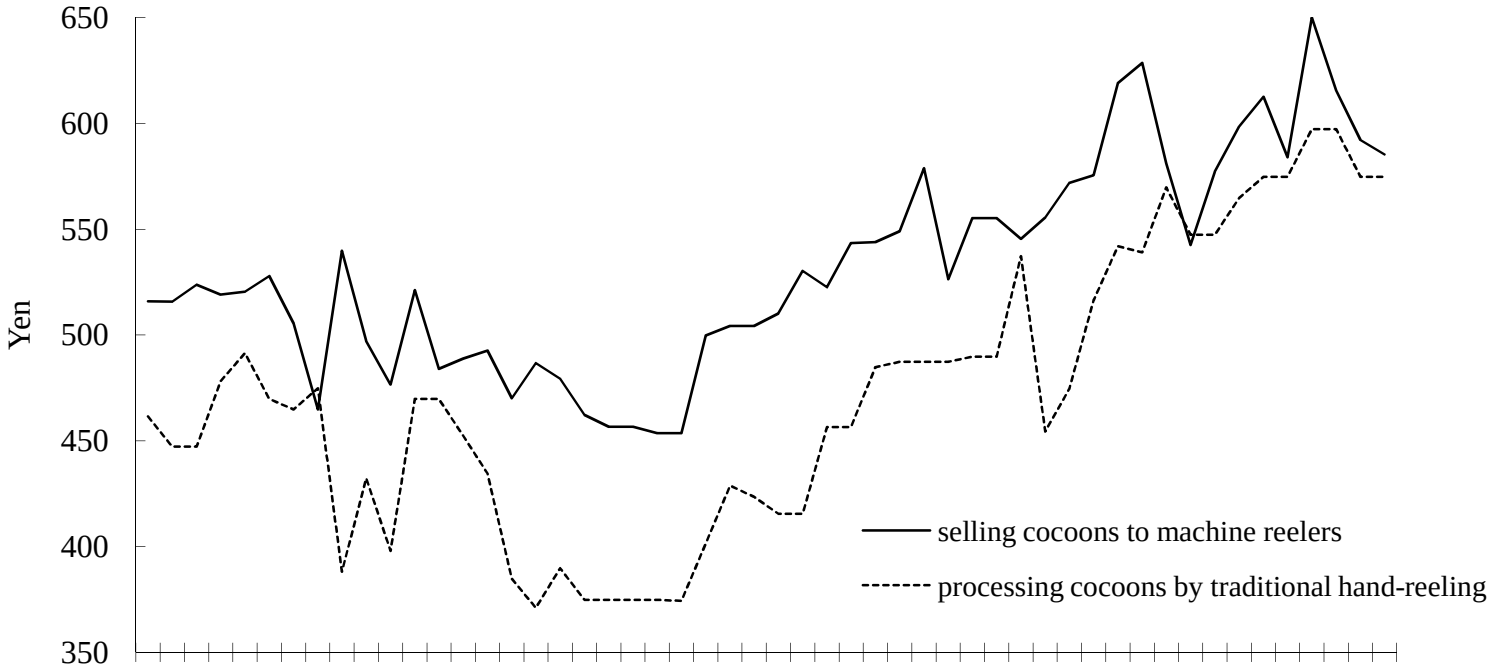
Source: *Tokyo keizai zasshi (Tokyo economic journal).*
Note: Weekly data.

