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the Shogunate Governance:
Concentration and Integration of
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Informational Efficiency under the Shogunate Governance: Concentration and Integration of the Rice Market in Tokugawa Japan *

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Abstract

In the Tokugawa period, the market transaction explosively grew, and the local markets of all Japan were effectively integrated as a national market. This is the common view shared among the historians. Then, an important question is how these markets performed. To

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evaluate the performance, this paper focusses on the co-movement of rice prices between Osaka and Otsu. Applying the Granger causality test, it is shown that the Otsu market had reflected the rice prices in Osaka within two days in the early 19th century, and within a day in the mid-19th century. This change had stemmed from the development of the communication technology. The rice merchants' appetite for the information had made the co-movement of the rice prices so fast that the Otsu market did not need even one trading day to reflect the rice prices in Osaka.

I. Introduction

Under the governance mechanism established by the Tokugawa Shogunate in Edo,¹ the Shogunate and the feudal lords collected rice as a tax in kind,² and shipped it to the market to finance their expenditure. Originally, this system of taxation emerged on the basis of the development of local markets, which subsequently led to the development of a sophisticated rice transaction mechanism in Osaka. The rice market in Osaka was called the Dojima rice market, and it was chartered by the Tokugawa Shogunate in 1730. Trades at the Osaka market were made, not through the trade of rice in kind, but through the trade of rice bills (“Kome kitte”),³ with the claim over rice in kind represented by the rice bill being protected by the Shogunate.⁴ The distribution network and the judicial system provided by the Shogunate made Osaka the center of the market, with its sophisticated trading mechanism.

The local markets, in turn, followed this trading system. One typical example of such a local market was the Otsu market. Otsu is located near Osaka and it had the second largest rice market after the Osaka market. The rice market in Otsu—“Goyo komekaisyo (The rice market authorized by the Shogunate, henceforth referred to as the Otsu market)” —was chartered by the Shogunate in 1735. Both Otsu and Osaka belonged to the Shogunate

¹Edo was the Shogunate capital, subsequently renamed Tokyo in 1868.

²In this context, tax refers to the total amount of tax and rent accrued to the Shogunate and the feudal lords.

³A rice bill was issued by the feudal lord’s warehouse, and represented a certain amount of rice. It was introduced as a means to reduce the transaction costs involved in trading large volumes of rice.

⁴See Takatsuki (2009a), Takatsuki (2009b).

domain. While the Shogunate gave feudal lords the authority to rule their domains, it had its own domains (“Ten-ryo”) in various regions in Japan, which covered the most important and developed cities such as Osaka and Otsu. The trades in the Shogunate domain were under the jurisdiction of the Shogunate local court. In fact, as discussed later, the Otsu market had a similar trading system, and judicial system, to the Osaka market.

These institutions resulted in an explosive growth of market transactions in the Tokugawa period, and the local markets of Japan were effectively integrated into a national market. Therefore, an important and interesting question is how these institutions performed.

According to neoclassical economics, the sufficient development of market transactions can lead to a Pareto-efficient allocation of resources. Unfortunately, it is not easy to directly evaluate the Pareto-efficiency of the real economy. However, the ability of market transactions to deliver an efficient resource allocation depended upon an important condition: informational efficiency. Using this basic but important idea, Fama (1970) established a useful and practical measure to evaluate markets.

The concept of informational efficiency is a proxy to measure how much, how fast, and how accurately available information is incorporated into prices. Fama classified this informational efficiency into three categories—weak, semistrong, strong—based on the nature of the “available information”.

Of these categories, the weak-form efficiency is the most basic but also the most important criterion, because if it does not hold, then neither the semistrong-form nor the strong-form efficiency will be satisfied. The weak-form efficiency exists if prices fully reflect all the information contained in the

history of past prices and returns. In such a situation, traders cannot earn excess profits from using only the information on past prices and returns.

The author has already documented that the weak-form efficiency was achieved at the Osaka market.⁵ The next step is to investigate the comovement of prices between Osaka and the local market. As in the case of a trading system, it is quite natural to think that the prices in Osaka were referred to by the local market.

