アメリカにおける卵価形成の計量分析

誌名	日本家禽学会誌
ISSN	00290254
著者	平児, 慎太郎 杉山, 道雄 荒幡, 克己
巻/号	36巻4号
掲載ページ	p. 236-244
発行年月	1999年7月

Econometric Analysis of Egg Pricing in USA

Shintaro HIRAKO, Michio SUGIYAMA*, Katsumi ARAHATA**,
Katsuyuki OGURI*** and Masakazu NAGAKI****

The United Graduate School of Agricultural Science, Gifu University
* Gifu City Women's College, Gifu, Japan
** Faculty of Agriculture, Gifu University, Gifu, Japan
*** Faculty of Regional Studies, Gifu University, Gifu, Japan
**** Institute of Agriculture and Forestry, Tsukuba University, Ibaraki, Japan

The purpose of this study is to clarify the effect and role of egg products on shell egg price in USA. In order to do it, the econometric model by Nagaki and USDA "Poultry Yearbook" was utilized.

The background of this study is as following :

Under the trend of changing the commodity style of egg and increasing egg products share in Japan, regarding the market in USA as a front type which this trend is already typical, and discuss the development of egg pricing in Japan, utilizing egg pricing model including egg products. For example, SUGIYAMA (1993) indicated that the egg consumption in every country has a shift of table eggs or shell eggs in which cracked egg market both in export and domestic has expanded and the products share has reached 35–40%. Particularly, this trend in USA is typical of many countries.

The motive of this study which is based on the actual condition such as the above mentioned, is as following :

Firstly, to analyze the relationship between table eggs and processed eggs, in other words, the shell egg market and the egg products market, including as the interrelationship between them.

Secondly, what effects the price formation for processed agricultural commodities.

Thirdly, what considerations the development of market structure under increasing egg products share.

The result was that egg products is a definite factor on the shell egg price. Market participants indicate that egg products achieve a function as price stabilizer, in other words, a buffer in the egg market, however the framework of this analysis is not a result to refer to it directly. We must recognize the limitation of this model, however we can consider that effect of egg products will be more important in shell egg pricing, unifying with the result of estimation and existing state of things.

*(Jpn. Poult. Sci., **36** : 236-244, 1999)*

Key words : Egg pricing, Econometric model, Shell egg, Egg products, Buffer

Introduction

The purpose of this study is to clarify the effect and role of egg products on shell egg price in USA.

The background of this study is as following :

Under the trend of changing a commodity style of egg and increasing egg products share in Japan, we regard the market in USA as a front type which this trend is already typical, discuss the development of egg pricing in Japan, utilizing egg pricing model

Received July 17, 1998 Accepted February 24, 1999

including egg products.

The motive of this study which is based an actual condition such as the above mentioned, is as following :

Firstly, to analyze the relationship between table eggs and processed eggs, in other words, shell egg market and egg products market, including the interrelationship between them.

Secondly, what effects the price formation for processed agricultural commodities.

Thirdly, what considerations the development of market structure under increasing egg products share. For example, SUGIYAMA (1993) indicated that the egg consumption in every country has a shift of table eggs or shell eggs which cracked egg market both in export and domestic, has expanded and the products share has reached 35-40%. Particularly, this trend in USA is typical of many countries. Incidentally, the definition of egg products in this analysis are eggs which have undergone the primary processing (for example, liquid eggs, dried eggs). SUZUKI *et al.* (1997) indicates a clear classification of egg products including the definition.

This is the historical detail of egg products' position in egg market. Under the surplus trend of the egg market in USA, which resulted due to development of large-scale egg production and integration, a technique for egg products utilization has been developed by the egg related industry relatively reduces the supply of the shell egg market. Shell egg pricing is affected by the market isolation, such as in egg processing.

