多様な食ベクトルを捉える需要分析の新展開

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はしがき

21 世紀に入って社会・経済構造は大きな変動期に直面している。まず、世界的な規模では地球環境問題への早急な対応がある。このためには持続的な発展ということが重要なコンセプトになっており、従来の効率重視の生産・消費から生活の質を向上しつつ経済レベルの維持を図ることが課題となっている。また、人口の高齢化の進展によって世帯構造も変化し、それに伴う食料需要構造の変化が予想される。さらに、女性の社会進出によって促されるライフ・スタイルの変化も食料需要構造を大きく変化させる要因である。

さて、近年農業及び農業経済の分野ではフード・システムが研究対象として大きくクローズ・アップされている。これは、生産から消費までを視野に入れようとするものである。従来生産面の研究実績が大半を占めていたことからすれば研究上の大きな変化であり、需要面の研究業績が少なかった農業経済学分野においては隔世の感がある。しかし、このような歴史的な経過とこれまで同様安易な方向に流れる農業経済学者の研究姿勢が原因で食料需要を計量的に分析する研究者は数少なく、このままでは将来のこの分野の研究発展に支障が生ずることが懸念される。

以上のように社会・経済構造の変動によって不可避といえる食料需要構造の変化や研究上の後継者不足に対応するために、計量的な食料需要分析のフロンティアを明確に示し、かつ、その意義を明らかにすることが本研究の目的である。

本研究の特徴とその意義は次のようにまとめることができる。

（1）本研究は、前年度研究代表者である佐々木康三氏中心とした研究メンバーがこれまで精力的に行ってきた計量的な手法に基づく食料需要研究分野におけるの研究の体系化を目指すことを意図した。

（2）本研究では、計量的な食料需要分析のみならず、「食」が人間にとってどのような意義を持つのかといった倫理的側面、さらには食文化をも考慮するという研究を併せておこなった。したがって、本研究はより広い視野のもとに今後の食料需要分析のフロンティアを明示しようという積極的な意義を持つ。

しかし、当初の目標に照らして得られた成果はきわめて不十分なので、研究の進展を促すには本報告書を読まれた方が忌憚のないご批判を寄せて頂くことが不可欠と思われる。

昨年 11 月、研究分担者である藤田夏樹氏が研究半ばにして急逝されたことは今もって痛恨の極みである。しかし、闘病中の同氏の真摯な研究態度は、この世に残された我々にとって励みとなるのみならず、我々の「生」に大きな力を与えてくれることを信じている。

なお、本研究成果報告書の作成は、大森夕美子さんの手によるものである。記して感謝したい。また、研究協力者を含めた研究組織と研究費の交付決定額は次頁の通りである。

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Contents

I A Recent Japanese Food Demand Analysis
A Review

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In this paper, we focused on some of most recent studies on Japanese food demand by reviewing the literature of past 10 years or so. We limited health and food safety, Japanese style of diet, scanner data(POS data) analysis , and other demand analysis.

1.Health and Food Safety

Hasebe, Chern,and Ito [2] made a cholesterol index and analyzed a demand for milk and milk products by using this index.

Sawada[19] analyzed the impacts of *Bovine Spongiform Encephalopathy*(BSE) scare and *Escherichia coli* (E.coli) O157:H7 outbreak on household demand for fresh meat. The perceived safety of meat is assumed to be a function of safety/risk information available to households. Availability of safety/risk information on fresh meat is proxied by measuring the news coverage of BSE scare *E.coli*O157:H7 outbreak by the major newspapers in Japan, during the period of May 1985 to October 1997. His result suggested:(1) that the news coverage of BSE scare has a significant impact on purchase of beef at one month time lag, and that of *E.coli*O157:H7 outbreak causes declines in purchases of beef, ground meat and "other fresh meat"(mainly,liver),but these news have shown no evidence of such effect for pork and chicken,(2)that there is no asymmetry in risk information effect between period of increasing and decreasing news coverage, and that the structure of fresh meat demand is not changed before and after these event,and(3)sixty to eighty percent of the observed change rate of beef consumption is due to BSE scare and *E.coli* O157:H7 information effects during the April to September 1996 period. These information effects are found to overwhelmingly exceed price and income effects on household demand for beef during the period.

Takeshita[20] focused on the links between health information related to food consumption and food consumption behavior. The impact of health risk information on salad oil consumption is investigated. Measurement of information is expressed in terms of the number of relevant articles on health risk topics in major newspapers in Japan. In recent years Japanese salad oil consumption has not changed drastically, but rapeseed oil and safflower oil consumption have grown steadily. The applied model in this study is based on a discrete/continuous model and the results of cointegration analysis indicate that there is a long equilibrium relationship among health risk information, salad oil consumption and salad oil price. The relevant estimated coefficient implies that increasing health risk information has caused so-called premium oils, such as rapeseed oil or safflower oil, consumption to increase in the long term. The hypothesis that consumers never decrease
health risk perception but increase it as additional health information is obtained over time is supported.

Oniki[17]estimated the dynamic change of the evaluation for food safety of consumer by using LA/AIDS model. He used WTA(Willingness To-Accept compensation) for evaluation for food safety. and applied this method the E-coli and BSE crisis case. The result suggested anxiety for beef safety increased instantly and then fell soon. But the

anxiety remained for long time. WTA for pork and chicken did not nearly change

2.Japanese Style of Diet

Kodama[10]evaluated the formation and diffusion of Japanese style of diet. But the long term effects have not been evaluated. The data used in this chapter is Japanese nutritional intake, which I use to formulate a time series model. He chose the ideal PFC balance to measure the formation and diffusion of Japanese style of diet. It is useful to show the mutual relationship of proteins, fat and carbohydrates, so he use a vector or correction model. He also consider cointegration to show that long term As a result of estimation, the hypothesis of stability was rejected when he used the data from 1955 to 1995. So he divided the data and tested again. The results of the estimation show that the ideal PFC balance has diffused fron1975 to 1995.