The literature has examined the comovements of the Osaka market and the local markets, focusing on price correlation between the markets. A high correlation among prices was found, and it was considered that the coefficient of correlation indicated that Osaka worked as a central market. However, the coefficient of correlation on which the literature relied can tell us only the results of the comovement of the variables. To argue that Osaka was the central market, we need to observe not the results but the process of transmission of the prices. As discussed below, this paper relies on the bivariate Granger causality test.

Moreover, the price indices used by the literature were not frequent at all, typically being monthly or yearly. In the Tokugawa period, letters from Edo to Osaka, which were approximately 500 kilometers apart, were delivered within about six days, and letters from Osaka to Otsu, a distance of about 50 kilometers, were delivered within a day. This implies that the prices at Osaka could be transmitted to very distant markets within a week, or to neighboring markets within a day. Given such a dense communication system, monthly or yearly price indices could not convey any meaningful

⁵See Takatsuki (2008a), Takatsuki (2008b).

results about informational efficiency.

Therefore, we need to construct a more reliable and price index based on frequent observations from an original historical document. Our new source is “Yorozu souba nikki (Daily memorandum of commodity price indices)”. From this memorandum, we can construct the daily price index in both Osaka and Otsu during the period from 1798 to 1856. Relying on this new index, this paper will evaluate the comovement of prices between Osaka and Otsu.

The structure of this paper is as follows. Section II introduces the institutional aspects of the Dojima market and the Otsu market, and reviews the daily price index that was newly constructed. This section serves as background for subsequent discussions. Section III establishes the model for capturing the comovement of prices and presents the results, followed by concluding remarks.

II. Institutions and the price index

Trades in the Osaka market

First, the trade activities in Osaka will be introduced.⁶ Rices, collected as tax in kind and shipped by the feudal lords, were stored in the warehouses (“Kura-Yashiki”) located in Osaka, and sold at the auction. Rice brokers who made a successful bid received the rice bills (“Kome-Kitte”) which, per bill, was worth 1500kg rice in kind stored in the warehouses.⁷ In principle,

⁶See Miyamoto (1988) and Schaede (1989) for further institutional descriptions of the Dojima rice market.

⁷In the late 17th century, each rice bill corresponded to a particular set of rice that the broker won at the auction. In later times, this correspondence gradually collapsed and

the rice brokers could have submitted their rice bills to the warehouse and received real rice in exchange. In reality, however, they mainly sold the bills in the secondary market, the Dojima rice market. Thus, the spot market in Osaka should be regarded as a market for the exchange of rice bills, not of rice in kind.

Issuing a rice bill without being backed by inventory had not been permitted by the Shogunate since 1761. However, the Shogunate did not really suppress that kind of rice bills. While the governor of Osaka⁸) implicitly allow the warehouses to issue a rice bill without being backed by inventory, he force the warehouses to respect the claim of the rice bill holders. It meant that the claim over rice in kind represented by the rice bill was protected by the court of the city of Osaka.⁹

In the spot market, rice bills were required to be delivered in exchange for cash within four days of the transaction. Formally, only officially chartered rice brokers could trade in the market, although in reality, anybody who paid a fee to the chartered traders could join in the market.

There were about 30 types of rice bills issued by feudal lords' warehouses, and the traders' association chose one rice bill among those 30 rice bills as the standard rice. This standard rice was the underlying asset for futures trade. Like the spot market, the traders in this market were formally limited to officially authorized members. However, other traders could trade in the market by paying a small fee to the authorized traders. The fee associated

rice bills came to take on the character of securities. See Shimamoto (1960).

⁸The governor, "Osaka-Machi-Bugyo", was in charge of the judiciary, the police, and other administrative services.

⁹For a further description, see Takatsuki (2009a), Takatsuki (2009b).

with the futures trades was less than that of the spot trades. In addition, the amount of cash required in the futures market was relatively low compared to that required for the spot market. These features of the futures market attracted many traders, especially speculators.