The center point at issue about the egg market in the review of previous research in agricultural economics and poultry economics, was to extract the fluctuations in price, egg cycle, by utilizing some methods of time-series analysis. For example, case study analysis of egg market in Japan, OGURI *et al.* (1992) clarifies a cause and effect relationship of egg pricing, utilizing auto regressive model and multiple regression equation model. Case study analysis of it in USA, HARTMAN, D.G. (1974) extracts the fluctuations in price of the egg cycle, utilizing a methods of time-series analysis, ROGERS, G.B. and L.A. VOSS (1971) examines the outline of egg pricing in USA, utilizing a method of econometrics. NAGAKI (1996), investigated egg pricing in Japan, utilizing simultaneous equations model. The analysis is full of useful suggestions for this analysis, including the methodology and the result of estimation, although he did not consider the effect and the role of egg products enough.

Materials and Methods

Framework of methodology

The method of this analysis is done by using simultaneous equations model, which is a staple method of econometrics. The simultaneous equations model is that the description simultaneous equations system, as a mutual relationship between economic variables rather than a unilateral cause and effect (BAN *et al.* 1989), and every optimal result of some regression equations including common variables is considered as retaining total equilibrium.

Under the provision of purpose and range, the economic variables used in the

simultaneous equations model, is defined as following : ① Endogenous variable : economic variable determined inside the model ② Exogenous variable : economic variable determined outside the model ③ Predetermined endogenous variable : endogenous variable including time lag. The purpose and range is as following : In the general concept of simultaneous equations model, a mutual relationship between economic variables is simplified corresponding it's purpose, even if a case that exogenous variable is affected by endogenous variable, so far the purpose is affected by it, it must be regarded. And, in accordance with the aforesaid purpose of this analysis, the relationship of economic variables is indicated model in Figure 1.

Considering the structure of egg price fluctuation in the short run, there were some implications for egg pricing in the long run and forecasting. The more observe egg price fluctuation in the short run, the more definite that there is a factor of simultaneous determination in the response of market, and the simultaneous estimation method should be utilized. However, considering the identification problem and defect of statistics, the characteristics of egg such as independent goods, there are some limitations. The price determination in the market is prescribed by the experiential behavior, which is including predetermination indexes, and taking precedence building more realistic model, it is appropriate that OLS (ordinary least squares) in recursive model is utilized.

Normally, there is a premise that explanatory variable is independent of error

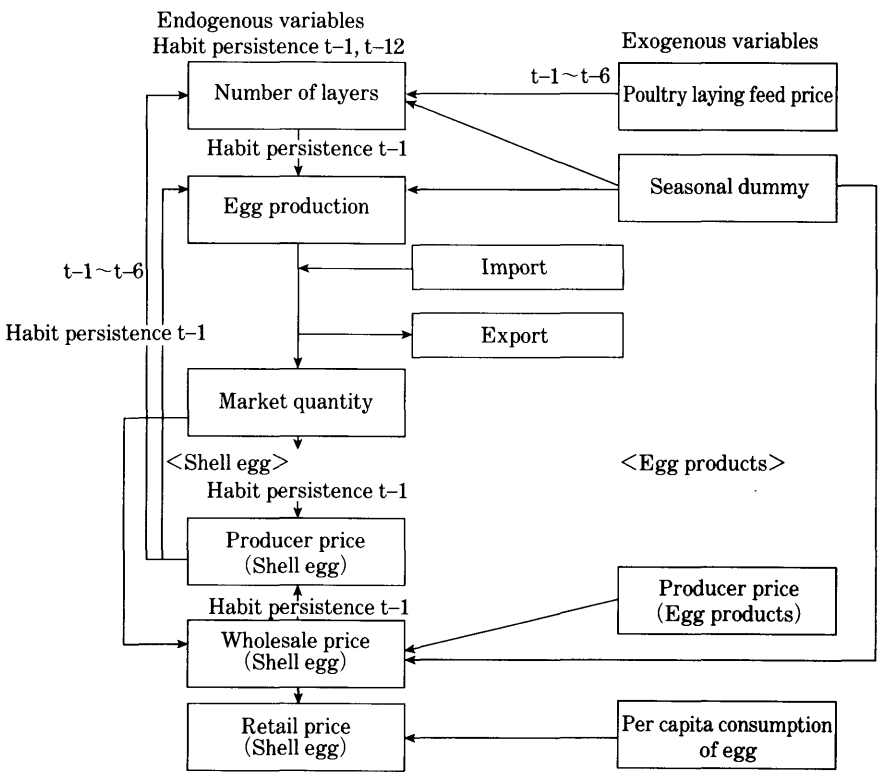

Fig. 1. Relationship of variables

term. When one of the explanatory variables is an endogenous variable, this premise is failed to materialize. For solving simultaneous equations model of simultaneous determination, it is a limitation. Therefore the premise of traditional regression equations falls down because of a limitation to estimate by the OLS. However the simultaneous equations model of this analysis includes the factors for successive determination, so there is no interference utilizing an OLS.