Ishibashi[5] analyzed the changes the Japanese diet and future demand for food products. The individual by age groups consumption of rice, fresh fish, fresh meat, fresh milk and milk products, fresh vegetables and fresh fruits were estimated from the early 1980s to the middle of 1990s. Panel data of approximately 96,000 Households per year of *Family Income and Expenditure Survey*(FIs) were used. The multiple regression model expressed monthly consumption of chosen commodity by a j-th household(dependent variable) as a linear function of the j-th household's number of family members by age groups(independent variable).At home consumption of beef by teen-agers increased the fastest: up 65% and those in their forties to sixties also increased substantially:20% over this period. Fresh milk increased greatly among the elderly:60-70%. Among young people, at home consumption of fresh vegetables and fruits declined gradually:25%,70% respectively over the same period. Extrapolating the trends consumption by age groups from the early 1980s to the middle of 1990s,demand was forecast for the year of 2010 considering the age composition of future society. The demand at home of rice and fresh fish is estimated to decline greatly(approximately 40%,10% respectively),while that of fresh meats(5%) and fresh milk(30%) is estimated to increase in 2010. The demand at home of fresh vegetables(5%) and fresh fruits(10%) will decrease. These findings may suggest that Japanese people will continue to move in diet toward the western nations in the future.

Tokoyama[21] considered "maturity" in food consumption in Japan, analyzed the relationship between trends and income elasticity of about 130 individual food items during 1969-1993,and indicated that the disappearance of or weaker trends in per capita consumption of individual food item and weaker influence of income or budget restriction on food consumption.

3.Scanner Data Analysis

Kawamura[9]analyzed demand for margarine at the brand level, and estimated LA/AIDS model for margarine utilizing scanner data(POS data) from 65 regional markets in the United States in 1992.the main results 1)own price elasticities at brand level are larger than the past analysis of commodity groups of food.2)
cross price elasticity has shown substitution between two brands produced by single company.3)private brands have a somewhat isolated market position with other brands.4)the top brand has the highest expenditure elasticity, suggesting its characteristic as a superior good.5)this paper has shown usefulness and significance of

demand analysis at the brand level, some problems(data coverage, range of commercial area, research cost)for conducting this type of research using Japanese data.

4 .Other Demand Analysis

Furutsuka,Yamashita,and Matsubara [1]analyzed the trend of demand and the regional disparity of demand for Welsh onions.

Ishibashi[3]estimated individual consumption of 20 vegetables by age groups and analyzed panel data(FIES)in regression analysis and used the number of persons in each age group of each household as independent variable. And she forecasted future vegetable demand by age groups.

Ishibasi[4] analyzed beef demand by using the same method in ishibashi[3].

Ishida,et al[6]analyzed the changes of food demand in Indonesia and the results suggested that Engele coefficient is declining in rural and urban area and that indicated the changes food demand pattern.

Kajikawa[7]investigated the impact of lifting the ban on import of fresh apples to Japan, indicated the fact the Japanese consumers have a tendency to distinguish among the characteristics of apples clearly.

Kajikawa[8]analyzed which apple characteristics could be used to explain the variation in prices by hedonic approach and showed that wholesale prices for apples in Japan are very much associated with the brix, brix/acid balances and juice content.

Matsuda[12]tested empirical validity of several constrains derived from microeconomic theory. The test resulted that the homogeneity and the Slutsky symmmetry restrictions were not rejected.

Kwang-Hyun Jho and Yoshida[11]analyzed food demand by using age of household head ,birth year, expenditure and prices.

Matsuda[13]estimated inverse demand system for fresh vegetables and the result suggested that the inverse demand system dominates the regular demand system and that prices are less responsive to change in consumption than found in the regular demand system.

Mori and Inaba[15]explained the declining consumption of fruits by the age factor.

Nanseki[16]analyzed long term changes in the variation of the prices and quantity of vegetables using data 1977-1998 wholesale market. the main reason for decrease in the daily variation in the daily price variation was the decrease in the price flexibility coefficients. Another reason was the demand functions shift according to the day of the week has decreased.

Sasaki[18]estimated consumption behavior of agricultural households by using AIDS. He indicated that(1) homogeneity and symmetry restrictions are supported to be acceptable,(2)the second-order condition of equilibrium is satisfied,(3)taste change in a modest way in agricultural households,(4)income elasticity of cereals as an inferior good is smaller in absolute value, and its own-elasticity is larger in absolute terms, as compared with the corresponding elasticities of non-agricultural households.

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II Household Food Expenditures and The Growth of Japanese Food Industries: 1985-1995

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1. Introduction

In this paper, we empirically examine the relationships between the change of household food expenditures and the growth of Japanese food industries. Much of the previous literatures have studied the "cause" of changes in household expenditures on food consumption. It is generally recognized that the proportion spent on food consumptions decline as household income increases. The effects of other economic variables, such as relative prices, and the change of social environment (e.g. the effects of urbanization on the diet style) have also been important subjects (Egaitsu and Tokoyama (1990)). These literatures, however, sometimes neglected the "consequences" of the changes in household food expenditures. Our purpose is to investigate the effects of such demand side changes on that of supply side, especially on the growth of food industries.