Figure 2. Relative Price of *Filature*: (Japan *Filature* No.1 in New York) / (Japan *Hanks* in Lyon)



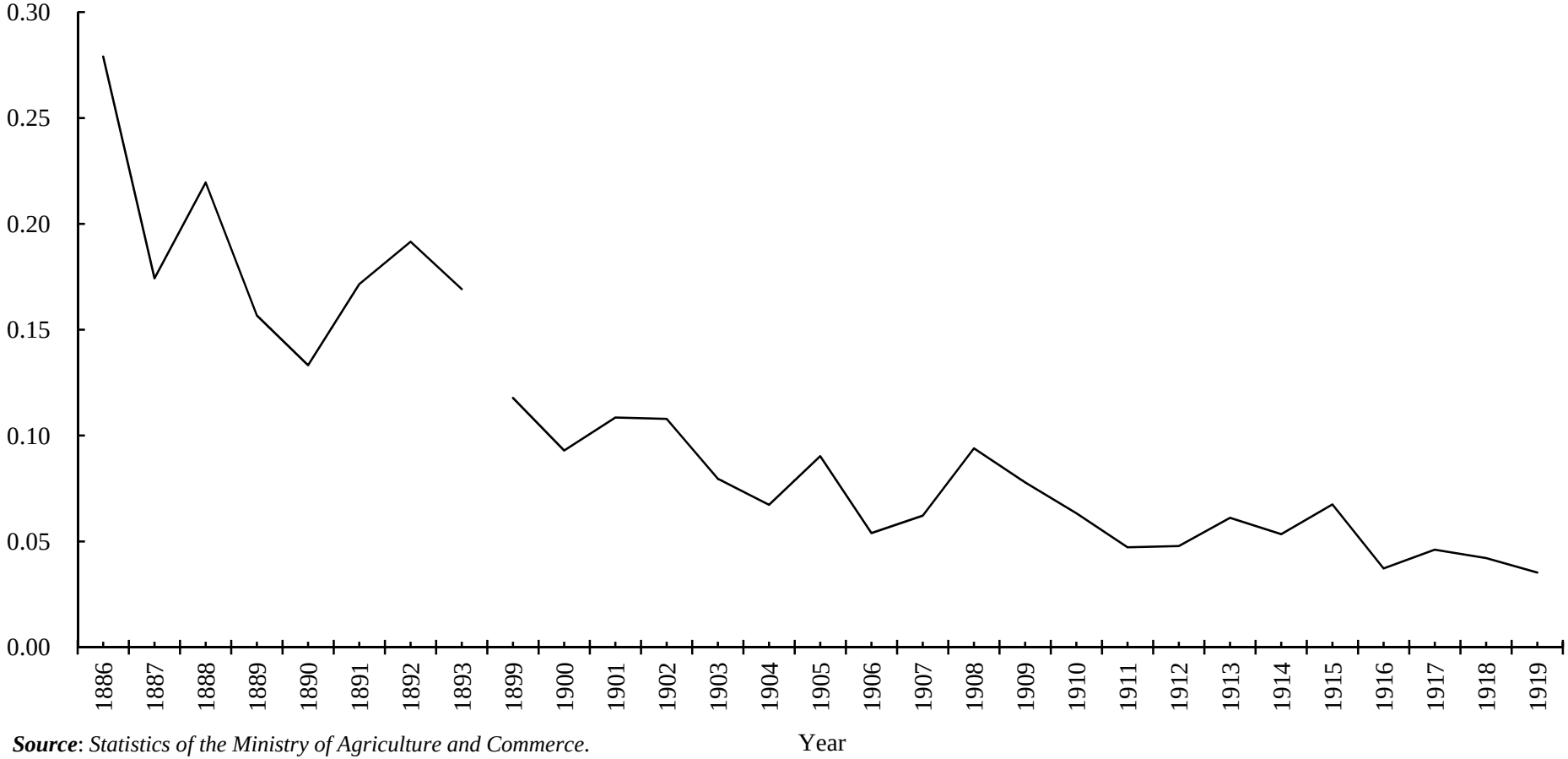
Source: Nakabayashi (2003), p. 90.
Note: Monthly data.

Figure 3. Gross Margins of Pesants per 1 picul (60kg) of Silk in 1886



Source: Nakabayashi (2003), p. 100.
Note: Weekly data.

