The Marketing and Price Formation of Diamond Squid *Thysanoteuthis rhombus* in Japan

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Abstract: This paper describes the marketing and price formation of diamond squid *Thysanoteuthis rhombus* in Japan. Marketing was investigated by interviews with persons involved in the distribution of diamond squid, and price formation was studied by analysis of collected landing records. The main producing districts were Okinawa, Kagoshima, and several prefectures facing the Japan Sea (Hyogo, Shimane, Kyoto, etc.), while the main consuming district was Nagoya city in Aichi prefecture. Supermarkets and *kaiten sushi-bars* in Nagoya utilized diamond squid as alternatives to frozen cuttlefish *Sepia officinalis*. Diamond squid caught in the Japan Sea were shipped fresh to wholesale markets in consuming districts. In other words, Japan Sea diamond squid were handled through visible distribution. This result suggests that fluctuations in the catch in the Japan Sea affect the wholesale market prices in consuming districts. On the other hand, though Okinawa diamond squid were handled frozen through invisible distribution, the wholesale market prices in consuming districts affected price formation in Okinawa.

Introduction

Set net and *tarunagashi* fishing methods have thus far been used to catch only a few hundred tons of diamond squid *Thysanoteuthis rhombus* annually from the Japan Sea (Shimane, Tottori, Hyogo, Kyoto, Fukui, and Toyama Prefectures). Thus, this resource has not been overly exploited (Nazumi, 1975; Iizuka, 1986; Kyoto Institute of Oceanic and Fishery Science, 1988). However, a fishing method similar to *tarunagashi* was introduced in Okinawa in 1990, which increased the catch dramatically (Kawasaki, 1990). In Okinawa alone, from 1990 to 1994 over 1,000 tons per year have been landed (Table 1). In Okinawa in 1992, the value of the annual catch exceeded one billion yen (Okutani, 1996), making Okinawa a major coastal fishery.

In light of this rapid development, the Okinawa Prefectural Resource Management Fishery (diamond squid) Promotion Association was formed by local fishermen for the purpose of assuring the continuity of the diamond squid resource. This association has established self-imposed controls on fishing seasons, mantle length, fishing areas, etc. However, many aspects of marketing and price formation for diamond squid remain obscure. Thus, fishing and shipping regulations, which require such information, have yet to be established. Future promotion of resource management in this fishery will depend on proper clarification of marketing and price formation for diamond squid, and the present study will attempt to contribute to this process through 1) interviews with those involved professionally in the distribution of diamond squid and 2) the collection and analysis of statistical data such as records of landing.

Table 1. Catch in tonnage of diamond squid in Japan from 1990 to 1995

Region	Year					
	1990	1991	1992	1993	1994	1995
Okinawa	1,138.0	1,127.2	1,154.4	1,492.2	2,286.6	743.1
Kagoshima	41.9	49.0	115.2	93.6	78.7	4.5
Japan Sea	444.4	470.9	379.2	28.0	305.6	1,543.9
Shimane	178.8	180.6	115.7	1.2	54.4	341.5
Tottori	71.5	63.4	69.6	1.0	38.2	126.3
Hyogo	191.3	219.3	181.5	7.6	165.8	330.2
Kyoto	-	-	-	-	-	128.6
Fukui	-	-	-	18.0	46.0	162.0
Toyama	2.8	7.6	12.4	0.2	1.2	455.3
Total catch	1,624.3	1,647.1	1,648.8	1,613.8	2,670.9	2,348.4

- : No data.

Materials and Methods

Marketing

To investigate the distribution of diamond squid, interviews were conducted from July 1995 to June 1996 with professionals involved in that distribution in both producing and consuming districts. Topics included volume handled, correspondents, commodity processing, and transaction methods. In a investigation of this kind, there is always the possibility of subjective preconceptions being transmitted from the interviewer to the interviewee. Therefore, for each type of business, as many people in the field as possible were interviewed to make the results as objective as possible. In addition, to substantiate the information received during the interviews, the forms of final commodity were confirmed through actual observation of goods displayed in stores.