Household food expenditures have varied substantially in its value, as well as in the share of its components. Table 1 summarizes the actual change in Japanese household food expenditures for the period of 1985-1995. The amount of food expenditures increased from 39,288 to 46,581 billion yen (in 1995 constant prices) and total household expenditures increased from 181,021 to 266,796 billion yen. Accordingly, the proportion spent on food decreased from 21.7 to 17.5 percent. The share of the components also changed. Restaurants, miscellaneous food and beverages sector gradually increased their shares while those of grain milling, other crops and fisheries sector shows relatively sharp drops in its share. It is apparent that the food obtained and eaten away from home (FAFH) has become a significant proportion in food expenditure these days.

To fully understand how these changes of household behaviors interrelate with the growth of food industries, market interactions should be considered explicitly. This requires, however, much fundamental information about preferences, technological conditions and also about the workings of market mechanism itself. In addition, quantitative results will critically depend on the way of model construction and on estimated parameter values. Instead, here we employ another strand of research framework using input-output tables, in which the changes in demand are associated, *ex post,* with the variation of outputs of all sectors in a systematic way. There have been already several studies which investigate the demand and supply linkages in a framework of input-output tables (Ueji and Oguchi (1989)). Fujita (1993) extended the traditional methods in decomposing the factors of output growth and has identified the

effects of household food expenditures on the growth of Japanese food industries in mid 1980s. We will modify the methods these studies have adopted and give empirical applications to new sets of data. Special emphasis will be played on the effects of recent increases in FAFH consumption on every other food industries.

Remaining sections are organized as follows. In the next section, a newly modified methodology is briefly explained. Some explanation on the data sets will be also given. Section 3 provides the basic results of decomposition. The increase (or decrease) in output of food industries are attributed to several factors, of which the aggregated effects of household expenditure expansion is important. Section 4 analyzes the household food expenditures in more detailed manner and the effects of FAFH expenditures will be examined. Section 5 concludes.

Table 1. Household Food Expenditures at 1995 Constant Prices. (Billion Yen)

	1985		1990		1995	
	Value	Percent	Value	Percent	Value	Percent
Grain milling	3,217	8.2%	3,059	7.1%	2,644	5.7%
Other crops	2,751	7.0%	2,731	6.4%	2,533	5.4%
Livestock	198	3.2%	204	2.7%	206	2.9%
Fisheries	959	2.4%	628	1.5%	616	1.3%
Meat & dairy proc	3,055	4.6%	3,322	5.0%	3,606	4.9%
Processed fish	3,879	9.9%	4,466	10.4%	4,405	9.5%
Misc. food	7,147	18.2%	8,248	19.2%	8,926	19.2%
Beverages	4,485	11.4%	5,505	12.8%	5,867	12.6%
Cigarettes	2,787	7.1%	2,706	6.3%	3,024	6.5%
Restaurants	10,812	27.5%	12,093	28.1%	14,754	31.7%
		100.0%		100.0%		100.0%
Food total	39,288	21.7%	42,962	18.7%	46,581	17.5%
Non-food total	141,733	78.3%	186,561	81.3%	220,215	82.5%
Grand total	181,021	100.0%	229,522	100.0%	266,796	100.0%

Source: 1985-1990-1995 Linked Input-Output Tables

2. Methodology

In the framework of input-output model, the following balance equation can be derived by definition:

$$X_t + M_t = A_t X_t + F_t + E_t$$

where t, X, M, F, E and A denote time period t, and vectors of output, import, domestic

final demand, export, and an import coefficient matrix, respectively. When imports are assumed to be a function of total demand, M can be written as follows:

$$M_t = (I - U_t)(A_t X_t + F_t) \tag{1}$$

where U denotes a diagonal matrix of self-sufficiency ratios. Then, by assuming X and M are endogenous variables, the following solution can be derived:

$$X_t = R_t(U_t F_t + E_t) \tag{2}$$

where $R=(I-UA)^{-1}$ is a domestic Leontief inverse matrix. Several decomposition methods have been proposed in the framework of I-O models (Chenery (1960)), Syrquin (1976), Bulmer-Thomas (1982)). Among them, Syrquin's method, which was developed for assessing the trade policy such as import substitution in developing countries, is beneficial. This method is useful not only to analyze manufacturing sectors of developing countries (Fujita and James(1990)) but also to analyze some aspects of agricultural growth (Fujita(1986), Lee(1990))

First, by using (3), the output at period t+1 can be written directly as follows:

$$X_{t+1} = R_{t+1}(U_{t+1} F_{t+1} + E_{t+1}) \tag{3}$$

Then, by using (3) and (4), it is possible to solve for the increase in output in terms of increases in internal and external demands and changes in two sets of parameters:

$$\Delta X = R_t U_t \Delta F + R_t \Delta E + R_t \Delta U Y_{t+1} + R_t U_t \Delta A X_{t+1} \tag{4}$$

where Δ denotes the differences of variables and parameters and Y is a vector of total domestic demand. Our interest is primary on the effect of changes in household expenditures; it is useful to divide the changes of domestic final demand into two parts. Let H and D be the vector of household expenditures and that of the other domestic final demand, then following equation is trivially derived.

$$\Delta X = R_t U_t \Delta H + R_t U_t \Delta D + R_t \Delta E + R_t \Delta U Y_{t+1} + R_t U_t \Delta A X_{t+1} \tag{5}$$

The right hand side of equation (5) can be interpreted as follows. First two terms are the effects of domestic final demand expansion. The ith element of these terms captures the effects of expansion of domestic final demand in all sectors on the output growth of sector i. We call these two effects HD and OD respectively. Third term is export expansion effect (EF). An interpretation of this term is almost the same as first two

terms. Fourth term captures an import substitution effect (IS). When the self-sufficiency ratio decreases in the relevant sectors, the effective demand for that sector and then for closely related other sector will also decrease. Thus, the ith element of the fourth term captures the effect of the changes in self-sufficiency ratios in all sectors on the output growth of sector i. The last term can be interpreted as technological change effect (TC). This term reflects the changes in technological coefficients of all sectors. Had any particular goods become more and more used as intermediate input by other industries, with fixed output levels, an industry producing such goods could enjoy positive effects n this last term.