Figure 4. Coefficient of variation of cocoon prices in East Japan

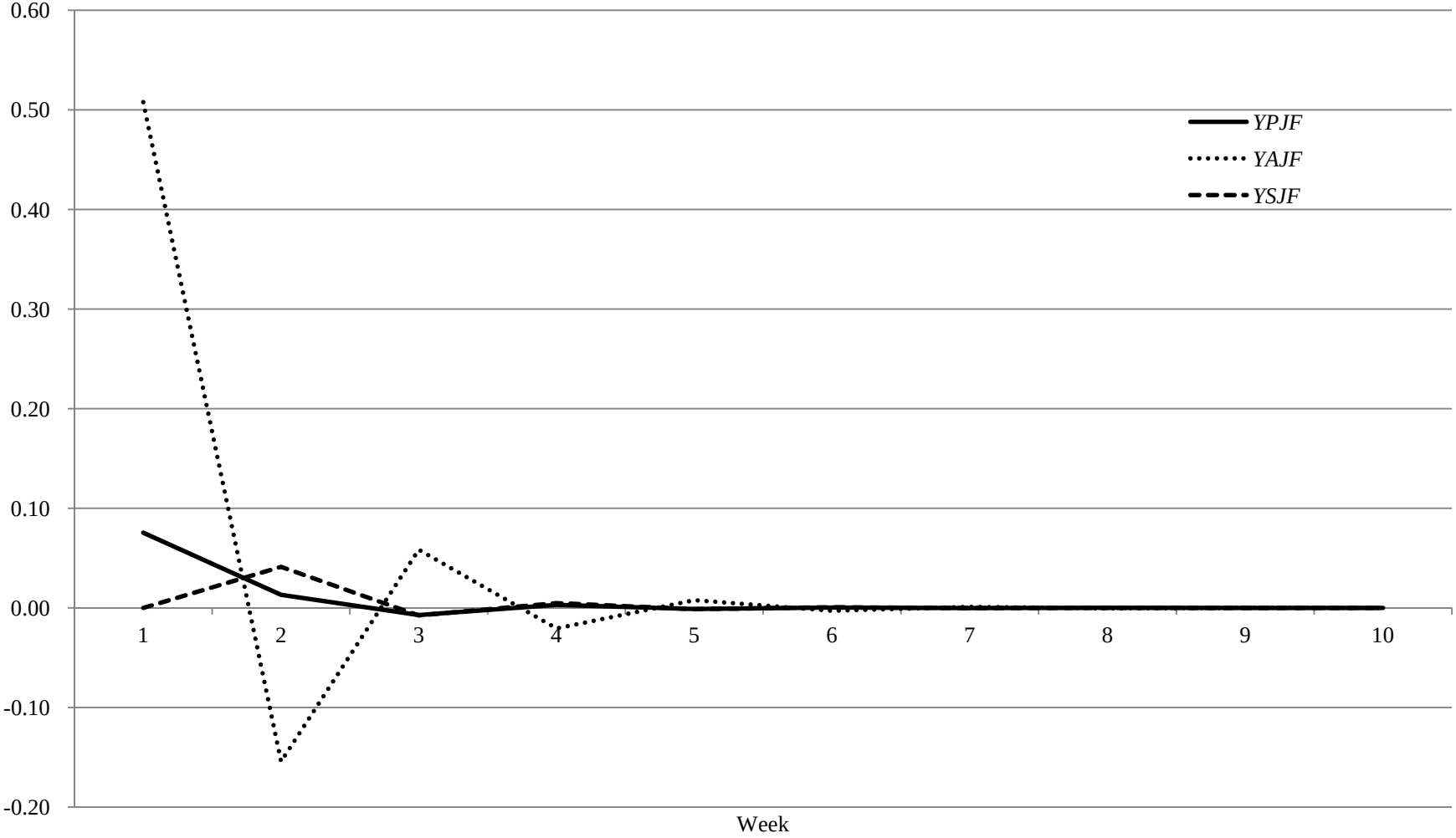


Source: *Statistics of the Ministry of Agriculture and Commerce*.
Note: Yearly data.