Price formation

Taya (1991) has previously used catch volume, stock, and shipments of alternate product as variables to explain annual fluctuations of prices of such fishery products as mass-landed fish and farmed fish. The weight of the fish, its freshness, and market prices in the consuming districts also affect fish prices. However, the present study, following the method of Yamaguchi *et al.* (1992), assumes that the most important factor determining fish prices is the volume of the catch. Thus, we will analyze the relation of yearly, monthly, and daily catch volume to catch value for diamond squid from the Japan Sea, which has been a producing district even before market participation of product from Okinawa and which still begins its fishing season before Okinawa. We will examine especially the time around the beginning of market participation by Okinawan product. We will further examine the monthly change in catch volume and value for Okinawan product.

The data used were the diamond squid annual catch volume and annual catch value for Hyogo Prefecture for the past 16 years (1980-1995), the daily catch volume and value for Shimane Prefecture for the past two years (1994-1995), and the monthly catch volume and value for Okinawa Prefecture for the past two years (1994-1995).

Hyogo Prefecture landed more diamond squid than any other prefecture on the Japan Sea from 1990 to 1994, accounting for 50% of the total Japan Sea catch (Table 1). Therefore, the annual catch volumes and values for Hyogo Prefecture can be used to represent the Japan Sea as a whole. The data were standardized using price index (investigation statistics from the Management and Coordination Agency) using 1980 as a standard year, and average annual prices (yen/kg) (hereinafter, "Price") were calculated.

The relationship between catch volume and price is expressed by the following exponential function.

$$P(C) = \exp(\alpha \cdot C + \beta) \quad (1)$$

... where $P(C)$ is the price (yen/kg) at a given catch volume C (ton), and α and β are the parameters of the price function. Transforming formula (1) linearly as in formula (2) and applying the least squares method to the data points, we obtain parameters α and β.

$$\ln\{P(C)\} = \alpha C + \beta \quad (2)$$

Since we were unable to obtain daily catch volume and value data for Hyogo Prefecture, data from Shimane Prefecture, which is second to Hyogo in catch volume on the Japan Sea, was used in its place. The same price index was used for the Shimane data, and the daily average unit price (yen/kg) (hereinafter, "Daily Price") was calculated. Then, with this as a base, the daily fluctuations in catch volume and price were studied.

For Okinawa, the largest diamond squid producing district, the same price index was used to calculate the average monthly unit price (yen/kg) (hereinafter, "Monthly Price"). On that basis, the monthly fluctuations in catch volume and price for 1994 and 1995 were studied, along with the relationship to the prices of Japan Sea product.

Results and Discussions

Marketing

Diamond squid landed in Kagoshima Prefecture are distributed nearly identically to those landed in Okinawa, so they will be included with the Okinawa product. In Okinawa, the largest diamond squid producing district, there are five distribution routes (Fig. 1). Fresh, whole diamond squid, called "round" in the trade, are processed initially by the fishermen, who remove head, legs, and guts. They commission the sale of their squid to the fisheries cooperative association (hereinafter, "Association") to which they belong. The Association sells them to deliveries traders[1)] at auction or to fisheries process man-

[1)] Trader making a profit on the margin of transaction prices.

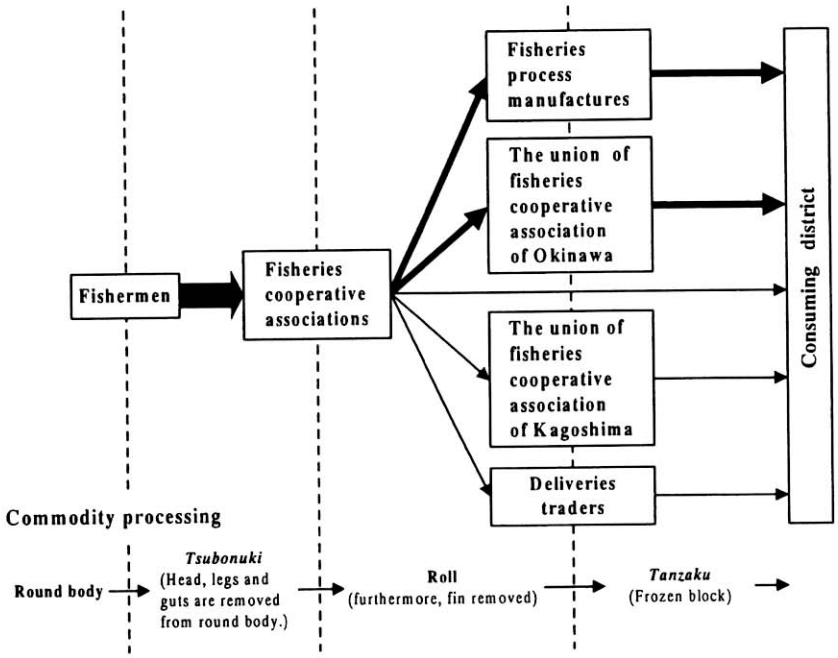

Fig. 1. Distribution routes of diamond squid in Okinawa Prefecture.
Thickness of the arrow shows the relative ratio of the amount distributed.