In principle, the futures market traders had to close their positions by buying back or selling back before the maturity date. That is, “roll over” across the trading periods was strictly prohibited. For example, a trader who took a long position during the trading period was required to close his position by the maturity date by selling the same amount involved in the contract. Settlement by delivery was permitted until the maturity date, subject to a constraint imposed by the Tokugawa Shogunate. That is, in the Osaka market, the amount permitted to be settled by delivery was strictly limited to a fixed level of 1000 rice bills for the whole market. Under this constraint, the futures market participants the rice bills thorough the futures market. Usually, net settlements were the dominant method of the settlement.

The spot and futures markets had three separate trading seasons, with the trading seasons for the spot market being a day longer (as shown in parentheses): January 4–April 27 (28), May 7–October 8 (9), and October 17–December 23 (24)¹⁰. These trading seasons were referred to as the spring market, the summer market, and the winter market, respectively. The markets were closed for about 10 days between any of the two trading seasons. Every time the trading season started, the futures market committee was supposed to reselect the standard rice measure. Usually, the standard rice was selected from among the warehouses of the Big Five lords ¹¹.

¹⁰The dates in parentheses are those for spot market.

¹¹That is, Kaga, Chikuzen, Chugoku, Higo, and Hiroshima. Each was regarded as

Trading began at about 8 a.m. in the futures market, followed by the spot trading, which began about 10 a.m. Both trading sessions began with an opening price being presented by the board members of the Dojima market. In the futures market, the opening price was determined by the closing price of the previous day. On the other hand, the opening price in the spot market was determined by two factors: the closing price on the previous day, and the price movements of the futures market preceding the spot market.

In both markets, the price was fixed by an open-outcry system. This involved traders in the circuit shouting the price, accompanied by gestures that indicated either an “ask” or a “bid”. The price was fixed only when the ask price and the bid price matched each other. Every time a trading deal was established, the clerk beat a wooden stick and shouted the price. In the futures market, the trading records were not written down until the completion of the trade at the end of the day. After trade was closed, the traders submitted the record to the clearing house. Then, the clearing house checked each traders’ transactions and canceled out his buying and selling. Finally, a record was kept of each traders’ remaining position.

The spot market closed around noon. On the other hand, the futures trade had a one-hour recess at noon and continued trading until around 2 p.m. The closing price of the futures market was fixed by a special method. First, the clerk lit a fuse cord; the traders were allowed to trade until the fire was extinguished. The closing price of the day was determined by the price at the moment the fire went out.

The features detailed above indicate that the trades in the Osaka market satisfying the requisite conditions, namely credibility and liquidity.

were designed to deal not only with real demand for rice and rice bills, but also for speculation. In other words, the market was designed to accumulate traders' information. The concentration of rice and information made Osaka the center of the market at that time.

Trades in the Otsu market

Some feudal lords whose domains were located along the Japan Sea coast tended to ship their rice to Otsu. As in Osaka, the rice was stored in warehouses and sold at auction. Then, rice bills were issued and traded on the Otsu markets. Again, here each rice bill was worth 1500 kg of rice in kind stored in the warehouses,¹² and claims over rice in kind represented by rice bills were protected by the governor in Otsu.¹³ Given that both the Otsu and the Osaka markets were located in the Shogunate domain, it was rather natural that both systems were similar.

The rice bills traded on the spot market in Otsu were issued mainly by Wakasa warehouse and Hikone warehouse. The former was called “Kumagawa-mai (The rice cropped in Kumagawa district, henceforth referred to as the Kumagawa rice)”, and the latter was called “Sawa-mai (The rice cropped in Sawayama district, henceforth referred to as the Sawa rice)”. Although a standard rice was not officially chosen, the Kumagawa rice was recognized as a kind of standard rice in Otsu.¹⁴ Both Kumagawa rice and Sawa rice were designated as the underlying assets for the futures trades. That is, mainly there existed two futures markets—the Kumagawa futures market, and the

¹² *Otsu-Shi-Shi gekan* (The history of Otsu city—volume 3), pp.94–95.