Figure 5. Exchange rate of Japanese Yen

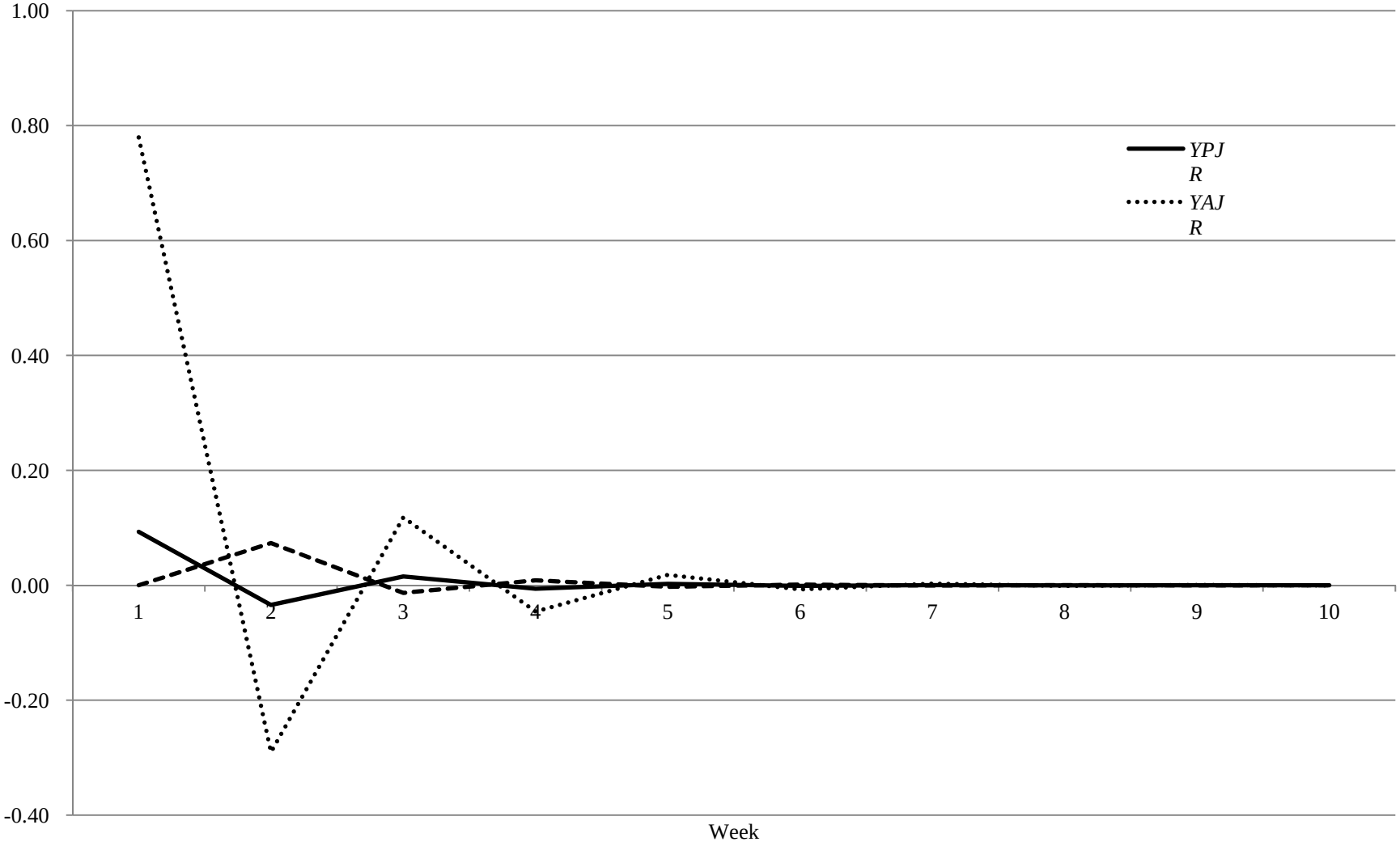
Source: *Chugai Shogyo Shimpo (Domestic and international news).*
Note: Weekly data.