The verification about methodology of this analysis is modified NAGAKI (1996), investigated egg pricing in Japan, utilizing the simultaneous equations model, there is described as Nagaki Model. In spite of that Nagaki model is a simple simultaneous equations model, it indicates a fine result of estimation. We used it with a modified selection of variables and function system. However there are some different points in method and item of research, which must be estimated with careful consideration.

The statistics used for this analysis are from the USDA "Poultry Yearbook", however, they have some defects. Therefore, we had to consider the case that used predetermined endogenous variables, the period of analysis was of January 1984 to December 1995. The variables used and their units appear in Table 1.

Function System of Empirical Model

The outline of function systems are as following :

(1) Function of the number of layers

The index that prescribes egg production is the function of the number of layers. It is conjectured that the process of decision making for the number of layers is

Table 1. List of the variables used

Classification	*Names*	*Unit*	*Abbreviations*
Endogenous variables	Number of layers	Thousands	NL
	Egg production	Millions	EG
	Market quantity	Millions	MQ
	Producer price (Shell egg)	Cents per dozen	PP
	Wholesale price (Shell egg)	Cents per dozen	WP
	Retail price (Shell egg)	Cents per dozen	RP
Predetermined endogenous variables	The same as the above		
Exogenous variables	Import	1,000 dozen (Shell egg equivalent)	IM
	Export	1,000 dozen (Shell egg equivalent)	EX
	Poultry laying feed price	Dollars per ton	FP
	Producer price (Egg products)	Cents per dozen	PP_{EP}
	Per capita consumption of egg	Number	EC
	Seasonal dummy (Monthly)		SD

prescribed by the following : ① the controlling factor of latent fluctuation ② predicting the functions necessary for it's occurrence.

The former is found in the investment of fixed capital for optimal process between occupation of input and productivity. In other words, it is the habit persistence. To explain it, the number of layers in the previous month from the selected month and the 12th month prior to the selected month (NC_{t-1}, NC_{t-12}) are used and seasonal fluctuation is explained by using a seasonal dummy.

The latter is found out in the decision making process in egg production. For egg production, it is conjectured that the fluctuations in chicks and feed price and final egg price from introduction of day old chicks to starting to lay eggs. To explain it, thoroughly, one of the feed prices from the previous month from the selected month to the preceding 6 months, and producer price of shell eggs for the same period ($FP_{t-1\sim t-6}$, $PP_{t-1\sim t-6,}$) were used.

(2) Function of egg production

The index that prescribes egg production is the function of the number of layers. Restricted by the lack of a data of the number of layers in Japan, NAGAKI (1996) conjectures it indirectly, as for the number of chicks there is a time lag going from starting to lay eggs, being chicks arriving at the peak of laying egg, then finally to doing away with the layers. However, using a data from USDA, this study uses it directly to measure more simply.

It is believed that commodity egg prices, egg production in the previous month from the selected month, and seasonal fluctuation (PP_{t-1}, EG_{t-1}, SD), and the affect on egg production.

(3) Function of wholesale price

The egg pricing process consists of price finding, formula or negotiated and finally determining the price. For example, egg prices are formed by three organizations in Japan, Zennoh, Toyo and Tokyo-Keiran Ltd. Between egg traders, producers and retailers, the egg price is negotiated or formula method according to the market is used.

