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An Analysis of the Causality between the Market Price of Imported Fishmeal and the Market Price of Marine Farmed Fish

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Abstract: The purposes of this paper are to introduce the historical background and price trends of the imported fishmeal market, and to reveal the pattern of causality between prices in the imported fishmeal market and the market prices of yellowtail and sea bream inlanding areas. Granger causality test was used in this analysis.

The results were as follows: 1) there is causality between the price of imported fish meal and the market price of sea bream in landing areas, 2) but there is no causality among the market prices of all combinations without imported fishmeal and sea bream.

Key words: Granger causality test, market price of imported fishmeal, market prices of pisciculture

In Japan, many piscicultural farmers are facing difficulties due to the impact of falling fish prices and the rising cost of feed. These are serious problems because they can result in a great reduction in profits for many farmers. According to statistics produced by the Japanese Corporation of Feed for Pisciculture (Nihon Yougyo Shiryou Kyoukai), the production of feed reached 360,000 tons in 2011, the majority of which was for yellowtail and sea bream. These feedstock were made from raw ingredients such as fishmeal, starch, and fish oil. Fishmeal was especially important, making up 50% or more of the feed content. Therefore, piscicultural farming yellowtail and sea bream always worry about soaring imported fishmeal prices. This research investigates the relationship of price changes in imported fishmeal on the market price of piscicultural products.

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The domestic production of fishmeal and the market price of major farmed fishes

The domestic production of fishmeal came mainly from inshore fisheries in northern Japan between 1959 and 1991 (Fig. 1), and the main ingredient, Pollack, was used on the grounds that it was fresh and suitable for processing. However, the catch of Pollack has decreased year by year from then as a result of increasing demand for fish pastes and the impact of fishery treaties such as the 200 mile exclusive fishing zone. As a result, the amount of imported fishmeal has increased gradually to make up for insufficient supplies of local ingredients in Japan. More than half current fishmeal stocks are imported from three countries in South America

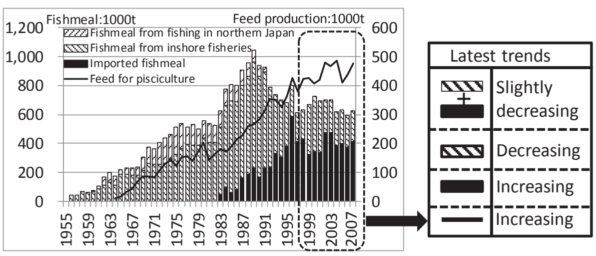

Fig. 1. Domestic production of fishmeal and feed for pisciculture in Japan

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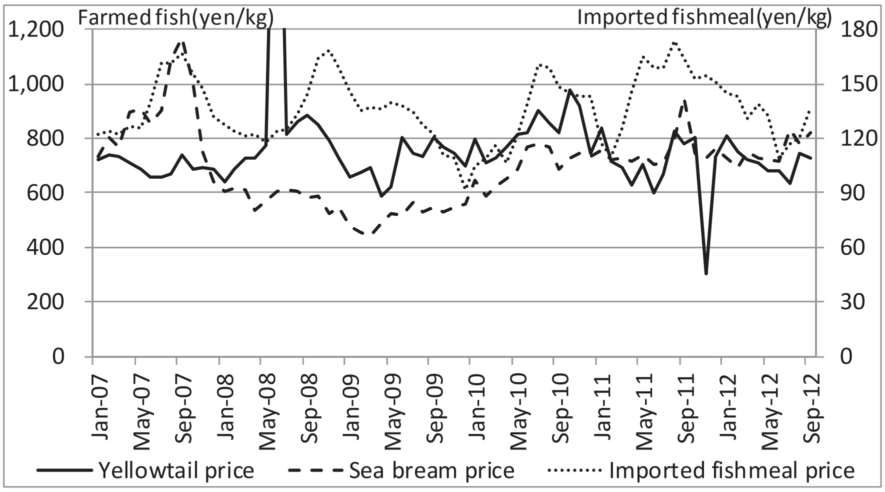

Note: Those prices were deflated using CPI and IPI (2010=100)

Fig. 2. Market prices for yellowtail, sea bream and imported fishmeal

(Peru, Ecuador and Chile).

