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1. Introduction

1-1. *Purpose and Objective*

This paper focuses on market conditions in Japan's flower market. The primary subject of this paper is how Japanese consumer behavior affects the flower market and how this, in turn, affects marketing approaches. We wanted to find out whether Japanese people behave rationally in the face of flower prices. If they do, we would advise stimulating the market with an economic-based policy. However, if they do not, a policy based on economic theory will not achieve the desired effect. We will analyze the flower market from the standpoint of rational behavior.

When we classified Japanese potted flowers into luxury varieties and popular varieties, we created the following typology : tropical orchid, cyclamen, chrysanthemum, primrose, begonia, and dendrobium.

The second objective of this study was to analyze whether consumption of the luxury varieties and popular varieties follow rational behavior that maximizes utility. As an original methodology used in this paper, we take the standard deviations between the actual and optimal values of growth in consumption of these potted plants and compare them to see if these deviations show whether consumers are behaving rationally.

In synthesizing these results, the third objective was to discuss an appropriate structure for the flower market in the future. If, regarding the second objective, we find that rational behavior is not being followed to maximize utility ; we will investigate what needs to be done to achieve maximum utility.

The methodology herein will use an original model that we developed and revised to analyze the current flower market. The methodology is based on the system-wide approach of Theil (1980b). Its originality lies in our incorporation of the above-mentioned index.

1-2. *Literature Review*

The system-wide approach was explained thoroughly by econometrician H. Theil (1980a and 1980b). In this study, we formulate a demand equation. The demand for each consumer good is expressed in an equation consisting of differential small-declension variables. The merit of that theory is that it is not necessary to assume the one-order homogeneous function. In other words, we can do a more realistic analysis. However, merely introducing this theory and a simple example is inadequate for analyzing the actual flower market.

Kaneko (2009) is a pioneering analyst of Japan's flower market. We divide people into those who purchase flowers and those who do not. Those who purchase flowers take many factors into consideration, including the store, the price, appearance, the variety of flowers, and the flower's usefulness. In other words, consumer behavior is not rational from the standpoint of economics, as it can be swayed by factors that have nothing to do with price. Consumers may opt not to buy any flowers, notwithstanding the price. This paper investigates whether consumers behave rationally when purchasing potted flowers.

Knaneko, Wong L, Selvanathan E. A., and Selvanathan S., (2015) study consumers' rational behavior based on a system-wide approach. The system-wide approach they use analyzes the meat market in Australia on the premise that meat is consumed under conditions of rational behavior. However, an analysis such as this one, which compares rational and irrational behavior, has not been conducted previously.

2. Methods

2-1. *The Herfindahl-Hirschman Index*

The Herfindahl-Hirschman index is a measure of market concentration. The index can show whether a market has become concentrated around certain brands to the point of becoming an oligopoly. Expressing this as H, we get the following equation :

$$H = \alpha_1^2 + \alpha_2^2 + \alpha_3^2 + \cdots \qquad -(1)$$

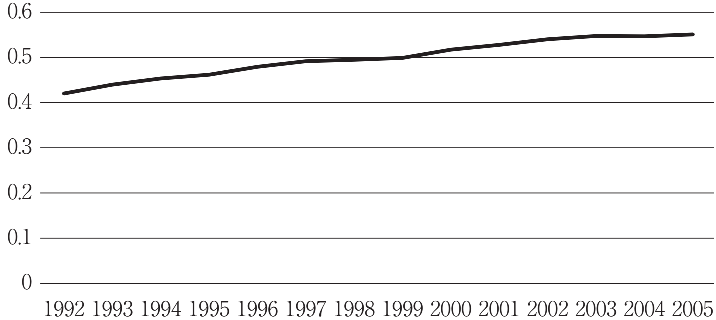
$\alpha 1$, $\alpha 2$, $\alpha 3 \cdots$ denote market shares. The larger the value, the greater the market concentration. Conversely, the smaller the value, the more competitive the market.

In Japan, flower varieties have had different uses, but these uses have recently become more diverse. We can use the Herfindahl-Hirschman index to analyze Japanese flower brands to find out whether the market is concentrated around certain brands. In other words, we can measure the degree of concentration in the Japanese flower market.

Here, in the flower market, H means the following : Although the use of different flower varieties has been determined in Japan, these rules have broken down somewhat in recent years. Tropical orchids were used for celebrations, but now they are also purchased for funerals, hobbies, and display. Investigating the size of H in Japan enables us to find out whether Japan's flower market is biased and gives us the opportunity to consider how the market for tropical orchids and other flowering plants should be ordered.

In this paper, let us first calculate this index for potted plants in Japan's flower market. The index is the sum of the squares of the market share for each brand. Figure 1 shows the values for Herfindahl's H for the six above-mentioned varieties.