Equation (5) can be utilized for identifying the factors of growth. These factors all capture the various kinds of aggregated effects of the changes in demand structure. However, we also want to examine the individual effect in the same manner. As mentioned previously, the proportion spent on FAFH increased significantly from late 1980s. For the sake of identifying this individual effect separately, further decomposition on Household expenditures expansion effect (HD) can be made. Firstly, H is divided in following way.

$$H = SF + N \tag{6}$$

where S is a vector of the shares in household food expenditures, H is total household food expenditures, N is a vector of non-food expenditures. Then, the first term of (5) can be modified as

$$R_t U_t \Delta H = R_t U_t (S_t \Delta F + \Delta S F_{t+1} + \Delta N) \tag{7}$$

The first term captures the effects induced by changes in total household food expenditures. Because total household food expenditures generally increase year after year, this effect (HFT) is expected to be positive. The second term captures the effects induced by changes in the shares of household food expenditures (HFS). This term will turn out to be either positive or negative. It is, however, expected this effect is positive for FAFH (especially for restaurants). The third terms capture the effects induced by changes in household non-food expenditures. We call these effects HN.

HFS of sector i captures the effects induced by the changes not only in the share of sector i captures the effects induced by the changes not only in the share of sector i but also in the shares of the other sectors. For example, HFS of meat and daily products is created by changes not only in the shares of meat and daily products but also in the shares of the other food sectors such as restaurants. Thus, in order to capture the sources of HFS, the following decomposition is useful:

$$R_t U_t \Delta S F_{t+1} = R_t U_t (\Delta s_1 \ 0 \ 0 \ 0)' F_{t+1} + ... + R_t U_t (0 \ 0 \ 0 \ \Delta s_n)' F_{t+1} \tag{8}$$

where $S'=(s_1 \ldots s_n)$. The jth element (e.g. meat and daily products) of the ith term (e.g. restaurants) indicates the effects induced by the change in sector i's share on sector j's output growth. The other effects can be decomposed in the same way.

At this stage, for the current research, 1985-1990-1995 Linked Input-Output Tables is applicable to the method derived above. These tables are competitive imports and evaluated in 1995 prices. We used 184 sectors matrix and, when showing results, some aggregations of food industries are conducted after calculations.

3. Empirical Results: Factors of Growth in Food Industries

Table 2 summarizes the empirical results from equation (5). These results provide the quantitative information about each factor which affected the growth of food industries. We will first explain the feature of each sector briefly. Comparisons between different industries, then between different periods will also be done subsequently.

Grain milling: Output decreased rapidly because of negative TC in 1985-1990 and negative HD in 1990-1995. *Other crops*: Negative TC offset other positive factors completely. *Livestock*: Household expenditure expanded (HC) but has been offset by negative import substitution effects (IS). *Fisheries*: Negative TC was substantial. *Meat and diary products*: HD effects have overcome the negative effects of IS. Positive TC in both periods is exceptional case. *Processed Fish*: Large increase in household expenditures effects in 1985-1990 has disappeared in the next period. The negative import substitution effects have been large in this sector. *Misc. Food*: This sector includes breads, cakes, noodles and other side dishes, as well as luncheon. HD is very large and out put grew in both periods. *Beverages*: This sector also had positive HD and IS was relatively small compared to the other sector. *Cigarettes*: No factor had dominant effects on growth.

Table 2. Foctors of Growth (Total)						(Billion Yen)
			1985-1990			
	ΔX	HD	OD	EE	IS	TC
Grain milling	-279	11	44	5	-39	-300
Other crops	-238	216	87	-4	-185	-352
Livestock	285	165	101	4	-277	292
Fisheries	-223	-1	17	-48	172	-363
Meat and daily products	341	491	82	9	-364	123
Processed Fish	-369	694	35	-111	-910	-76
Misc. food	1544	1481	323	2	-256	-6
Beverages	1622	1181	466	-3	-162	140
Cigarettes	-416	40	46	11	-244	-270
Restaurants	1592	1258	790	50	-506	0
			1990-1995			
	ΔX	HD	OD	EE	IS	TC
Grain milling	-313	-303	49	-2	-6	-51
Other crops	-430	-7	22	-3	-173	-269
Livestock	-105	257	-14	-9	-326	-14
Fisheries	-545	32	13	-32	-253	-306
Meat and daily products	-63	409	-28	-17	-436	7
Processed Fish	-492	47	26	-64	-387	-113
Misc. food	593	1002	-46	-2	-265	-96
Beverages	584	610	-13	-1	-5	-8
Cigarettes	168	285	-31	15	-89	-11
Restaurants	3098	2547	489	-1	63	0

Source: Calculated from 1985-1990-1995 Linked Input-Output Tables.

Restaurants: The growth of output has been very large in both periods. Increases in HD are the major sources for this growth. In addition, the contributions of other domestic final demand (OD) were not small.

Comparison between different industries

Each sector can be categorized into two different groups. One is the group of growing sectors, and the other is stagnating sectors. Restaurants, beverages and miscellaneous food were the most vital industries in growing sectors. On the other hand, grain milling, other crops and fisheries were all stagnant in both periods. Without exception, growing sectors were benefited from significant household expenditures expansion effects (HD). However, the inverse is not necessarily true. For example, processed fish had positive HD in both periods, while its output growth rate was negative.