Fig. 2 shows the trend of market prices in imported fishmeal, farmed yellowtail and farmed sea bream during the six years from 2007. The market price changes of yellowtail and sea bream have been subject to violent fluctuations within certain limits. As for only yellowtail, there is an exception that the price of yellowtail soared upwards in June 2008 because of little production. Imported fishmeal has also ranged in price from 90 to 175 yen/kg.

Generally, the market price of a commodity tends to rise when the price of ingredients rises; this phenomenon is called "cost push inflation". As seen in Fig. 2, there have been price changes over time, but we cannot conclude that there has been any relationship between changes in the price of one commodity and that of another. Therefore we decided to analyze the relationships among prices using statistical approaches.

Data and Method

Data: Time series data about piscicultural products such as yellowtail and sea bream are available from the website of JAFIC (Japan Fisheries Information Service Center). These original data are nominal, so for this paper these were deflated with "yellowtail" and "sea bream" in the CPI (Consumer Price Index). Also time series data of imported fishmeal are available from the website of the MOF (Ministry of Finance), and have also been deflated with "fishmeal" in the IPI (Import Price Index).

Table 1. Result of the DF-GLS test

	First difference data								
	Yellowtail price			Sea bream price			Imported fishmeal price		
	lag	statistic	significant	lag	statistic	significant	lag	statistic	significant
DF-GLS Test	0	−6.326	**	0	−0.702	*	0	−1.476	*
	1	4.494	*	1	−0.474		1	0.773	
	2	3.803	*	2	−0.612	*	2	0.799	
	3	3.258		3	−0.611	*	3	0.499	
	4	2.817		4	−0.494		4	0.570	
	5	2.401		5	−0.496		5	0.646	
	6	2.004		6	−0.396		6	0.438	
	7	1.620		7	−0.325		7	0.069	
	8	1.249		8	−0.448	*	8	0.229	
	9	0.957		9	−0.356		9	0.305	
	10	0.636		10	−0.216		10	−0.015	
	11	0.323		11	−0.135		11	0.114	
	12	0.119		12	−0.243		12	0.094	

Note: "**" indicates statistical significance at the 1%level, "*" at 5% level

The data first had to be tested for "stationarity" or "not stationarity" before processing in the Granger causality test, because time series data in economics has an almost unit root. Regression among data sets having unit roots has no meaning because of the potential for high correlations among those data. The DF-GLS (Dicky-Fuller is Based on GLS Detrending) test is reliable statistical method to check for unit root, so this was applied. The first test with raw data was not suitable for null hypothesis testing. As a countermeasure for the unit root problem, first difference data was used and then retested in the same way. The result of this retest made it possible for null hypothesis testing to function correctly (Table 1). From this, first difference data whose lag is 0 was adopted.

Analysis method: Analysis method used in this paper was the Granger causality test in a VAR (Vector Autoregression) model. An AR (Autoregression) single variable model was used, and current value was determined by past own value and white noise (for more information on the VAR model and Granger Causality Test, see chapter 12 and chapter 13 in Maddla (1992)). The VAR model is an expanded AR model, from single to multivariable cases, although the current values of the multivariables are also determined by past own values and white noise. In this section, the two variables VAR(1) model that was actually used is described. The values given in parentheses are lag numbers. Here, x_t and y_t are the price data of commodity at time t, ε denotes error terms, and α_{ij} is an individual parameter.

$$\left.\begin{aligned} x_t &= \alpha_{11} x_{t-1} + \alpha_{12} y_{t-1} + \varepsilon x_t \\ y_t &= \alpha_{21} x_{t-1} + \alpha_{22} y_{t-1} + \varepsilon y_t \end{aligned}\right\} \quad \cdots\cdots(1)$$