Still, it is well considered that there is mutual inter-reaction in the final determination between shell egg wholesale price and egg products price. For the index to explain about the future market of egg in USA, egg products wholesale price is needed. However for convenience, egg producer price : Breaking eggs (Heavy nest run) : Price paid to producer at plant in Central States for trucklot is used. Incidentally, KAKU (1997) used the wholesale price in New York City for Grade A large, egg products is Breaking eggs (Heavy nest run) : Price paid to producer at plant in Central States for trucklot. In this analysis egg products producer price is regarded as the exogenous variable rather than the endogenous variable.

Under the premise such as stated above, it is estimated by market quantity (MQ), egg products producer price (PP_{EP}), wholesale price in the previous month from the selected month as a habit persistence (WP_{t-1}), and seasonal dummy (SD).

(4) Function of retail price

Retail price is affected by wholesale price. It is explained by wholesale price (WP) and per capita consumption of egg (EC).

(5) Function of producer price

It is conjectured that producer price is affected by wholesale price, same as retail price. And as habit persistence, producer price in the previous month from the selected month (PP_{t-1}) is added to.

(6) Function of market quantity

This is a definitional equation in this model. Market quantity (MQ), in other words, net domestic circulation quantity is that egg productions (EG), adding to import (IM), and deducting export (EX).

Function of the number of layers	$NL=f(NL_{t-1}, NL_{t-12}, FP_{t-1\sim t-6}, PP_{t-1\sim t-6}, SD)$
Function of egg production	$EG=f(NL, PP_{t-1}, EG_{t-1}, SD)$
Function of wholesale price	$WP=f(MQ, WP_{t-1}, PP_{Ep}, SD)$
Function of retail price	$RP=f(WP, EC)$
Function of producer price	$PP=f(WP, PP_{t-1})$
Function of market quantity	$MQ=EG+IM-EX$

Result of Estimation

The results were obtained using the model in the previous section. Still, the method of the estimation is OLS, utilizing a logarithmic function model. Therefore, every explanatory variable has a coefficient of elasticity. Table 2 shows suitable conditions and level of significance (t-value), coefficient of determination (adjusted for degree of freedom) to effect a composite result, we can confirm the effect of seasonal dummy by inserting it into the function.

For the following functions, we will describe some particular items necessary for optimal results.

(1) Function of the number of layers

$$\log NL = \underset{}{0.113} + \underset{(29.630)}{0.939}\log NL_{t-1} + \underset{(1.324)}{0.040}\log NL_{t-12} - \underset{(-0.304)}{0.002}\log FP_{t-4} + \underset{(0.853)}{0.003}\log PP_{t-1} \quad R^2=0.942$$

The main factor for the egg production is determined by number of layers in the previous month from the selected month but number of layers in the 12th month is

Table 2. Result of estimation (Method by OLS)

(1) Function of number of layers

$$\ln NL = 0.113 + 0.939\ln NL_{t-1} + 0.040\ln NL_{t-12} - 0.002\ln FP_{t-4} + 0.003\ln PP_{t-1} \quad R^2=0.942$$

(2) Function of egg production

$$\ln EG = 0.004 + 0.824\ln NL - 0.035\ln PP_{t-1} - 0.181\ln EG_{t-1} \quad R^2=0.300$$

$$\ln EG = -0.477 + 0.815\ln NL - 0.016\ln PP_{t-1} - 0.045\ln EG_{t-1} - 0.037 D_2 \quad R^2=0.649$$

(3) Function of wholesale price

$$\ln WP = -0.524 + 0.189\ln MQ + 0.308\ln WP_{t-1} + 0.461\ln PP_{EP} \quad R^2=0.812$$

$$\ln WP = -0.326 + 0.160\ln MQ + 0.316\ln WP_{t-1} + 0.434\ln PP_{EP} - 0.041 D_5 - 0.011 D_6 \quad R^2=0.846$$

(4) Function of retail price

$$\ln RP = 0.555 + 0.782\ln WP - 0.050\ln EC \quad R^2=0.843$$

(5) Function of producer price

$$\ln PP = -0.541 + 0.977\ln WP - 0.2540\ln PP_{t-1} \quad R^2=0.932$$

(6) Function of market quantity

$$MQ = EG + IM - EX$$

insignificant. The egg production material price and final egg price affect the decision making process in egg production. However feed price before 4th months from the selected month and producer price before the 1st month were examined but those two combined effects are insignificant and we can disregard them. Still, every explanatory variable includes intrinsic of seasonal fluctuation, it is impossible to extract it with independence.