ufactures[2], or the Union of Fisheries Cooperative Association of Okinawa (hereinafter, "Okinawa Fisheries Association"), or the Union of Fisheries Cooperative Association of Kagoshima (hereinafter, "Kagoshima Fisheries Association") by negotiated transaction[3]. The fisheries process manufactures and the Fisheries Associations receive the squid as "rolls" (fin removed), turn them into blocks called "*tanzaku*", then ship them to the consuming district. The deliveries traders do some processing into *tanzaku*, but most ship the squid as rolls to the consuming district. In some cases, the Associations also ship rolls directly to consuming district.

As described above, the wholesalers are divided into branches, so the commodity processing forms in which the squid enter the consuming districts vary. However, because the fisheries process manufactures and the Okinawa Fisheries Association handle approximately 70% of Okinawa's entire product (1,500t during the 1994 fishing season out of a total catch for Okinawa of 2,300t), the form in which most of the squid enters the consuming districts is *tanzaku*. Moreover, the processing companies and Fisheries Association do not ship all of their *tanzaku* immediately. They hold it in freezers and ship it periodically. Thus, they deal primarily in frozen goods. The primary destination for product from Okinawa's fisheries process manufactures, Fisheries Association, and deliveries traders is Nagoya City in Aichi Prefecture.

In contrast, the fishermen and all the distributors in the various prefectures of the Japan Sea consider diamond squid a sideline or bonus. No agents in the area specialize in diamond squid. As a result, the majority of the diamond squid caught in the Japan Sea are shipped round and unfrozen. The Japan Sea prefectures also ship most of their diamond squid to Nagoya.

Nagoya has two distribution routes (Fig. 2) for diamond squid. One is through wholesale markets and from brokers to final distributing outlets.

Since this channel passes through the wholesale market, it is referred to as "visible distribution". The other route is direct from the fisheries process manufactures and Fisheries Associations to wholesale dealers, and from there to brokers and final distributing outlets. This route does not pass through the wholesale market, so it is referred to as "invisible distribution".

As stated above, the fisheries process manufactures and the Okinawa Fisheries Association, which handle about 70% of Okinawa's entire product, trade primarily in frozen goods. The processing from round squid to rolls and *tanzaku* takes place within Okinawa Prefecture. Thus, the diamond squid landed in Okinawa are, for the most part, handled as frozen goods through invisible dis-

[2] Trader making a profit on the margin of transaction prices and the added value by processing.

[3] Method transacting commodities on the basis of the selling price determined in advance.

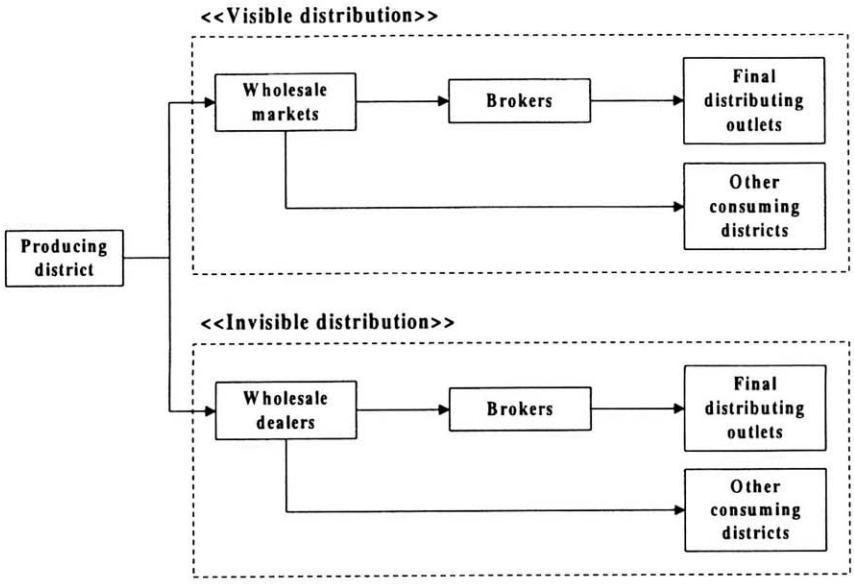

Fig. 2. Distribution routes of diamond squid in Nagoya city.

tribution transactions.