This can be largely attributable to the rapid increase in (negative) import substitution effects (IS). In stagnating sectors, large part of positive HD was offset by negative IS. TC had also tendency to be negative in these stagnant sectors.

Comparison between different periods

There is only one sector, restaurants, which growth rate went upward from late 1980s to early 90s. The main reason of this growth is in the great acceleration of household expenditures expansion effects. On average, other sector experienced the slow down of HD in 1990-1995, while negative IS was left unchanged in its value. TC has been always negative for many sectors in both periods. This implies that many agricultural and food industry's goods had become relatively less important for intermediate use in an economy as a whole. Meat and dairy products was growing in an intermediate market and was notable exception in this regard.

Household expenditures effects are possibly most important factor for growth of food industries in Japan. Household behaviors, however, has never had a symmetric impacts on the food industries as was shown in Table 2. Restaurants sector has experienced highest growth among all food industries and its major source of growth was household expenditures effects. Did it work against other sectors? Next section provides the results of further decomposition and gives some empirical implications for this question.

4. Decomposition of Household Food Expenditures

Table 3 shows the decomposition results from equation (7) and (8). HD is the same with household expenditures effects in Table 2, which can be decomposed into three parts. HFT captures an effect of the change of household food expenditures in total, given the share of each sector fixed. HFS reveals the share effects. The effects of non-food expenditures by households are counted as HN.

Table 3. Foctors of Growth (Household Food Expenditures)						(Billion Yen)
	1985-1990					
	HD	HFT		HFS		HN
Grain milling	11	384	(24)	-397	(7)	24
Other crops	216	361	(29)	-183	(8)	39
Livestock	165	192	(17)	-75	(5)	48
Fisheries	-1	228	(18)	-258	(5)	30
Meat and daily products	491	352	(24)	86	(6)	52
Processed Fish	694	430	(26)	229	(7)	35
Misc. food	1,481	824	(57)	558	(15)	99
Beverages	1,181	484	(63)	645	(17)	51
Cigarettes	40	254	(0)	-333	(0)	119
Restaurants	1,258	992	(992)	266	(266)	0
	1990-1995					
	HD	HFT		HFS		HN
Grain milling	-303	332	(19)	-655	(30)	20
Other crops	-7	316	(23)	-355	(38)	32
Livestock	257	186	(26)	46	(41)	25
Fisheries	32	192	(16)	-173	(26)	13
Meat and daily products	409	338	(32)	37	(52)	34
Processed Fish	47	376	(23)	-354	(37)	24
Misc. food	1,002	847	(68)	99	(109)	56
Beverages	610	528	(74)	53	(120)	29
Cigarettes	285	204	(0)	81	(0)	0
Restaurants	2,547	975	(975)	1,572	(1,572)	0
Note: The effects induced by the change in restaurants sector are in the parenthesis.						
Source: Calculated from 1985-1990-1995 Linked Input-Output Tables.						

In 1985-1990, beverages and misc. food sectors have experienced significant increase in share effects. HFS of restaurants was moderate value in this period. On the other hand, restaurants have gained large portion of this effects in 1990-1995. As was noted in previous section, thanks to this share effects, restaurants were the only sector which increase his growth rate of output in the that period.

Given the share of household food expenditures, HFT gave the symmetrically positive effects on all sectors. Total effects, however, was heavily subject to the share effects (HFS). Grain milling, other crops and fisheries have lost their shares in these periods, and this negative effect was nearly equal to the amount of HFT. The case of processed fish in 1990-1995 is almost the same. Intuitively, if growing sector needed more goods from stagnant sector instead of households, these share effects could be mitigated. Individual effect of restaurants, not aggregated, is showed in the parenthesis in Table 3.

According to the Table, the increase in household expenditures on restaurants has definitely positive effects on the entire food industries. The absolute value, however, was so small in 1985-1990 that this individual effect cannot offset the negative share effect of stagnant sectors any more. In 1990-1995, the effect has changed to relative large amounts especially for Misc. food and beverage sectors. This was partly because of rapid growth of restaurants itself in that period.

From late 1980s, individual effect of restaurants increased but careful examination reveals that this increase has been asymmetric by the different sectors. Misc. food and beverages was more benefited from this effect than that of other sectors. Technological relationships between restaurants and other food industries in demand linkage will be the most plausible account for this problem. These individual effects of restaurants must have contributed to the positive growth of output in these two sectors.

5. Conclusions

This paper analyzed the *ex post* relationship between household food expenditures and output growth of food industries. Main results obtained in the empirical estimation are as follows. (1) Output growth of food industries are most closely related with household expenditures effects, especially with changes in shares of household food expenditures. (2) Import substitution and the changes of technological interdependence have been negative factors for many food industries during the estimation periods. (3) Increasing household demand for restaurants have positive growth effects on other sectors. But these effects are different in size by sectors.

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Ⅲ How to Detect the Structural Change in Food Demand Structure: A Note on Time-Varying Parameter Approach

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1. Introduction

Demand analysis plays an important role in economic policy analysis. In recent years, a system wide approach has been used in the estimation of food demand. From theoretical viewpoints, these demand systems should satisfy restrictions such as adding up and homogeneity conditions, and symmetry constraints. When estimating system wide demand equations, economic theory provides a series of constraints that the estimated parameters of the system should satisfy. Standard regression theory provides, for example, the Generalized Least Square method with constraints. This method has been widely used in system wide approaches to demand analysis. The most critical assumption is that parameters to be estimated are constant over the measurement period. This assumption is appropriate if no structural change for demand occurs. In a system wide approach to demand analysis, the large number of parameters to be estimated requires a long measurement period for stable estimates. In such a case, the constant parameter assumption may be inadequate, since this assumption seems inadequate when investigating structural change in an economy.