(2) Function of egg production

$$\log EG = -0.477 + \underset{(10.101)}{0.815}\log NL - \underset{(-1.493)}{0.016}\log PP_{t-1} - \underset{(-0.749)}{0.045}\log EG_{t-1} - \underset{(-11.824)}{0.037}D_2 \qquad R_2 = 0.649$$

The function of egg production can be easily inferred on the analogy of the relationship between egg production and the number of layers. This is reflected in the results of estimation, egg production is greatly affected by it. The effects of commodity egg price in the previous month from the selected month, seasonal fluctuation of egg production are slight. However, because of decreasing egg laying in February, seasonal dummy (dummy of February) was inserted.

(3) Function of wholesale price

$$\log WP = -0.326 + \underset{(1.264)}{0.160}\log MQ + \underset{(6.109)}{0.316}\log WP_{t-1} + \underset{(12.256)}{0.434}\log PP_{EP} - \underset{(-5.414)}{0.041}D_5 - \underset{(-1.325)}{0.011}D_6 \quad R^2 = 0.846$$

The factor of the wholesale price is affected by increasing or decreasing of market quantity the result is slightly negative. It was substantiated that the wholesale price and producer price of egg products in the previous month from the selected month affect on it. However, because of depreciation of wholesale price in May and June, seasonal dummies (dummy of May and June) were inserted.

(4) Function of retail price

$$\log RP = 0.555 + \underset{(27.548)}{0.782}\log WP - \underset{(-1.179)}{0.050}\log EC \qquad R^2 = 0.843$$

The factor of the retail price is greatly affected by the wholesale price. The effect on per capita consumption is slight, but negative.

(5) Function of producer price

$$\log PP = -0.541 + \underset{(24.371)}{0.977}\log WP - \underset{(8.173)}{0.2540}\log PP_{t-1} \qquad R^2 = 0.932$$

The factor of the producer price is greatly affected by wholesale price. It can be substantiated that the effect is in the previous month.

(6) Function of market quantity

$$MQ = EG + IM - EX$$

Conclusion

Utilizing empirical model as stated above, each function of egg pricing was estimated. It generally indicates a relationship of Figure 1, in spite of utilizing a simple simultaneous equations model.

Egg pricing in USA is clarified as following :

Firstly, shell egg wholesale price is the main factor of egg pricing, it affects both the demand side and supply side, in other words, the retail price and producer price are extremely influenced by it.

Secondly, egg products price is strongly related to egg wholesale price. It is inferred that egg products producer price will be an important factor in shell egg wholesale price in the future, unifying with result of estimation and existing state of things. Market participants indicate that egg products achieve a function as price stabilizer, in other words, a buffer in the egg market, however the framework of this analysis is not a result to refer to it directly. Egg products producer price is regarded as one of the exogenous variables in this model. However, if we appraise the effect and the role of egg products on shell egg price essentially it will be regarded as one of the endogenous variables. This is a limitation of this model and necessary to improve it.

Thirdly, the effect that the shell egg wholesale price is affected by increasing or decreasing the market quantity is slight and negative. This model is built on the assumption that based on successive determination, total supply is a premise habitual. It is inferred that trend affects on it over an extended period of time, but is not affected by it in the short run.

Fourthly, the effect that per capita consumption affects on is slight, though negative. Because of monthly data, it is inferred that the trend of consumer behavior in the short run is unexpected or its affect on retail price is underestimated. Response is found to be the trend of consumer behavior which is over an extended period of time. Still, the absolute value is low, it is inferred that price elasticity of demand of egg which is one of the staple foods is gradually lowering, can instead be linked to food consumption.

Fifthly, the effect of the net market quantity : egg production adding to import and then deducting export, affects on shell egg wholesale price is slighter than the effect of number of layers on egg production. In other words, it will be more stable than increasing or decreasing of market quantity affects on shell egg wholesale price. Increasing or decreasing of it acts as a buffer function.

Considering these points, it will be necessary for further studies.

