A Study on the Development Process of the Egg Industry and Structures of Egg Demand and Supply in Japan

Toshihisa KANAYAMA*, Tong Seng CHAN** and Shoichi ITO*

(*Received May 31, 1990*)

The developmental process of the Egg Industry in Japan can be classified into four stages since 1955. This paper attempts to analyze structures of demand and supply for eggs at the third and fourth stages which are classified as the Mature Period (1974-79) and the Period of Formation of Specialized Production Areas (1980-), respectively.

The results of a demand equation estimated for eggs in this research indicated that price and income elasticites are both relatively small and that the time trend is negative. Thus, egg consumption appears to have become saturated. On the other hand, two employed supply equations were estimated for eggs. Annual data was employed for one type (model I) and monthly data for the other (model II). The estimated elasticities of egg prices and coefficients of time trend were relatively small in both models. Therefore, egg supply may be inelastic to change in prices, and the technical progress of egg production may not be so rapid. The coefficient of feedstuff prices estimated in model II was smaller than that in model I. With the recent decline in egg prices and no reduction in supply, supply for eggs must be affected by feedstuff prices. On this point, model II is a better estimate than model I.

Introduction

The egg industry in Japan has developed rapidly since 1955 along with the remarkable growth of Japanese economy. The egg production in Japan has undergone severe class and regional divisions taking a benefit of large scale management and expansion in scale in response to the enlargement of egg market. This resulted in a rapid increase in production and a surplus in supply which brought about stable low prices for eggs. For instance, the volume of eggs produced in 1955 was 356,000 tons, and it increased to 1,788,000 tons in 1975 and 2,375,845 tons in 1987. In this paper, an outline of the egg industry since 1955 is reviewed, and the structures of egg demand and supply in 1972-1987, and the period of gradual saturation in consumption, are analyzed.

**Department of Agricultural Information Science, Faculty of Agriculture, Tottori University*

***The Malaysia Agriculture Department*

Outline of the Egg Industry since 1955

The developmental process of the egg industry in Japan can be classified into four stages since 1955. These stages are (i) the period of stable growth, 1955-1964, (ii) the period of structural change, 1965-1973, (iii) the mature period, 1974-1979, and (iv) the period of formation of specialized production areas, 1980-today. The stages of (i)-(iii) were already founded in a previous study.[3] These different stages of developmental process of the egg industry are discussed briefly below.

(i) The Period of Stable Growth (1955-1964)

This period witnessed a continuous growth in demand for eggs along with the rapid growth of Japanese Economy. Prices of eggs were generally stable. The supply of eggs increased rapidly as a result of better layer management and expansion of operation scale. The size of total layer flocks increased rapidly as shown in Fig. 1, although the majority of egg producers were part-time producers. There was also a reduction in the number of total layer farm households during this period, though flock size per farm household continued to increase (Fig. 2 and Fig. 3). This period was generally termed the turning point of the egg industry as there were big changes in the egg production organization.

(ii) The Period of Structural Change (1965-1973)

The supply of eggs increased rapidly during this period except in 1972 and 1973 when the supply volumes just tapered off as compared to previous production years. On the consumption side, a continuos increase in egg demand had stimulated and caused an increase in egg

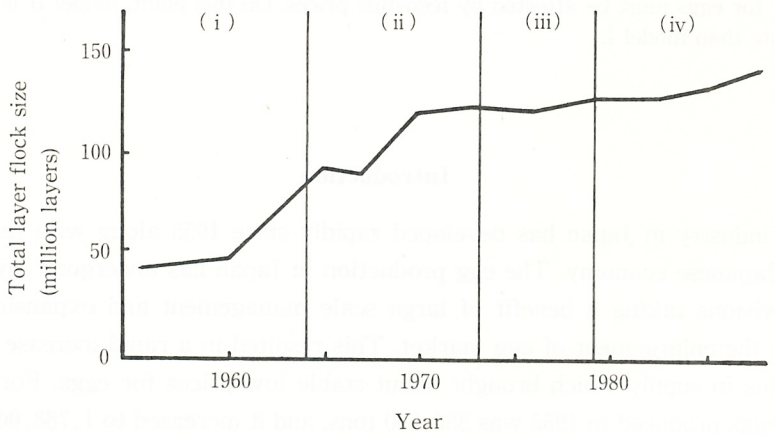

Fig. 1 Size of total layer flocks
(i) Period of stable growth
(ii) Period of structural change
(iii) Mature period
(iv) Period of formation of specialized production areas