¹³ *Otsu-Shi-Shi gekan* (The history of Otsu city—volume 3), pp.80–81.

¹⁴ *Otsu-Shi-Shi gekan* (The history of Otsu city—volume 3), pp.94–95.

Sawa futures market. While the “Yorozu souba nikki (Daily memorandum of commodity price indices)”, our new source for constructing a daily price index, recorded the prices of both markets, only the Kumagawa futures prices can be tracked continuously. Therefore, we focus on the Kumagawa market.

While the trading activities in Otsu have not been clearly described, especially compared with Osaka, we can provide an outline.

Trading began at about 10 a.m. in the spot market and the Kumagawa futures market. In both markets, trading began with the opening price being presented by the board members of the market. As mentioned in Section III, the opening price was determined with reference to prices in Osaka on the previous day. The Kumagawa futures market closed at about 2 p.m. as a general rule.

While traders in both the spot market and the futures market were formally limited to officially chartered members, in practice, other traders could join the market by paying a small transaction fee.¹⁵ In the Kumagawa futures market, the traders closed their positions by buying back or selling back in principal. These procedures of the futures market were similar to those in Osaka.

Despite these similarities between the Osaka and Otsu markets, some differences existed. In the Otsu markets, settlement by delivery was permitted up to the maturity date without any constraints, and the traders could “roll over” trades across trading periods. While the Osaka markets were closed between each trading period, the Otsu market was open throughout the year.

¹⁵ *Otsu-Shi-Shi gekan* (The history of Otsu city—volume 3), p.85.

The new price index

As mentioned above, because infrequent price indices do not yield any insights regarding informational efficiency, we need to construct a highly frequent price index from an original historical document. Our new source, “Yorozu souba nikki (Daily memorandum of commodity price indices)”, is the memorandum described by a contemporary rice merchant who traded rice and fertilizer. Although this merchant traded mainly in the Otsu market, he regularly recorded prices in both Osaka and Otsu. The memorandum mentions that his trades in Otsu were closely linked with the prices in Osaka.

From this memorandum, we can construct a daily price index for both Osaka and Otsu, which covers the period from 1798 to 1856.¹⁶ Among the prices listed, we will focus on: i) the futures price in Osaka, and ii) the futures price of Kumagawa rice in Otsu. In Osaka, as mentioned above, the opening price in the spot market was determined by the price movements in the futures market, and the spot market closed about three hours before the futures market did. For this reason, all prices in Osaka can be seen as summarized in the futures price. On the other hand, as the price indices of Sawa rice and the spot prices of Kumagawa rice cannot be tracked continuously, the futures prices of Kumagawa rice are used as representative prices of the Otsu market. Using these two price indices, we will investigate the comovement of prices between Osaka and Otsu.

¹⁶The prices in the period from 1819 to 1839 cannot be observed because the document’s state of preservation for these years is very poor.

III. The comovement of rice prices between Osaka and Otsu

Communication between Osaka and Otsu

The following historical document was submitted by the rice merchants to the governor in Otsu. It reports the trading systems and practices in Otsu, focusing on the relationship between Osaka and Otsu.

Because the rice prices in Osaka are representative prices of all rice markets, a trader in Otsu cannot trade without information about the rice prices in Osaka. A market report from Osaka, which records the prices on the previous day, arrives at the Otsu market every morning. In addition, some traders personally gather information on the Osaka markets before the market report arrives at Otsu, because they are eager to catch the information as soon as possible.¹⁷

There are at least two points to be noted. First, the traders in Otsu market referred to the prices in Osaka as representative ones. This supports the results of Takatsuki (2008b); the Osaka market had achieved informational efficiency at least in terms of weak-form efficiency. In fact, a market report from Osaka can be found in many other markets. Not only the Otsu market, but also many other local markets tried to determine the prices in Osaka as

¹⁷“Ho-reki 11 nen ku-gatsu, bugyo-no otazune-ni kootauru ko-jo-syo (The report submitted to the governor in September 1761)”, cited by *Otsu-Shi-Shi tyu-kan* (The history and culture of Otsu city—volume 2), pp.856–859.

soon as they could. Indeed, the rice price indices in Osaka were referred to as the informative prices by the local markets.