Figure 1.　Herfindahl's H



The greater the differential in the brand strength of a flower and the greater the concentration in the more popular flowers, the greater is the value of H. Conversely, the more diffuse a flower's popularity and the less concentrated, the lower the value of H.

The value of H, which was 0.42 in 1992, rose to 0.55 by 2005. This means that the market became more oligopolistic. Let's examine this.

3. Model Analysis : Results

3-1. *Analysis Using a System-Wide Approach*

We apply the system-wide approach of Theil (1980a and 1980b). The demand equation for this theory can be expressed in the following relative price equations for the differential demand equation (2) :

$$w_1 d\ln q_1 = \theta_1 d\ln Q + \phi\theta_{11} d\ln\frac{p_1}{p_F} + \phi\theta_{12} d\ln\frac{p_2}{p_F}\cdots$$

$$w_2 d\ln q_2 = \theta_2 d\ln Q + \phi\theta_{21} d\ln\frac{p_1}{p_F} + \phi\theta_{22} d\ln\frac{p_2}{p_F}\cdots$$

$$\cdots\cdots$$

$$w_n d\ln q_n = \theta_n d\ln Q + \phi\theta_{n1} d\ln\frac{p_1}{p_F} + \phi\theta_{n2} d\ln\frac{p_2}{p_F}\cdots \qquad -(2)$$

Where :

q_1 : tropical orchid volume, q_2 : cyclamen volume, q_3 : chrysanthemum volume, q_4 : primrose volume, q_5 : begonia volume, q_6 : dendrobium volume, p_1 : tropical orchid price, p_2 : cyclamen price, p_3 : chrysanthemum price, p_4 : primrose price, p_5 : begonia price, p_6 : dendrobium price

In equation(2), $d\ln p_F = \theta_1 d\ln p_1 + \theta_2 d\ln p_2 + \cdots$ is the Frish price index, dlnQ is the Divisia quantity index, and $d\ln Q = w_1 d\ln q_1 + w_2 d\ln q_2 + \cdots$. Also, ϕ is income elasticity. Here w_i (I=1, 2, 3, …) stands for the share of the total budget (i. e., each good's share of the budget) , and θ_{ij} (I=1, 2, 3,… j=1, 2, 3, …) stands for the marginal share(i. e., the rate of increase in each good's share when the budget increases). Each of these must add up to 1, as follows :

$$w_1 + w_2 \cdots + w_n = 1 \qquad -(3)$$

$$\theta_1 + \theta_2 \cdots + \theta_n = 1 \qquad -(4)$$

The actual estimation is done according to the following absolute price equation. This is the same value as in the relative price equation :[1)]

$$w_1 dln q_1 = \theta_1 dlnQ + \pi_{11} dlnp_1 + \pi_{12} dlnp_2 + \cdots\ldots\ldots$$

$$w_2 dln q_2 = \theta_2 dlnQ + \pi_{21} dlnp_1 + \pi_{22} dlnp_2 + \cdots\ldots\ldots$$

$$\ldots\ldots\ldots\ldots\ldots$$

$$w_n dln q_n = \theta_n dlnQ + \pi_{n1} dlnp_1 + \pi_{n2} dlnp_2 + \cdots\ldots\ldots \quad -(5)$$

Here, we take the parameter restrictions of the Slutsky symmetry into consideration. Based on these restrictions, we estimate equation (5) using a limited three-stage least-squares method. The price corresponding to the sixth good, dendrobium, is subtracted from the second price variable, and there is no estimate for a sixth equation. This is because the parameters for the sixth equation are solved by the parameter restrictions.[2)]

Example

$$w_1 dln q_1 = \theta_1 dlnQ + \pi_{11} (dlnp_1 - dlnp_6) + \pi_{12} (dlnp_2 - dlnp_6) + \cdots\ldots\ldots$$

$$\ldots\ldots\ldots\ldots\ldots$$

$$w_5 dln q_5 = \theta_5 dlnQ + \pi_{51} (dlnp_5 - dlnp_6) + \pi_{52} (dlnp_5 - dlnp_6) + \cdots\ldots\ldots$$

$$-(5)'$$

The estimation results for equation (5) are as follows : The estimation period was 1992-2006.[3)]

Table 1. Estimation values of θ_i and π_{ij}

	Divisia quantity index θ_i	Tropical orchid price	Cyclamen price	Chrysanthe -mum price	Primrose price	Begonia price	Coefficient of determination
Tropical orchid	0. 7789	−0. 1026	0. 0508	0. 0141	0. 0084	−0. 0123	0. 9893
Cyclamen	0. 0789	0. 0508	−0. 0796	0. 0130	0. 0103	−0. 0108	0. 8016
Chrysanthemum	0. 0142	0. 0141	−0. 0228	−0. 0022	−0. 0022	0. 0102	0. 6288
Primrose	0. 0374	0. 0084	0. 0103	−0. 0022	−0. 0076	0. 0064	0. 5404
Begonia	0. 0164	−0. 0123	−0. 0108	0. 0102	0. 0064	−0. 0058	0. 1939