In this paper, we will overcome this constant parameter assumption by employing the Kalman Filter (Kalman[7]). Many applications of the Kalman Filter can be found in the field of econometrics. However, most are applications to single equation models, and they are free from the restrictions required by economic theory. When measuring system wide demand structures, as mentioned above, theoretical constraints are required. Thus, we will develop an estimation method for random varying coefficients model with linear constraints.

2. A System Wide Approach to Demand Analysis

Several demand systems are used for empirical study. Examples of these include the Linear Expenditure Demand , the Rotterdam Demand and the Almost Demand Systems. In this paper, the Rotterdam Demand System is used as an example.

The Rotterdam Demand System was developed by Theil[8] and Barten[1]. This model is derived from utility maximization under a budget constraint as follows:

$$\underset{q}{Maximize}\ U(q)\ \ s.t.\ {}^{t}p \cdot q \leq y \quad .$$

where $U(q)$ is the utility function; p, q, y are price vector, and quantity vectors of demand and income, respectively.

The demand system is derived as a function of the price vector and income by solving first order conditions for above maximization problem:

$$q_i = q_i(p_1, p_2, \text{L}\ , p_n, y)$$

After totally differentiating the demand equations, one obtains

$$w_i d\ln q_i = \beta_{i0} d\ln \text{real}+\sum_{j=1}^{n}\beta_{ij} d\ln p_j$$

where, $w_i = p_i q_i / y$ is the budget share w.r.t. the i-th commodity,

$$d\ln \text{real}=\sum_{j=1}^{n} w_j d\ln q_j = d\ln y-\sum_{j=1}^{n} w_j d\ln p_j \quad \text{is the change in real income,}$$

and

$$\beta_{i0} = p_i \frac{\partial q_i}{\partial y},\ \ \beta_{ij} = \frac{p_i p_j}{y}\cdot S_{ij},\ \ S_{ij} = \frac{\partial q_i}{\partial p_j} + q_j \cdot \frac{\partial q_i}{\partial y}.$$

Note that, at this stage, β_{ij} s appeared in the model ***need not to be constant***. Rather, it will change as preference shifts, even if prices and income were constant.

The restrictions imposed on this system are

$\sum_i \beta_{i0} = 1$ (Adding up condition),

$\sum_j \beta_{ij} = 0$ (Homogeneity Condition),

$\beta_{ij} = \beta_{ji}$ (Symmetry Condition),

and we know adding up and symmetry conditions are cross equation constraints.

When applying the Rotterdam Demand System to actual data, adding up and homogeneity conditions are imposed on the above equations and the measurement equations will be

$$w_{it} d\ln q_{it} = \beta_{i0} d\ln \text{real}_t + \sum_{j=1}^{n-1}\beta_{ij}(d\ln p_{jt} - d\ln p_{nt}) + \varepsilon_{it}\quad i = 1,2,\text{L}\ ,n-1.$$

When estimating these equations, firstly ***assume*** β_{ij} ***are all constants*** and apply Constrained Generalized Least Estimation. The general form of the model is as follows:

$$\begin{cases} y = X\beta + \varepsilon \\ R\beta = r \end{cases} \qquad \varepsilon \sim N(0, V)$$

where $R\beta = r$ represents linear restriction (symmetry constraints). The estimator will be obtained by applying GLS method to the following extended linear model:

$$\begin{pmatrix} y \\ r \end{pmatrix} = \begin{pmatrix} X \\ R \end{pmatrix} \beta + \begin{pmatrix} \varepsilon \\ 0 \end{pmatrix} \quad , \quad Var\begin{pmatrix} \varepsilon \\ 0 \end{pmatrix} = \begin{pmatrix} V & O \\ O & O \end{pmatrix}.$$

Since the variance-covariance matrix of the extended linear model is singular even if V is non-singular, use generalized inverse matrix[1].

3. The Kalman Filter

The Kalman filter has been applied to the estimation of time-varying regression parameters. This method is optimal in that it is a minimum variance unbiased estimator. In addition, it is easier to get estimates using this procedure than other procedures such as random coefficient model from the viewpoint of computation. This is due to the recursion process for parameter estimation in the Kalman Filter.

3.1 State Space Model

The typical form of the State Space Model[2] is composed of the following two equations:

$$y_t = X_t \beta_t + \varepsilon_t$$

$$\beta_t = \Phi_t \beta_{t-1} + u_t$$

where y_t, X_t are observation data at period t,

β_t is state vector,

Φ_t is transition matrix for state vector,

ε_t and u_t are disturbance at period t.

The first equation is called the measurement equation, which has the role of measuring the state vector with given data.
The second is called the transition equation, which represents the trajectory or the dynamic path of state vector.