References

BAN, K., NAKAMURA, J. and ATODA, N. (1989) Econometrics. Yuhikaku Co., Tokyo

HARTMAN, D. G. (1974) "The Cycle and the Ability of Recursive Models to Explain It" Amer. J. Agr. Eco. 56-2 : 254-262

KAKU, K. (1997) "Management of Business Risks by Broiler and Egg Futures Markets in the U. S." Journal of Food System Research Vol4-2 : 43

NAGAKI, M. (1996) "Econometric Analysis of Egg Pricing in Japan" Current Poultry Industry in Japan : 135-177

OGURI, K., ADACHI, H., YI, C., CHO, Y. and SUGIYAMA, M. (1992) "Study on Egg Price Forecasting in Japan" Res. Bull. Fac. Agr. Gifu Univ. (57) : 157-164

ROGERS, G. B. and L. A. VOSS (1971) Readings on Egg Pricing College of Agriculture University of Missouri-Colombia

SUGIYAMA, M. (1993) Egg Economics in the World. Fuminkyokai, Tokyo

SUZUKI, M., ARAHATA, M., SUGIVAAMA, M. and OGURI, K. (1997) "Shell Eggs Products Utilization in the Food Processing Industry" Res. Bull. Fac. Agr. Gifu Univ. (62) : 75-84

アメリカにおける卵価形成の計量分析

平児慎太郎・杉山道雄 *・荒幡克己 **・小栗克之 ***・永木正和 ****

岐阜大学大学院連合農学研究科
* 岐阜市立女子短期大学
** 岐阜大学農学部
*** 岐阜大学地域科学部
**** 筑波大学農林学系

本研究は，アメリカにおける鶏卵市場を事例とし，卵価形成における加工卵の影響とその役割を究明したものである。

本研究の背景として，既に杉山（1993）が指摘するように，先進国における鶏卵消費は，従来の殻付卵のみの消費形態から，割卵された鶏卵のウェイトが増大しつつあり，加工卵の割合は35-40%に到達する様相を呈している。特に，この傾向は，アメリカにおいて顕著に認められることから，それを他の諸国と比して先行的な事例と見なしつつ，加工卵のウェイトが大きい市場における卵価形成のメカニズムを解明することとした。

本研究の分析方法は，永木による計量経済モデルに依拠しつつ，逐次方程式モデルによって卵価と，それに影響を与える採卵鶏飼養羽数，鶏卵生産量，出回量等との関係を計測した。関数形は両対数関数とし，最小二乗法（ordinary least squares method）を適用した。故に，係数は直ちに弾力性を示す。関数体系は，構造方程式5本（採卵鶏飼養羽数関数，鶏卵生産量関数，卸売卵価関数，小売卵価関数，生産者卵価関数），定義式1本（出回量）である。殻付卵の価格，および採卵鶏飼養羽数，鶏卵生産量，出回量，飼料価格，国民一人当たり鶏卵消費量，輸出入量などのデータは，アメリカ合衆国農務省（USDA）"Poultry Yearbook"より1984年1月～1995年12月までの月次データとした。

分析の結果，殻付卵の卸売卵価の規定関係を示す式では，加工卵の価格の係数が0.434となり，両者の間に強い関係が認められた。本関数の中で最も強く作用する要素であった。また，殻付卵の小売卵価がその卸売卵価に強く影響を受けていることは容易に推測出来たが，国民一人当たり鶏卵消費量の影響はほとんどなく，鶏卵の価格形成がsupply sideで決定されていることを明示する結果となった。以上のことから，殻付卵の卵価形成において加工卵が重要な要素となり得ることが明らかになった。

市場関係者によれば「加工卵が殻付卵需給の緩衝（buffer）機能を果たしているのではないか」という旨の指摘がなされている。本分析の結果は，明示的にこのことを検証するものではないが，現状を併せ見れば，加工卵が殻付卵の卵価形成に及ぼす影響は今後ますます大きくなるものと考えられる。

（家禽会誌，***36*** : *236-244*, *1999*）

キーワード：卵価形成，計量経済モデル，殻付卵，加工卵，緩衝