Table 2. Standard error

	Divisia quantity index	Tropical orchid price	Cyclamen price	Chrysanthe -mum price	Primrose price	Begonia price
Tropical orchid	0. 0210	−0. 1026	0. 0107	0. 0070	0. 0082	0. 0073
Cyclamen	0. 0171	0. 0107	0. 0107	0. 0055	0. 0065	0. 0053
Chrysanthemum	0. 0105	0. 0070	0. 0047	0. 0047	0. 0044	0. 0042
Primrose	0. 0113	0. 0082	0. 0065	0. 0044	0. 0067	0. 0045
Begonia	0. 0164	−0. 0123	0. 0053	0. 0042	0. 0045	0. 0055

The dendrobium figures are calculated as follows, using equation (4) and the restrictions in footnote 2:

Table 3. Dendrobium

	Divisia quantity index	Tropical orchid price	Cyclamen price	Chrysanthe -mum price	Primrose price	Begonia price	Dendrobium price
Dendrobium	0. 0742	0. 0416	0. 0163	0. 0029	−0. 0154	0. 0124	0. 0164

Therefore, the marginal share, which is the first parameter on the right in equation (5), is as follows:

$\theta_1 = 0.7789$ $\theta_2 = 0.0789$ $\theta_3 = 0.0142$ $\theta_{4i} = 0.0374$ $\theta_5 = 0.0164$

$\theta_6 = 0.0742$

Calculating the respective parameters and setting ϕ (i. e., the above parameter restriction and income elasticity) at −0. 5 gives the following : [4)]

Table 4. θ_{ij}

	Tropical orchid	Cyclamen	Chrysanthe-mum	Primrose	Begonia	Dendrobium
Tropical orchid	0. 8118	−0. 0402	−0. 0172	0. 0123	0. 0374	−0. 0252
Cyclamen	−0. 0402	0. 1654	−0. 0249	−0. 0177	0. 0228	−0. 0265
Chrysanthemum	−0. 0172	−0. 0249	0. 0046	0. 0049	−0. 0202	0. 0670
Primrose	0. 0123	−0. 0177	0. 0049	0. 0165	−0. 0122	0. 0336
Begonia	0. 0374	0. 0228	−0. 0202	−0. 0122	0. 0118	−0. 0232
Dendrobium	−0. 0252	−0. 0265	0. 067	0. 0336	−0. 0232	0. 0485

3‐2. *Flower Income Elasticity*

To find out which flowers are luxury varieties and which are popular varieties, we calculate their respective income elasticities. $\theta i/wi$ corresponds to income elasticity.[5)] Table 5 shows the income elasticity for each flower variety :

Table 5. Flower income elasticity

Tropical orchid	1. 1432
Cyclamen	0. 4325
Chrysanthemum	0. 7203
Primrose	1. 0819
Begonia	0. 5276
Dendrobium	1. 4592

An income elasticity of more than 1 indicates a luxury variety, and an income elasticity of less than 1 indicates a necessity. In this study, we also regard a number higher than 1 as indicating a luxury variety, and a number lower than 1 as indicating a popular variety. Thus, the tropical orchid and dendrobium are luxury varieties, while the cyclamen, chrysanthemum, and begonia are popular varieties. The primrose is somewhere between these groups.

Now, let's look at the change in share of these flowers. We will not look at time series data but at the average value of market share w_i to enable comparisons among flowers.

Table 6. Change in market share

	Tropical orchid	Cyclamen	Chrysanthe-mum	Primrose	Begonia	Dendrobium
1992	0. 6061	0. 2195	0. 0266	0. 0407	0. 0465	0. 0606
2006	0. 7293	0. 1653	0. 0144	0. 0272	0. 0231	0. 0407
Change	0. 1232	−0. 0542	−0. 0122	−0. 0135	−0. 0234	−0. 0199

Although the market share of tropical orchids has increased in monetary terms in terms of the number of plants from 1994 to 2004, annual production of tropical orchids exceeded 20 million. It then began declining, dropping to 16 million by 2015. Tropical orchids did not substantially change, but continued to be regarded as a luxury variety. Meanwhile, cyclamen production, which was 15 million in the early 1990s, has remained stable at 20 million since 2000.

3-3. *The Presence or Absence of Rational Economic Behavior*

We will now calculate the deviation between the actual values and optimal values of marginal shares. To do this, we calculated the number that corresponds to the actual marginal shares. Theil (1980b, p. 49) demonstrate how to calculate θ_i with respect to w_i, as follows :

$$w_i = a_i + b_i \ln Y \qquad -(6)$$

$$\theta_i = a_i + b_i (1 + liY) \qquad -(7)$$

Y : Total value of flower shipments (i. e., total consumption value).