In the case of system wide demand analysis, the measurement equation will be

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1 Refer Theil [9] for detail, especially chapter 6.
2 Refer Harvey[4]and Harvey[5] in detail.

obtained by arranging , for example, Rotterdam model:

$$w_{it} d\ln q_{it} = \beta_{i0} d\ln \text{[illegible]} + \sum_{j=1}^{n-1} \beta_{ij} (d\ln p_{jt} - d\ln p_{nt}) + \varepsilon_{it} \quad i = 1,2,\text{L}\ ,n-1.$$

Note that adding and homogeneity conditions are imposed on the system. The measurement equation will be,

$$\begin{pmatrix} w_{1t} d\ln q_{1t} \\ \text{M} \\ w_{n-1t} d\ln q_{n-1t} \end{pmatrix} = I_{n-1} \otimes \begin{pmatrix} d\ln \text{[illegible]} & d\ln p_{1t} - d\ln p_{nt} & \text{L} & d\ln p_{n-1t} - d\ln p_{nt} \end{pmatrix} \begin{pmatrix} \beta_{10}(t) \\ \beta_{11}(t) \\ \text{M} \\ \beta_{n-1n-1}(t) \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \text{M} \\ \varepsilon_{n-1t} \end{pmatrix}$$

As for transition equation, it is sometimes difficult to estimate transition matrix statistically, this matrix is often assumed to be identity matrix. That is,

$$\beta_t = \beta_{t-1} + u_t .$$

This assumption means that state vector follows a random walk. If the variance covariance matrix is O, this model reduces to the classical fixed coefficient model. The transition equation for Rotterdam model will be

$$\begin{pmatrix} \beta_{10}(t) \\ \beta_{11}(t) \\ \text{M} \\ \beta_{n-1n-1}(t) \end{pmatrix} = \begin{pmatrix} \beta_{10}(t-1) \\ \beta_{11}(t-1) \\ \text{M} \\ \beta_{n-1n-1}(t-1) \end{pmatrix} + \begin{pmatrix} u_{1t} \\ \text{M} \\ u_{n-1t} \end{pmatrix}$$

The transition equation may be rewritten as $\beta_t = \beta_{t|t-1} + u_t$, where $\beta_{t|t-1} = \Phi_t \beta_{t-1}$ (prior information). $\beta_{t|t-1}$ is the conditional estimate of β_t on given information up to time $t-1$.

3.2 Prediction, Filtering and Smoothing

Let Ω_s be the information set available at period s, and β_t be the state vector at period t. Define the conditional estimator of a state vector and its variance-covariance matrix by

$$\hat{\beta}_{t|s} := E(\beta_t \mid \Omega_s)$$

and

$$\hat{\Sigma}_{t|s} := Var(\beta_t \mid \Omega_s),$$

$\hat{\beta}_{t|s}$ is called prediction, if $t > s$. $\hat{\beta}_{t|s}$ is called filtering, if $t = s$. $\hat{\beta}_{t|s}$ is called smoothing, if $t < s$.

3.3 Derivation of the Kalman Filter

In this sub-section, the Kalman Filter is derived by following Duncan & Horn[3][3]. A State Space Model is assumed to be:

$$y_t = X_t\beta_t + \varepsilon_t$$

$$\beta_t = \Phi_t\beta_{t-1} + u_t$$

where $\begin{pmatrix}\varepsilon_t \\ u_t\end{pmatrix} \sim WS\left(\begin{pmatrix}0\\0\end{pmatrix},\begin{pmatrix}Q_t & O\\ O & R_t\end{pmatrix}\right)$, $t = 1,2,\mathrm{L}\ ,T$, and β_0 is ***known***.

WS is abbreviation of " wide sense", and this means no distributional assumptions are made except the same ones specifying the first and second moments. Assume $\Phi_t = I$.

Combining the two equations

$$\begin{pmatrix} y_t \\ \beta_{t|t-1}\end{pmatrix} = \begin{pmatrix} X_t \\ I\end{pmatrix}\beta_t + \begin{pmatrix}\varepsilon_t \\ -u_t\end{pmatrix},$$

and applying the GLS procedure,

$$\begin{aligned}\beta_t \equiv \beta_{t|t} &= \left\{{}^t\begin{pmatrix} X_t \\ I\end{pmatrix}\begin{pmatrix}Q_t & O\\ O & R_t\end{pmatrix}^{-1}\begin{pmatrix} X_t \\ I\end{pmatrix}\right\}^{-1}{}^t\begin{pmatrix} X_t \\ I\end{pmatrix}\begin{pmatrix}Q_t & O\\ O & R_t\end{pmatrix}^{-1}\begin{pmatrix} y_t \\ \beta_{t|t-1}\end{pmatrix} \\ &= \left(R_t^{-1} + {}^tX_tQ_t^{-1}X_t\right)^{-1}\left(R_t^{-1}\beta_{t|t-1} + {}^tX_tQ_t^{-1}y_t\right)\end{aligned}$$

$$\Sigma_{t|t} \equiv Var\left(\beta_t \mid \Omega_t\right) = \left\{{}^t\begin{pmatrix} X_t \\ I\end{pmatrix}\begin{pmatrix}Q_t & O\\ O & R_t\end{pmatrix}^{-1}\begin{pmatrix} X_t \\ I\end{pmatrix}\right\}^{-1} = \left(R_t^{-1} + {}^tX_tQ_t^{-1}X_t\right)^{-1}.$$

Then using an updating formula[4][4], we obtain recursive estimation equation

$$\beta_t = \beta_{t|t} = \beta_{t|t-1} + \Sigma_{t|t-1}{}^tX_t\left(X_t\Sigma_{t|t-1}{}^tX_t + Q_t\right)^{-1}\left(y_t - {}^tX_t\beta_{t|t-1}\right)$$

$$\Sigma_{t|t} = \Sigma_{t|t-1} - \Sigma_{t|t-1}{}^tX_t\left({}^tX_t\Sigma_{t|t-1}X_t + Q_t\right)^{-1}X_t\Sigma_{t|t-1}\ .$$

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[3] Viewpoints of Didrerich[2] is also the same as Duncan & Horn[3].

[4] See appendix.