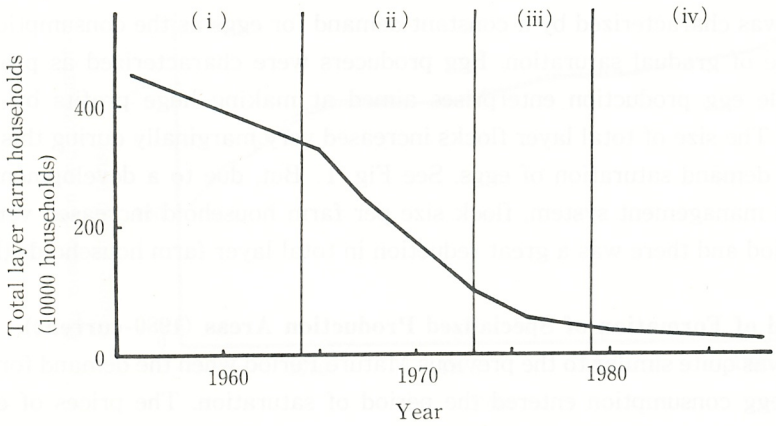

Fig. 2 Total layer farm households
(i) Period of stable growth
(ii) Period of structural change
(iii) Mature period
(iv) Period of formation of specialized production areas

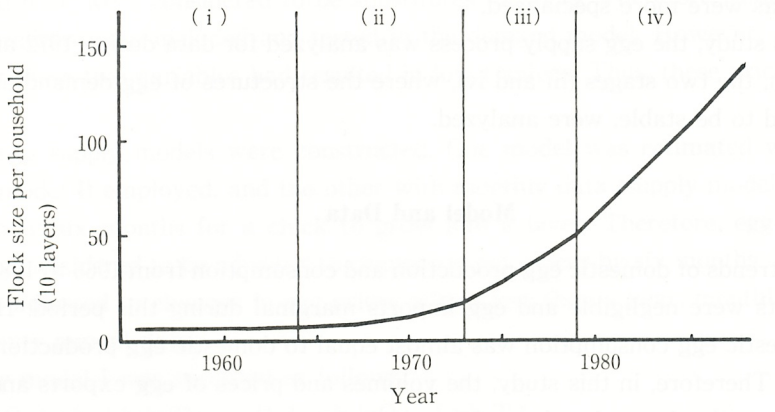

Fig. 3 Average layer flock size per household
(i) Period of stable growth
(ii) Period of structural change
(iii) Mature period
(iv) Period of formation of specialized production areas

supply. On the production side, larger layer flock size per farm household and improved management also resulted in increases in egg supply. The number of total layer farm households continued to decline throughout this period (Fig. 2).

(iii) The Mature Period (1974-1979)

This period was characterized by a constant demand for eggs as the consumption of eggs entered a phase of gradual saturation. Egg producers were characterized as professionals with large scale egg production enterprises aimed at making huge profits by capturing market shares. The size of total layer flocks increased very marginally during this period as a result of the demand saturation of eggs. See Fig. 1. But, due to a development in layer production and management system, flock size per farm household increased very rapidly during this period and there was a great reduction in total layer farm households (Fig. 2 and Fig. 3).

(iv) The Period of Formation of Specialized Production Areas (1980-current)

This period was quite similar to the previous Mature Period when the demand for eggs was constant, and egg consumption entered the period of saturation. The prices of eggs were generally low because of the constant large supply of eggs as a result of cheaper imported feedstuff prices caused by appreciation of the Japanese Yen during the 1980's. The size of total layer flocks grew considerably during the latter part of this period as shown in Fig. 1. However, flock size per farm household continued to increase rapidly throughout this period. This was a result of new innovation and improved technology in layer production and management (Fig. 3). In this period, the district of Tohoku increased its share of egg production, while shares of districts of Tokai, Chugoku, Shikoku and Kinki decreased. Production areas were more specialized.

In a previous study, the egg supply process was analyzed for data during 1972 and 1976.[2] In this research, the two stages (iii and iv), where the structures of egg demand and supply were considered to be stable, were analyzed.

Model and Data

Fig. 4 shows trends of domestic egg production and consumption from 1966 to 1987. Notice that egg exports were negligible and egg imports marginal during this period. Hence, the volume of domestic egg consumption was almost equal to domestic egg production throughout the period. Therefore, in this study, the volumes and prices of egg exports and imports are excluded from the demand and supply analyses.

Domestic egg production and consumption from 1966 to 1987 were shown in Fig. 4. During the 1960's, annual egg consumption and production increased at a high rate. However, during the 1970's, egg consumption and production were sluggish and increased at only a moderate rate. Throughout the periods of the two stages (iii and iv), the increasing rates of egg demand and supply were almost constant.