Most of the diamond squid caught in the Japan Sea prefectures, however, are shipped to Nagoya fresh and round. There they are processed into *tanzaku* by brokers, and sent to the final distributing outlets. Japan Sea diamond squid are sold in Nagoya as visible distribution. Whereas Okinawan product is processed into *tanzaku* in the producing district, the Japan Sea product is processed in the consuming districts. This difference leads to separation into visible and invisible distribution routes.

Next, we will discuss the final distributing outlets and final product forms. Diamond squid, from both Okinawa and the Japan Sea, are used as alternate product for B-grade cuttle fish *Sepia officinalis*, for which the price range is very similar. They are used in *kaiten sushi-bars* and supermarkets in forms suitable for *sashimi* and *sushi*. The reason diamond squid are used in such place is that once they have been processed into *tanzaku*, they are extremely easy to slice. Because no special skill is necessary, the task can be assigned to part-time employees. Therefore, purchasing decisions at the final distributing outlets are determined more by ease of handling than by taste.

Price formation

The final distribution outlets and final commodity forms are the same for both Okinawa and Japan Sea diamond squid. Therefore, we can assume a link between the two with respect to price formation.

Fig. 3 shows the relationship between catch volume and price for Japan Sea diamond squid in Hyogo Prefecture. The figure shows that each point since 1990 is lower than the corresponding point in the 1980s. Thus, we fit regression lines by formula (2) to the data points for the two separate periods: 1980-1989 and 1990-1995, respectively. These regression lines are the price function transformed linearly.

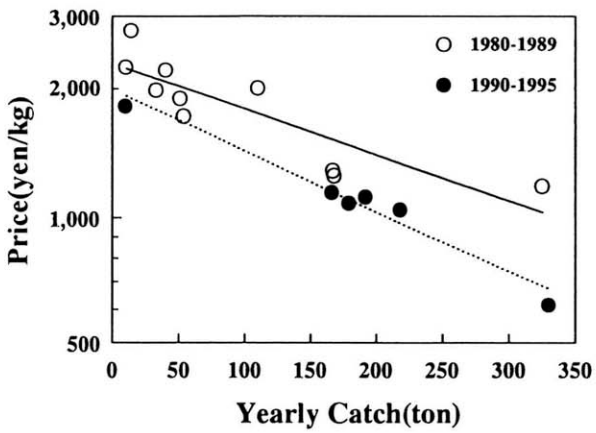

Fig. 3. Relationship between yearly catch and price in Hyogo Prefecture. Solid line and dotted line are regression lines of 1980-1989 and 1990-1995, respectively.

The price function since 1990 is lower than the corresponding figure for 1980-1989. Parameters in price function were tested by analysis of covariance for comparing two price functions. No significant difference was found in α ($P>0.05$, Table 2), but β did differ significantly ($P<0.05$, Table 2). Therefore, the 1990-1995 price function can be assumed to be a simple leftward shift of the

Table 2. Comparison of parameters in two price functions by analysis of covariance

Years	Value of parameters in price function α	β	Correlation coefficient
1980-1989	-2.76 × 10-3	7.74	0.86
1990-1995	-3.19 × 10-3	7.63	0.98
F-value	0.876	7.16*	

F(1,12;0.05)=4.747 F(1,13;0.05)=4.667

1980-89 price function. This implies that after 1990 the prices for equal catch volumes had fallen. The cause of this fall in prices is the increase in distribution volume due to the dramatic increase in catch volume coming from Okinawa after 1990. In other words, it appears that after 1990 Okinawan product began flowing into the final distributing outlets that had previously utilized Japan Sea production, the supply increased dramatically, and the price of Japan Sea product fell.