We can calculate θ_i with respect to w_i for each year. These can be considered actual marginal shares. a_i and b_i are parameter values when the six flower types are measured with the above equations. We estimated the above equations using the ordinary least-squares method.

Table 7. Estimation value for parameters a and b in equation (6)
Estimation period : 1992-2006

	a	b
Tropical orchid	−0. 4511	0. 0454
Cyclamen	1. 1362	−0. 0383
Chrysanthemum	−0. 0095	0. 0011
Primrose	−0. 1689	0. 0082
Begonia	0. 5776	−0. 0219
Dendrobium	−0. 0814	0. 0053

Using these, we calculated the marginal share of each with the following equation : we calculated the deviation from the marginal share when utility is maximized (as with the marginal share found previously). The averages of their absolute values are listed in the table below :

Table 8. Deviation between the actual and optimal marginal share

Tropical orchid	Cyclamen	Chrysanthemum	Primrose	Begonia	Dendrobium
0. 0685	0. 8193	0. 3387	0. 1665	0. 3903	0. 2458

Tropical orchid and dendrobium, which we determined to be luxury varieties because of their income elasticity values, had low deviation values, while the popular varieties of cyclamen, chrysanthemum, and begonia had high deviation values. We found that consumers behaved rationally toward the luxury varieties, but behaved irrationally toward the popular varieties. We propose that rational behavior be adopted for popular varieties as well, so that producers can stabilize their operations and market activity can be stimulated further. In other words, as Kaneko (2009) concludes, we extrapolate that consumers are not influenced by the price of the latter, so they do not behave rationally, but make their purchasing decisions based on appearance and other preferences. Our paper could point to the need of marketers to elicit as much rationality as possible from consumers with respect to the popular varieties of flowers.

4. Discussion and Conclusion

This paper divided flowers into two types and found that consumer behavior toward each type differs.

These were the luxury varieties of tropical orchid and dendrobium and the popular varieties of cyclamen, chrysanthemum, and begonia.

In addition, with respect to the two types of consumer behavior, the reasons for buying the luxury varieties of tropical orchid and dendrobium were very clear, and consumers behave rationally when buying them. In contrast, for the popular varieties of cyclamen, chrysanthemum, and begonia, consumers did not behave rationally, but chose the plants based on their appearance, variety, and usefulness. One of the outcomes of this paper is that in identifying the two types (with cyclamen, chrysanthemum, and begonia being the popular types), we could prove that this behavior corresponded with the theory set forth in Kaneko (2009).

To stabilize product supply, consumers need to behave rationally in economic terms with respect to the popular varieties. Creating a market that conforms with economic theory will allow for an efficient supply and demand system to take hold. One way to do this is to promote consumption behavior influenced by prices, advertising, appearance, variety, and usefulness.

The problem we face is the limited data we have. The government stopped publishing its statistical survey of the flower business in 2006. Therefore, our analysis could be performed only for data up to 2006. A new picture of data estimates by variety will need to be drawn using market statistics and other sources.

Appendix: Data

Tropical orchid price

Statistical survey report on the flower business

Government statistics on potted plants (per plant, in yen)

Tropical orchid shipment volume

Annual statistics on crop acreage and shipments by item (1976-)

Ministry of Internal Affairs and Communications Statistics Bureau for data on potted plant shipments.

Capital: Statistics on floral product shipments

Area under cultivation (a)

Cost of capital: Bank of Japan Research and Statistics Dept.

Interest rate (yield on newly issued 10-year Japanese government bonds)

Labor force: Statistics on floral product shipments

Number of farms that produce each flower variety

Wages

Income per farm (total shipments divided by number of farms)

Footnotes

1) See Theil (1980b) pp. 29-33.

2) The Slutsky Coefficient is found with the following equations.

$\pi_{ij} = \pi_{ij}$

$\pi_{i1} + \cdots \pi_{in} = 0$

3) The data only go up to 2006 because that was the year of the last statistical report on the flower business. There are no data of the flower business after 2007 in Japan.

4) Theil's analysis uses −0.5 as income elasticity. See Mizuno (1998) p. 151.

5) See Theil (1980b) p. 18.

6) The statistical values are as follows.

	t value of constants	t value of coefficients	Coefficients of determination
Tropical orchid	−0.1439	0.361196	0.0099
Cyclamen	0.713981	−0.59937	0.0268
Chrysanthemum	−0.02068	0.063648	0.0003
Primrose	−0.45793	0.551721	0.0228
Begonia	0.811454	−0.76778	0.0433
Dendrobium	−0.15093	0.245168	0.0046

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