The egg demand model was first structured as follows:

$$\ln Q_{Dt} = a_0 + a_1 \ln P_{Dt} + a_2 \ln I_t + a_3 \ln T_t$$

Where, Q_{Dt} : Per capita annual egg consumption in year t,

P_{Dt} : Retail price of eggs in year t,

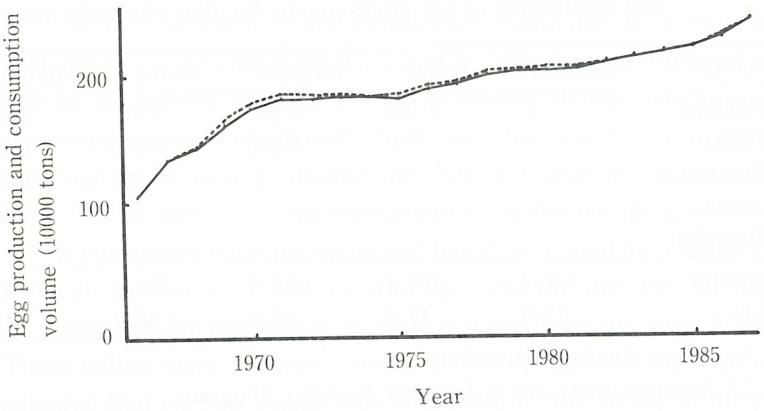

Fig. 4 Volumes of domestic egg production and consumption
------ Domestic egg consumption
—— Domestic egg production

I_t : Income per worker in year t,
T_t : Trend variable (1, 2, •••n),
a_0-a_3 : Parameters to be estimated.

Beef and milk were considered to be substitutes for eggs. Therefore, retail beef and milk price variables were included and tested in the demand model. However, estimated coefficients of these two variables had resulted in low t-values. Thus, these price variables were dropped.

Two egg supply models were constructed. One model was estimated with annual data (supply model I) employed, and the other with monthly data (supply model II) employed. It takes about six months for a chick to grow into a layer. Therefore, egg productions are generally considered to be adjusted to changes in egg prices by six months. If egg production could be adjusted to changes in egg prices within less than a year, monthly data should be chosen over annual data.

Supply model I was specified as follows:

$$\ln Q_{St}^{y} = b_0 + b_1 \ln(P_{wt-1}^{y} / P_{ft}^{y}) + b_2 \ln Q_{St-1}^{y} + b_3 T_t^{y}$$

Where, Q_{St}^{y} : Egg supply volume in year t,
P_{wt}^{y} : Egg price in a wholesale market in year t,
P_{ft}^{y} : Feedstuff price in year t,
T_t^{y} : Annual trend in year t,
b_0-b_3 : Parameters to be estimated.

Supply model II was constructed as:

$$\ln Q_{St'}^{m} = c_0 + c_1 \ln P_{Wt'-6}^{m} + c_2 \ln Q_{St'-6}^{m} + c_3 \ln P_{ft}^{y} + c_4 \ln T_t^{y}$$

Where, $Q_{St'}^{m}$: Egg supply volume in period t′ (monthly data),
$P_{Wt'}^{m}$: Egg price in wholesale market in period t′ (monthly data),

Table 1 Averages and standard deviations of egg prices and simple correlation coefficients of egg prices among the five wholesale markets

market	Sapporo	Tokyo	Nagoya	Osaka	Fukuoka
Sapporo	1	0.980	0.985	0.975	0.974
Tokyo		1	0.996	0.999	0.997
Nagoya			1	0.997	0.995
Osaka				1	0.997
Fukuoka					1
average	271.7	260.4	256.8	258.0	248.8
S.D.	41.0	40.4	40.6	40.0	40.0

1) S.D. is standard deviation.
2) Average prices are in Japanese yens per kilogram.

P_{ft}^{y} : feedstuff price in year t (annual data),
T_t^{y} : Annual trend in year t,
c_0-c_4 : Parameters to be estimated.

The annual data of feedstuff prices and egg prices had a multicollinearity problem. Therefore, a ratio of egg prices to feedstuff prices was used in model I. Trend variables were included in both models, and the trend variable was a log-linear form in model II.

Time-series annual and monthly data were used to estimate these models. Annual data used for model I were from the period between 1972 and 1987, which included the stages of (iii) and (iv). Monthly data for model II were from July 1976 through December 1987, the stage of (iv) only.

Price movements in the major wholesale markets, such as in Sapporo, Tokyo, Nagoya, Osaka and Fukuoka, were closely related to one another as shown in Table 1. The correlation coefficients of egg prices among these markets were over 0.97. The averages and the standard deviations of egg prices were nearly the same among those markets. Hence, the data of egg prices to be used in this research were the prices of the Tokyo wholesale market. Price and income variables were deflated by consumer price index.

The source of data for prices and the volumes of eggs and prices of feedstuff was *Annual Statistics on the Distribution and Marketing of Eggs and Broilers*, Ministry of Agricultural, Forestry and Fishery, Japan. Data for income were collected from the Statistics Bureau, Management and Coordination Agency, Japan.