The price elasticity coefficient ε of demand from formula (1) was found by $\varepsilon = -(1/\alpha C)$. When we actually calculate the price elasticity coefficients of the price functions in Fig. 3 and Table 2 for a 200t catch, those are 1.79 and 1.56 respectively, both over 1. Thus, the demand for the usual catch of 0 to 200t is elastic. For most commodities that can easily be replaced by other item, when the price rises significantly, demand is usurped by the alternate item, which makes the price elasticity coefficient large (Shimizu & Iwasaki, 1982; Kurasawa, 1993; Okuno, 1995). The similar α in two price functions show that even before the Okinawa product was participating in market (1980-1989), the price elasticity coefficient was the same. This finding suggests the presence of effective substitute products for the squid landed in Hyogo Prefecture, and by extension all Japan Sea production, before participation by Okinawan product. The substitute products may have been cuttle fish imported from Southeast Asia and elsewhere which, in final commodity forms, resemble diamond squid.

Therefore, since 1990 and the appearance on market of large volumes of Okinawan product (Table 1), prices for Japan Sea product have dropped, but at the same time, Okinawan product has taken a larger share away from Japan Sea product distributed to the final distributing outlets. Given this relationship between Okinawan and Japan Sea product, we can make the following discussions about the price formation of diamond squid.

Fig. 4 shows the fluctuations in the daily prices of

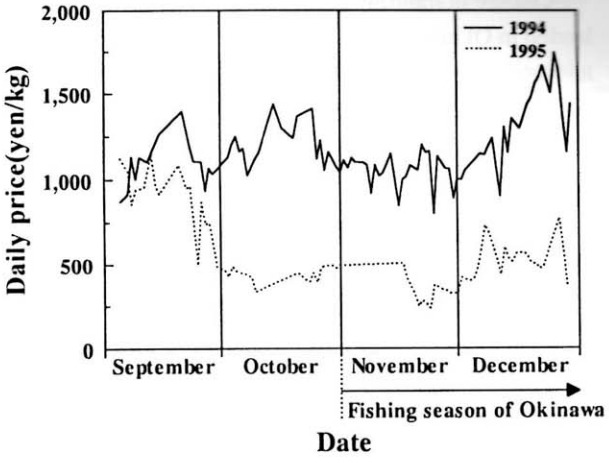

Fig. 4. Change in daily price of diamond squid landed in Shimane Prefecture.

Japan Sea diamond squid from Shimane Prefecture. The solid line represents the fishing season[4] of 1994, the dotted line is for 1995. The total catch for the Japan Sea prefectures was 306t and 1,544t respectively (Table 1). The catch during the 1995 season was unusually good, so the daily prices during 1995, while almost the same in September at the start of the fishing season, had fallen to half that amount by October. During the 1995 season in Hyogo Prefecture, over 330t were landed. The price elasticity coefficient for this time, sought with α from 1990-1995 on Table 3, was less than 1, which shows that the price varied greatly with increases and decreases in catch volume. Thus, the larger-than-usual catch from the Japan Sea was shipped in large volumes to the consuming districts, and prices at the wholesale markets in the consuming districts fell to half the normal price (obtained from interviews).

The prices formed in the consuming district markets are reflected in retail prices, and these prices are also communicated to the producing districts, so prices in the producing districts are highly sensitive to changes. Therefore, the fall in daily prices during the fishing season of 1995 can be assumed to have been caused by the fall in prices at the consuming district markets due to the large volume of shipments of Japan Sea product. The Japan Sea product, which flows through visible distribution, is smaller in volume than product from Okinawa, but increases and decreases in Japan Sea catch volume have a powerful influence on prices at consuming district markets.

[4] Fishing season in the Japan Sea : September - December
Fishing season of Okinawa : November - next June

Change in monthly catch and price of diamond squid landed in Okinawa is shown in Fig. 5. The monthly price in November, early in the fishing season of 1995, was about half the price of previous year, despite a reduction in catch volume (one third the catch of the same month the previous year). This depreciation in price is thought to be caused by the following two factors. The first, as stated above, is that the unusually large catch from the Japan Sea was shipped in large volumes to the consuming districts, and the demand for Okinawan product was reduced. Thus, the price in Okinawa was rather low. The second factor was remaining inventory among the Okinawa Fisheries Association and the fisheries process manufactures. Because the catch in Okinawa was so large (1.5 times greater than the previous year, Table 1) they were unable to sell all the product procured during the 1994 fishing season before the beginning of the 1995 season. Thus, the frozen surplus remained in stock as initial inventory for the 1995 fishing season, which inhibited purchasing in Okinawa early in the season.