Second, the traders in Otsu were eager to know the prices in the Osaka market as soon as they could. This meant that they could not earn excess profits until the market report arrived in the morning.

The rice merchants' appetite for excess profits led to the development of a communication technique. According to the "Yorozu souba nikki", from 1840, the prices in Osaka were transmitted to Otsu within a day. By this stage, the communication methods developed from the mailman to a system of flag signaling. In fact, while the "Yorozu souba nikki" recorded the closing prices of the Osaka rice market before 1818, from 1840 onwards, it recorded not only the closing prices but also the intra-day prices. This clearly shows that dense trades in both Osaka and Otsu required an update of the communication technique.

How did these developments influence the comovement of prices between Osaka and Otsu? This is the question to be answered in the following section.

The test statistics

To inquire into these points, this paper relies on the bivariate Granger causality test. Here, we estimate the two-variable vector auto regressive (VAR) model to assess the comovement of prices between Osaka and Otsu. The model includes both the log return of the futures prices in Osaka and the log return of the futures prices of Kumagawa rice in Otsu. The VAR model is given as follows:

$$\mathbf{y}_t = \psi_1 \mathbf{y}_{t-1} + \psi_2 \mathbf{y}_{t-2} + \cdots + \psi_p \mathbf{y}_{t-p} + \mathbf{u}_t,$$

where \mathbf{y} is the two-dimensional vector, consisting of the logarithmic returns of the futures markets in Osaka and Otsu, \mathbf{u} is the white noise vector, and t is timing.

Running the least squares analysis, we can observe the cross-interaction between Osaka and Otsu. The optimal number of lags is determined by the Schwarz's Bayesian Information Criterion (SBIC).

The results

The results of the tests are shown in Table 1. In the period from 1798 to 1818, the futures prices in Otsu obviously followed the prices in Osaka. In addition, according to the SBIC, the futures prices in Osaka tended to precede those in Otsu by one trading day. This result implies that the Otsu market reflected the prices in Osaka within two days. Here, we need to remember that, in this period, the information about the Osaka market was transmitted to Otsu by mailman. Hence, the delay of one trading day does not necessarily mean that the Otsu market took two trading days to reflect the prices in Osaka. Given the communication technique utilized in those days, the Otsu market reacted to the Osaka market immediately after market participants received a market report.

On the other hand, in the period from 1840 to 1856, a clear lead-lag relationship did not exist between the two markets. There are two possible ways to understand the relationship in this period. First, both prices moved independently. Second, both prices moved simultaneously. In both cases, the lead-lag relationship cannot be detected by the VAR model.

To determine which case occurred in reality, the coefficient of correlation

was calculated. Table 2 shows that both prices are highly correlated with each other, and the coefficient in the latter period is bigger than that in the earlier period. This implies that both prices moved simultaneously. That is, the Otsu market reflected the prices in Osaka within a day. It was the development of the communication technique that brought about this result. After this stage, the Otsu market did not need even one trading day to reflect the prices in Osaka.

Concluding remarks

The comovement of prices in the Tokugawa period reached a level that previously had not been experienced. The Otsu market did not need even one trading day to reflect the prices in Osaka in the early 19th century, and the traders at that time could not earn excess profits without the latest information about the Osaka market.

Thus, Osaka did indeed work as a center market, with neighboring markets following Osaka sufficiently quickly. The distribution network had led to a sophisticated trading system in Osaka, and the integration of the rice market had led to a dense communication network being developed between the center market and the local markets.