Figure 6. Impulse response of *YAJF* to Choleski factored shocks in *YPJF*, *YAJF*, and *YSJF*.



Note: Weekly data.

Figure 7. Impulse response of *YAJR* toCholeski factored shocks in *YPJR*, *YAJR*, and *YSJR* .



Note: Weekly data.

Table 1. Performance of the Yokohama silk and exchange markets: Summary of vector auto regression of $YPJF$ and $YEXUSD$, 1880/01-1889/12.

AIC optimal noumber of lags			6	
Series frequency			Weekly	
Number of observation			512	
Dependent Variables	Independent Variables $k = 1, 2.$	χ^2 (Block exogeneity Wald test)	P-value	Responding to
$\Delta \log[YPJF_t]$	$\Delta \log[YPJF_{t-k}]$	-	-	None
	$\Delta \log[YEXUSD_{t-k}]$	4.626	0.593	
	constant	-	-	
$\Delta \log[YEXUSD_t]$	$\Delta \log[YPJF_{t-k}]$	23.731	0.001	$YPJF$ **
	$\Delta \log[YEXUSD_{t-k}]$	-	-	
	constant	-	-	

Notes : $YPJF$: Price of Japanese filature (machine-reeled raw silk) at Yokohama. $YEXUSD$: Foreign exchange rate at Yokohama. **: significance at 1 percent level.

Table 2. Performance of the New York silk market: Summary of vector auto regression of $NPJF$ and $NPIF$, 1882/10-1903/12.

AIC optimal noumber of lags			1	
Series frequency			Mothly	
Number of observation			244	
Dependent Variables	Independent Variables $k = 1.$	χ^2 (Block exogeneity Wald test)	P-value	Responding to
$\Delta \log[NPJF_t]$	$\Delta \log[NPJF_{t-k}]$	-	-	None
	$\Delta \log[NPIF_{t-k}]$	0.159	0.690	
	constant	-	-	
$\Delta \log[NPIF_t]$	$\Delta \log[NPJF_{t-k}]$	21.872	0.000	$NPJF$ **
	$\Delta \log[NPIF_{t-k}]$	-	-	
	constant	-	-	

Notes : $NPJF$: Price of Japanese filature (machine-reeled raw silk) at New York. $NPIF$: price of Italian filature at New York. **: significance at 1 percent level.

Table 3. Performance of the New York market: Summary of vector auto regression of $NPJF$, $NPIF$, and $NPCF$, 1884/08-1903/12.

AIC optimal noumber of lags			4	
Series frequency			Mothly	
Number of observation			188	
Dependent Variables	Independent Variables $k = 1, \ldots, 4$	χ^2 (Block exogeneity Wald test)	P-value	Responding to
$\Delta \log[NPJF_t]$	$\Delta \log[NPJF_{t-k}]$	-	-	$NPCF^{**}$
	$\Delta \log[NPIF_{t-k}]$	3.182	0.528	
	$\Delta \log[NPCF_{t-k}]$	37.364	0.000	
	constant	-	-	
$\Delta \log[NPIF_t]$	$\Delta \log[NPJF_{t-k}]$	11.903	0.018	$NPJF^{*}$ and $NPCF^{**}$
	$\Delta \log[NPIF_{t-k}]$	-	-	
	$\Delta \log[NPCF_{t-k}]$	23.566	0.000	
	constant	-	-	
$\Delta \log[NPCF_t]$	$\Delta \log[NPJF_{t-k}]$	28.460	0.000	$NPJF^{**}$
	$\Delta \log[NPIF_{t-k}]$	4.706	0.319	
	$\Delta \log[NPCF_{t-k}]$	-	-	
	constant	-	-	

Notes : $NPJF$: Price of Japanese filature at New York. $NPIF$: Price of Italian filature at New York. $NPCF$: Price of Chinese filature at New York.
**, *: Significance at 1 percent 5 percent level, respectively.