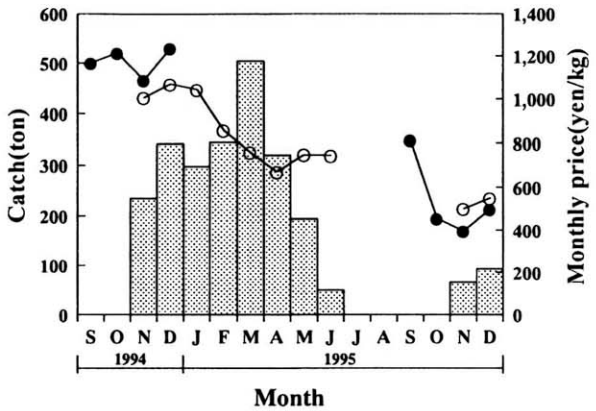

Fig. 5. Change in monthly catch and price of diamond squid landed in Okinawa Prefecture.
□: Monthly catch of diamond squid in Okinawa Prefecture.
○ and ●: Monthly price of diamond squid in Okinawa and Shimane Prefecture, respectively.

As can be seen from the above, the price for diamond squid at the beginning of the season in Okinawa is influenced more by earlier price formation based on the size of the Japan Sea catch and by the stock held by the fisheries process manufactures and the Okinawa Fisheries Association.

A price formation system for diamond squid is shown in Fig. 6. Most of the diamond squid caught in the Japan Sea goes round and unfrozen to the wholesale markets in the consuming districts. As a result, increases and decreases in catch volume in the Japan Sea are immediately linked to fluctuations in volume shipped to the wholesale markets. Thus, the Japan Sea catch has a powerful influence on price formation in the consuming district markets. Okinawan product, on the other hand, is mostly frozen and transacted through invisible distribution, with very little being shipped to consuming district markets, so its influence on market prices is low. The price in Okinawa Prefecture is determined by inventory volumes at the beginning of the season and the prices in the consuming district markets. Based on the findings of this study, the differences in distribution route between Okinawan and Japan Sea product (invisible and visible

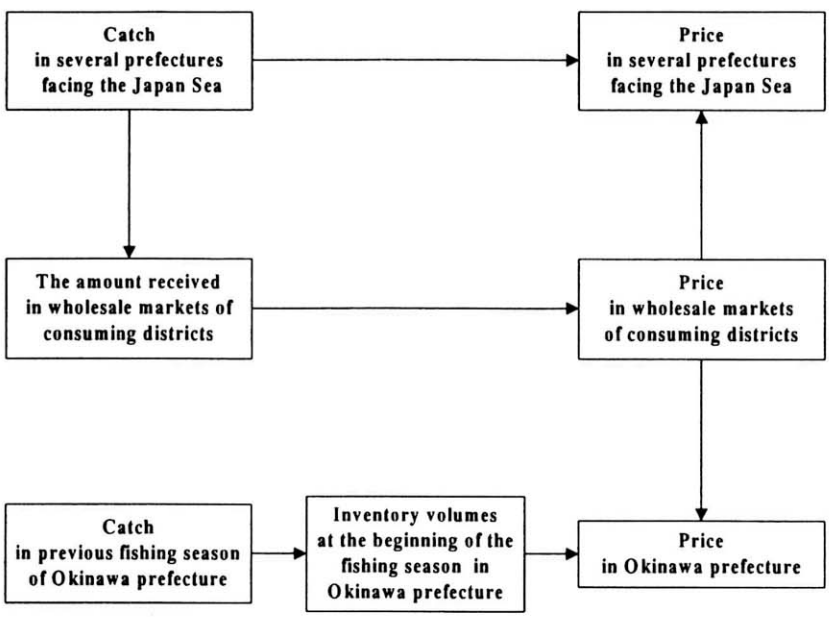

Fig. 6. Price formation system for diamond squid in Japan.

distribution) has little influence on actual price formation for diamond squid.

We were unable to obtain for this investigation the figures for diamond squid volume and value handled in Nagoya, the primary consuming district. As a result, the price formation system described in this paper is not based on an analysis of concrete volume in the consuming districts. For more detailed quantitative analysis, it will be necessary to gather and analyze consuming district market data, such as daily volume received and prices by each producing district.

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