Results and Discussion

The estimated results of the egg demand and supply functions are shown in Table 2. While the estimated coefficient of income variable in the egg demand function was not significant, the coefficients of price and trend variable were significant. Price and income elasticities calculated from the coefficients were 0.177 and 0.423, respectively. Both of these elasticities

were in the range of those founded in the previous studies: price elasticities estimated previously were between 0.16 and 0.19 and expenditure elasticities between 0.38 and 0.74.[1)] Further, the coefficient of T was negative. This may be reflecting saturation of egg consumption and increase in the number of kinds of food available. Strong consciousness on health during the recent years was also considered to have contributed to decline in egg consumption because eggs are high in cholesterol despite the fact that eggs are nutritious and rich in protein. Therefore, the prospects for egg consumption are discouraging in the future.

The results of the egg supply equation estimated based on annual data (model I) were quite satisfactory, although the t-value of coefficient of the trend variable was not significant. The calculated price elasticties for egg supply in short run and long run were 0.084 and 0.167, respectively. These values were relatively small. The coefficient of expectation, $1-b_2$, was 0.167. This indicated that current supply was influenced by the supply in the previous year more than change in egg prices. The estimated coefficient of T was relatively small. Therefore, the technical progress of the egg industry may not have been so rapid during the period of this analysis. This coincides with a report on stagnation of scale economy in the egg industry.[4)]

Finally, the estimated coefficients in model II were all significant. The results indicated that the effects of changes in feedstuff prices on the variation in supply volumes were relatively large. The price elasticities in short run and long run calculated from model II were smaller than those of model I. According to the recent decline in egg prices, it was considered that the supply volumes for eggs were affected by change in feedstuff prices in the short term because egg producers had to adjust costs of production. The calculated coefficient of expectation was 0.416, larger than that of model I. The influence of previous supply volumes

Table 2 Estimated results of egg demand and supply equations

model	parameter					R^2	DW
	a_0	a_1	a_2	a_3			
demand	−1.130	−0.177	0.423	−0.078		0.866	0.328
	(−0.357)	(−3.472)	(1.713)	(−2.097)			
	b_0	b_1	b_2	b_3			
supply I	2.487	0.084	0.833	0.007		0.978	1.829
	(0.528)	(2.122)	(2.504)	(1.232)			
	c_0	c_1	c_2	c_3	c_4		
supply II	5.647	0.041	0.584	−0.148	0.033	0.755	2.176
	(5.430)	(2.161)	(7.681)	(−4.026)	(4.695)		

1) T-values are in parentheses.
2) R^2 is the collected coefficient of determination.
3) DW is the Durbin-Watson statistic.

of current eggs on the decision of egg supply in model II was smaller than that in model I. The coefficient of T was relatively small.

A main difference between supply model I and II was a different response to feedstuff prices. On the whole, the coefficients of these two supply models to be estimated indicated the similar responses to egg prices and time trend. The model II was considered to be theoretically better than model I.

Conclusion

The developmental process of the egg industry in Japan could be classified into four stages since 1955, that is, (i) the period of stable growth from 1955 to 1964, (ii) the period of structural change from 1965 to 1973, (iii) the mature period from 1974 to 1979 and (iv) the period of formation of specialized production areas from 1980 to today. This study focused on demand and supply for eggs at the stages of (iii) and (iv).

Price and income elasticites for egg consumption were both found to be inelastic. The estimated coefficient of time trend, which was considered to indicate changes in tastes over time, was negative. Therefore, it may be concluded that egg consumption in Japan has become saturation.

For egg supply on the other hand, two types of supply models were estimated. Annual data were used in one type (model I) and monthly data in the other type (model II). Estimated elasticities of egg prices and coefficients of time trend were small in both models. Therefore, egg supply may be inelastic to change in egg prices, and technical progress of the egg industry in Japan was not so rapid at stages of (iii) and (iv). The coefficient of feedstuff prices in model II was smaller than that in model I. With the recent decline in egg prices, the supply for eggs was considered to be affected by feedstuff prices in the short term because egg producers had to adjust costs of production costs. Generally, egg production is adjusted to changes in economic environments every six months, a period of reproduction of layer. Accordingly, model II based on monthly data may be a better estimate than model I.

References

1) Sawada, M.: A Hierarchical Model of Demand for Food in Japan. *Journal of Rural Economics*, **56** 163-173 (1984)

2) Shimizu, T.: An Econometric Analysis on the Egg Supply Process. *Journal of Rural Problem*, **14** 22-29 (1978)

3) Sugiyama, K.: *Layer Production and Management Theory*. Meibun Publisher, Tokyo (1981) pp. 1-54

4) Yamamoto, Y. and Kuroyanagi, T.: Technical Change on Japanese Hen Egg Production, 1964-83. *The Review of Agricultural Economics Hokkaido University*, **42** 1-28 (1986)