Table 4. Performance of the New York market: Summary of vector auto regression of $NPJR$ and $NPCT$, 1881/01-1903/12.

AIC optimal noumber of lags			9	
Series frequency			Mothly	
Number of observation			111	
Dependent Variable	Independent Variables $k = 1, \ldots, 9.$	χ^2 (Block exogeneity Wald test)	P-value	Responding to
$\Delta \log[NPJR_t]$	$\Delta \log[NPJR_{t-k}]$	-	-	$NPCT^{*}$
	$\Delta \log[NPCT_{t-k}]$	17.390	0.043	
	constant	-	-	
$\Delta \log[NPCT_t]$	$\Delta \log[NPJR_{t-k}]$	-	-	$NPJR^{**}$
	$\Delta \log[NPCT_{t-k}]$	56.466	0.000	
	constant	-	-	

Notes : $NPJR$: Price of Japanese re-reels (hand-reeled raw silk) at New York. $NPCT$: Price of Chinese tsatlee (hand-reeled raw silk) at New York.
**, *: Significance at 1 percent and 5 percent level, respectively.

Table 5. Performance of the New York market and the Yokohama market: Summary of vector auto regression of *YPJF* and *NPJF*, 1881/10-1903/12.

AIC optimal noumber of lags			6	
Series frequency			Mothly	
Number of observation			270	
Dependent Variable	Independent Variables $k = 1, ..., 6.$	χ^2 (Block exogeneity Wald test)	*P*-value	Responding to
$\Delta \log[YPJF_t]$	$\Delta \log[YPJF_{t-k}]$	-	-	
	$\Delta \log[NPJF_{t-k}]$	29.205	0.000	*NPJF* **
	constant	-	-	
$\Delta \log[NPJF_t]$	$\Delta \log[YPJF_{t-k}]$	14.313	0.026	
	$\Delta \log[NPJF_{t-k}]$	-	-	*YPJF* *
	constant	-	-	

Notes : *YPJF* : Price of Japanese filature at Yokohama. *NPJF* : Price of Japanese filature at New York. **, *: Signifincance at 1 percent level and 5 percent level, respectively.

Table 6. Performance of the New York market and the Yokohama market: Summary of vector auto regression of *YPJR* and *NPJR*, 1881/02-1903/12.

AIC optimal noumber of lags			4	
Series frequency			Mothly	
Number of observation			160	
Dependent Variable	Independent Variables $k = 1, ..., 4.$	χ^2 (Block exogeneity Wald test)	*P*-value	Responding to
$\Delta \log[YPJR_t]$	$\Delta \log[YPJR_{t-k}]$	-	-	
	$\Delta \log[NPJR_{t-k}]$	20.726	0.000	*NPJR* **
	constant	-	-	
$\Delta \log[NPJR_t]$	$\Delta \log[YPJR_{t-k}]$	8.576	0.073	
	$\Delta \log[NPJR_{t-k}]$	-	-	None
	constant	-	-	

Notes : *YPJR* : Price of Japanese re-reels at Yokohama. *NPJR* : Price of Japanese re-reels at New York. **: Significance at 1 percent level.

Table 7. Performance of the the Yokohama ma+B135rket: Summary of vector auto regression of *YPJF* and *YPJR*, 1880/01-1903/12.