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Year	lags	d.o.f	direction	F-value (p-value)	leader	Year	lags	d.o.f	direction	F-value (p-value)	leader
1798	1	117	Otsu → Osaka	0.191 (0.663)	Osaka	1813	1	235	Otsu → Osaka	4.044 (0.045)	-
			Osaka → Otsu	72.315 (0.000)					Osaka → Otsu	0.713 (0.399)	
1799	1	132	Otsu → Osaka	2.324 (0.130)	Osaka	1814	1	201	Otsu → Osaka	0.667 (0.415)	-
			Osaka → Otsu	15.004 (0.000)					Osaka → Otsu	4.668 (0.032)	
1800	1	144	Otsu → Osaka	1.399 (0.239)	Osaka	1815	1	81	Otsu → Osaka	0.619 (0.682)	Osaka
			Osaka → Otsu	14.907 (0.000)					Osaka → Otsu	51.966 (0.000)	
1801	1	174	Otsu → Osaka	0.111 (0.74)	Osaka	1816	1	187	Otsu → Osaka	0.861 (0.355)	Osaka
			Osaka → Otsu	60.854 (0.000)					Osaka → Otsu	144.225 (0.000)	
1802	1	169	Otsu → Osaka	0.030 (0.863)	Osaka	1817	2	193	Otsu → Osaka	1.922 (0.149)	Osaka
			Osaka → Otsu	33.640 (0.000)					Osaka → Otsu	17.210 (0.000)	
1803	1	167	Otsu → Osaka	0.051 (0.822)	Osaka	1818	1	180	Otsu → Osaka	0.106 (0.745)	Osaka
			Osaka → Otsu	49.768 (0.000)					Osaka → Otsu	9.355 (0.003)	
1804	1	161	Otsu → Osaka	1.178 (0.279)	Osaka	1840	1	141	Otsu → Osaka	2.129 (0.147)	-
			Osaka → Otsu	17.318 (0.000)					Osaka → Otsu	0.071 (0.790)	
1805	1	184	Otsu → Osaka	0.000 (0.945)	-	1841	1	202	Otsu → Osaka	0.056 (0.813)	-
			Osaka → Otsu	2.330 (0.129)					Osaka → Otsu	2.189 (0.141)	
1806	1	143	Otsu → Osaka	2.144 (0.145)	Osaka	1842	1	172	Otsu → Osaka	0.980 (0.323)	-
			Osaka → Otsu	39.173 (0.000)					Osaka → Otsu	0.513 (0.462)	
1807	1	189	Otsu → Osaka	3.974 (0.048)	-	1843	1	233	Otsu → Osaka	4.227 (0.041)	-
			Osaka → Otsu	0.100 (0.752)					Osaka → Otsu	0.493 (0.483)	
1808	1	138	Otsu → Osaka	3.371 (0.069)	Osaka	1846	1	209	Otsu → Osaka	0.879 (0.350)	Osaka
			Osaka → Otsu	41.202 (0.000)					Osaka → Otsu	14.112 (0.000)	
1809	1	163	Otsu → Osaka	0.132 (0.717)	Osaka	1851	1	203	Otsu → Osaka	0.875 (0.351)	-
			Osaka → Otsu	19.444 (0.000)					Osaka → Otsu	0.285 (0.594)	
1810	1	131	Otsu → Osaka	1.139 (0.288)	Osaka	1854	1	207	Otsu → Osaka	0.154 (0.695)	-
			Osaka → Otsu	16.431 (0.000)					Osaka → Otsu	0.012 (0.913)	
1811	1	166	Otsu → Osaka	0.059 (0.809)	Osaka	1855	1	207	Otsu → Osaka	3.400 (0.067)	-
			Osaka → Otsu	76.337 (0.000)					Osaka → Otsu	2.024 (0.156)	
1812	1	150	Otsu → Osaka	3.799 (0.053)	Osaka	1856	1	203	Otsu → Osaka	0.140 (0.709)	-
			Osaka → Otsu	7.796 (0.006)					Osaka → Otsu	0.097 (0.756)	

Table 1: The results of the Granger causality tests

<u>Period</u>	<u>The coefficient of correlation</u>
all	0.588
1798-1818	0.554
<u>1834-1856</u>	<u>0.667</u>

Table 2: The coefficient of correlation between Osaka and Otsu