The Granger causality test is examined by equation (1). The basic idea of the Granger causality test is that the past value of variable y can affect variable x (or not). It can determine that variable y can affect variable x if the null hypothesis of "$\alpha_{12}=0$" is rejected by F test. The following equation (3) is the form of equation (2) where "$\alpha_{12}=0$".

$$x_t = \alpha_{11} x_{t-1} + \alpha_{12} y_{t-1} + \varepsilon x_t \quad \cdots\cdots(2)$$

$$x_t = \alpha_{11} x_{t-1} + \varepsilon y_t \quad \cdots\cdots(3)$$

The residual sum of squares of equation (2) replaces RSS, the residual sum of squares of equation (3) replaces RSS_0, and we can define the F value using the following equation:

$$F = \frac{(RSS_0 - RSS)/q}{RSS/(n - r - 1)},$$

Where n is the number of samples, q is the number of constraint conditions such as "$\alpha_{12}=0$", and r denotes the number of variables without a constant term in equation (2).

Results and Discussion

The VAR model has a problem with respect to lag length selection, so it is necessary to select optimal lag length to obtain an accurate result before applying the Granger causality test. In this paper, the estimation of lag length selection was carried out with four model types which were "none", "const", "trend" and "both". "None" has no drift and trend, "const" has only drift, "trend" has only trend, and "both" has both of these. The estimation of these four types were judged by using S.C. (Schwarz Information Criteria). Consequently, "none" and "lag length = 1" are selected in all combinations of two variable VAR models.

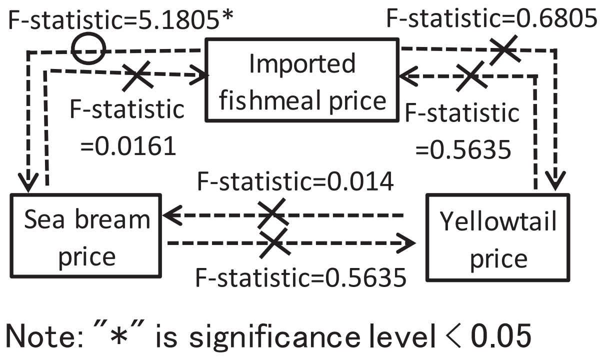

Fig. 3. Result of market linkages in Japan

Fig. 3 shows the results of the Granger causality test. There is no causality of price between yellowtail and sea bream, and this is natural because yellowtail cannot be substituted for sea bream. Also, changes in the price of farmed fish have no influence on the price of imported fishmeal. Why the price of imported fishmeal can affect the market price of sea bream in Japan. We do not have a scientific explanation for the fact that this relationship only affects the price of sea bream. Nevertheless, according to Demura (2010), feed stocks for farmed sea bream are dependent on fishmeal even if the price of imports rises. Conversely, feed stocks for yellowtail can be changed to other ingredients such as raw fish if the price of imported fishmeal rises too high. This situation is probably the explanation.

References

Demura M., 2010: A trend of fishmeal price and impact on the aquacultural industry, *Finance of Agriculture and Forestry*, **45**, 601–605 (in Japanese).

Maddla G. S., 1992: Introduction to Econometrics, 2nd edition, Prentice-Hall, USA.

Japanese Corporation of Feed for Pisciculture, 2007: Pisciculture and formula feed in Japan: A historical record of 40th anniversary of Japanese Corporation of Feed for Pisciculture, Japanese Corporation of Feed for Pisciculture, Tokyo, Japan (in Japanese).

Yano I., 2010: Heading towards construction of recycling-oriented society associated with food production and consumption: food wastes problem and recycle problem. in Yamao, M. (Ed.), Our “food safety and security” and environmental problem, Hirodai Seibutsuken Shuppankai, Hiroshima, Japan: 83–92 (in Japanese).