AIC optimal noumber of lags			8	
Series frequency			Weekly	
Number of observation			1,222	
Dependent Variable	Independent Variables $k = 1, ..., 8.$	χ^2 (Block exogeneity Wald test)	*P*-value	Responding to
$\Delta \log[YPJF_t]$	$\Delta \log[YPJF_{t-k}]$	-	-	
	$\Delta \log[YPJR_{t-k}]$	42.187	0.000	*YPJR* **
	constant	-	-	
$\Delta \log[YPJR_t]$	$\Delta \log[YPJF_{t-k}]$	115.412	0.000	
	$\Delta \log[YPJR_{t-k}]$	-	-	*YPJF* **
	constant	-	-	

Notes : *YPJF* stands for price of Japanese filature at Yokohama, and *YPJR* for price of Japanese re-reels at Yokohama. **: Significance at 1 percent level.

Table 8. Lead-lag relationship among price, arrival, and stock of Yokohama Filature: Summary of Vector Auto Regression of *YPJF* , *YAJF* , and *YSJF* , 1888/11-1903/12.

AIC optimal noumber of lags			5	
Series frequency			weekly	
Number of observation			757	
Dependent Variable	Independent Variables $k = 1, \ldots, 5.$	χ^2 (Block exogeneity Wald test)	P-value	Responding to
$\Delta \log[YPJF_t]$	$\Delta \log[YPJF_{t-k}]$	-	-	$YAJF^*$
	$\Delta \log[YAJF_{t-k}]$	12.983	0.024	
	$\Delta \log[YSJF_{t-k}]$	7.332	0.197	
	Constant	-	-	
$\Delta \log[YAJF_t]$	$\Delta \log[YPJF_{t-k}]$	21.408	0.001	$YPJF^{**}$ and $YSJF^{**}$
	$\Delta \log[YAJF_{t-k}]$	-	-	
	$\Delta \log[YSJF_{t-k}]$	21.149	0.001	
	Constant	-	-	
$\Delta \log[YSJF_t]$	$\Delta \log[YPJF_{t-k}]$	13.481	0.019	$YPJF^*$ and $YAJF^{**}$
	$\Delta \log[YAJF_{t-k}]$	34.317	0.000	
	$\Delta \log[YSJF_{t-k}]$	-	-	
	Constant	-	-	

Notes : *YPJF* : Price of Japanese filature at Yokohama. *YAJF* : Arrivals of Japanese filature at Yokohama. *YSJF* : Stock of Japanese filature at Yokohama. **, *: Significance at 1 percent level and 5 percent level, respectively.

Table 9. Lead-lag relationship among price, arrival, and stock of Yokohama Filature: Summary of Vector Auto Regression of *YPJR* , *YAJR* , and *YSJR* , 1888/11-1903/12.

AIC optimal noumber of lags			6	
Series frequency			weekly	
Number of observation			755	
Dependent Variable	Independent Variables $k = 1, \ldots, 6.$	χ^2 (Block exogeneity Wald test)	P-value	Responding to
$\Delta \log[YPJR_t]$	$\Delta \log[YPJR_{t-k}]$	-	-	$YSJR^*$
	$\Delta \log[YAJR_{t-k}]$	13.019	0.043	
	$\Delta \log[YSJR_{t-k}]$	10.111	0.120	
	Constant	-	-	
$\Delta \log[YAJR_t]$	$\Delta \log[YPJR_{t-k}]$	12.027	0.061	$YSJR^{**}$
	$\Delta \log[YAJR_{t-k}]$	-	-	
	$\Delta \log[YSJR_{t-k}]$	65.016	0.000	
	Constant	-	-	
$\Delta \log[YSJR_t]$	$\Delta \log[YPJR_{t-k}]$	9.801	0.133	$YAJR^{**}$
	$\Delta \log[YAJR_{t-k}]$	46.685	0.000	
	$\Delta \log[YSJR_{t-k}]$	-	-	
	Constant	-	-	

Notes : *YPJR* : Price of Japanese re-reels at Yokohama. *YAJR* : Arrivals of Japanese re-reels at Yokohama. *YSJR* : Stock of Japanese re-reels at Yokohama. For estimation, $YAJR+1$ and $YSJR+1$ instead of *YAJR* and *YSJR* respectively are used because the sample period includes the dates with no arrival ($YAJR=0$). **, *: Significance at 1 and 5percent level, respectively.

Table A.1 Summary of Augmented Dickey-Fuller unit root test.

Variables	Definition	Series frequence	Term Year/Month		Included observations	AIC optimal lag	ADF statistics	*P*- value of lower tail area
YPJF	Yokohama Price of Japan *Filature* (machine-reeled silk)	Weekly	1880/01-1903/12	level	1,228	2	-3.868	0.014
				1st difference	1,228	1	-28.349	0.000
YPJR	Yokohama Price of Japan *Re-reels* (hand-reeled silk)	Weekly	1880/01-1903/12	level	1,220	10	-3.891	0.013
				1st difference	1,220	9	-11.236	0.000
YEXUSD	Yokohama Exchange Rate of US Dollar	Weekly	1880/01-1903/12	level	1,207	23	-1.616	0.787
				1st difference	1,207	22	-8.134	0.000
YAJF	Yokohama Arrival of Japan *Filature* (machine-reeled silk)	Weekly	1888/11-1903/12	level	721	23	-11.021	0.000
				1st difference	715	25	-8.487	0.000
YAJR	Yokohama Arrival of Japan *Re-reels* (hand-reeled silk)	Weekly	1888/11-1903/12	level	721	23	-9.654	0.000
				1st difference	729	18	-8.324	0.000
YSJF	Yokohama Stock of Japan *Filature* (machine-reeled silk)	Weekly	1888/11-1903/12	level	759	11	-6.661	0.000
				1st difference	744	25	-8.598	0.000
YSJR	Yokohama Stock of Japan *Re-reeles* (hand-reeled silk)	Weekly	1888/11-1903/12	level	760	10	-7.204	0.000
				1st difference	744	25	-9.258	0.000
YPJF	Yokohama Price of Japan *Filature* (machine-reeled silk)	Monthly	1881/01-1903/12	level	261	14	-3.856	0.015
				1st difference	260	14	-5.806	0.000
NPJF	New York Price of Japan *Filature* (machine-reeled silk)	Monthly	1881/01-1903/12	level	271	4	-4.543	0.002
				1st difference	274	0	-16.088	0.000
YPJR	Yokohama Price of Japan *Re-reels* (hand-reeled silk)	Monthly	1880/01-1903/12	level	274	1	-3.474	0.044
				1st difference	274	0	-20.093	0.000
YEXUSD	Yokohama Exchange Rate of US Dollar	Monthly	1880/01-1897/09	level	198	2	-1.880	0.661
				1st difference	198	1	-11.430	0.000
NPJR	New York Price of Japan *Filature* (machine-reeled silk)	Monthly	1881/02-1903/12	level	126	12	-4.183	0.006
				1st difference	175	0	-15.505	0.000
NPCF	New York Price of Chinese *Filature* (machine-reeled silk)	Monthly	1884/04-1903/12	level	209	1	-1.876	0.664
				1st difference	209	0	-17.180	0.000
NPCT	New York Price of Chinese *Tsatlee* (hand-reeled silk)	Monthly	1881/01-1903/12	level	167	4	-2.887	0.170
				1st difference	167	3	-7.842	0.000
NPIF	New York Price of Italian *Filature* (machine-reeled silk)	Monthly	1882/09-1903/12	level	230	3	-3.656	0.027
				1st difference	234	1	-9.527	0.000

Notes : (1) Trend and intercept are included in estimated equations. (2) Maximum lag for Schwarz Information Criterion optimal lag estimatimation is 25 for weekly data series and 15 for monthly data series. (3) Japan moved from the silver standard to the gold standard on October, 1897.