4. Imposing Restrictions

Suppose that the state vector β_t varies under the set of linear constraints $R\beta_t = r$, where R and r are known matrix and vector, respectively. In this case, a little modification of measurement equation gives us the Kalman Filter with constraints. Linear restrictions should be thought of as artificial "measurement equations", i.e.,

$$r_t = R\beta_t + \varepsilon_{2t}$$

Then we rewrite the measurement equation as follows:

$$\begin{pmatrix} y_t \\ r \end{pmatrix} = \begin{pmatrix} X_t \\ R \end{pmatrix} \beta_t + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix}.$$

And define

$$\tilde{y}_t = \begin{pmatrix} y_t \\ r \end{pmatrix}, \quad \tilde{X}_t = \begin{pmatrix} X_t \\ R \end{pmatrix}, \quad \tilde{\varepsilon}_t = \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix}.$$

Then, the above "measurement" equation can be expressed as

$$\tilde{y}_t = \tilde{X}_t \beta_t + \tilde{\varepsilon}_t .$$

Transition equation is rewritten as

$$\beta_t = \beta_{t-1} + u_t$$

Combining these two equations system gives us the recursion process of Kalman filter as follows:

$$\beta_t = \beta_{t|t} = \beta_{t|t-1} + \Sigma_{t|t-1} \tilde{X}_t' \left(\tilde{X}_t \Sigma_{t|t-1} \tilde{X}_t' + Q_t \right)^{-1} \left(\tilde{y}_t - \tilde{X}_t' \beta_{t|t-1} \right)$$

$$\Sigma_{t|t} = \Sigma_{t|t-1} - \Sigma_{t|t-1} \tilde{X}_t' \left(\tilde{X}_t' \Sigma_{t|t-1} \tilde{X}_t + Q_t \right)^{-1} \tilde{X}_t \Sigma_{t|t-1} .$$

Many econometric packages such as TSP provide the recursive procedure of Kalman Filter. It is not difficult to write source code for the recursive process in any language. Thus, imposing any linear restriction on Kalman Filtering or Smoothing presents no difficulties in estimation.

5. Concluding Remarks

When applying time varying coefficient model to system wide demand analysis, imposing theoretical constraints are indispensable. Usual Kalman Filter approach

enables us to avoid the fixed parameter assumption. However, it cannot impose linear restrictions on the parameters to be estimated. Thus, usual Kalman Filter should be extended in order to capture structural changes in demand.

By treating linear restriction as an "artificial measurement equation", we show that linear restrictions can be imposed on Kalman Filter. This means the extended Kalman Filter can be applied to capture structural changes in the demand for food.

No application is shown in this paper. The author thinks empirical applications should be conducted in order to illustrate the proposed approach. The proposed method will be applied to detect the structural changes in food consumption for asian countries as well as Japan.

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Appendix

The following theorem and lemma as well as the Goldberger-Theil (mixed) estimator[5] are essential for deriving the Kalman Filter with and without linear constraints.

Theorem(Gauss-Markov-Aitken) Consider the following generalized linear model

$$y = X\beta + \varepsilon,$$

where y is the response vector, X is a full column rank observation matrix, β is unknown, fixed and non-stochastic parameters, and ε is a disturbance vector with zero mean and covariance matrix V (positive definite).

Then, the Generalized Least Square estimator of β:

$$\hat{\beta} = \left({}'XV^{-1}X\right)^{-1}{}'XV^{-1}y$$

is Best Linear Unbiased Estimator. And the variance-covariance of the estimator is given by

$$Var\left(\hat{\beta}\right) = \left({}'XV^{-1}X\right)^{-1}.$$

Outline of proof

There exists an orthogonal matrix A such that ${}'AA = V^{-1}$. After multiplying A to regression equation from the left side, the transformed model follows the classical assumptions. Apply the Gauss-Markov Theorem. The estimator is Best Linear Unbiased Estimator.

Lemma (Updating Formula)

(1) $\left[A \pm b'b\right]^{-1} = A^{-1}\,\mathrm{m}\left[\dfrac{1}{1 \pm {}'bA^{-1}b}\right]A^{-1}b'bA^{-1}$

(2) $\left[A \pm b'c\right]^{-1} = A^{-1}\,\mathrm{m}\left[\dfrac{1}{1 \pm {}'cA^{-1}b}\right]A^{-1}b'cA^{-1}$

(3) $\left[A \pm BC'B\right]^{-1} = A^{-1}\,\mathrm{m}A^{-1}B\left[C^{-1} \pm {}'BA^{-1}B\right]^{-1}{}'BA^{-1}$

Proof

Easy to show[6].

---

[5] See Theil[9].

[6] See Greene[10] for example.

TSP procedure for Kalman Filter

$$\begin{cases} y_t = X_t\beta_t + \varepsilon_t \quad \varepsilon_t \sim N(0,\sigma^2 H) & \text{(measurement equation)} \\ \beta_t = T\beta_{t-1} + \eta_t \quad \eta_t \sim N(0,\sigma^2 Q) & \text{(transition equation)} \\ \beta_0 \sim N(\bar{\beta}_0, \sigma^2 P_0) & \text{(initial condition)} \end{cases}$$

The corresponding procedure for above model is:

KALMAN (BPRIOR= β_0, VBPRIOR= $\sigma^2 P_0$, VMEAS= $\sigma^2 H$, BTRANS= T,

VTRANS= $\sigma^2 Q$, MEAS, ETRANS, PRINT, SILENT, SHOOTH, TERSE,

XFIXED = X_t)

list of dependent variables| list of independent variables;

```
? Structural Change in Japanese Food Demand
? Application of Multivariate Kalman Filter with Linear Constraints.
? The Kalman Filter Model
?   Y(t)     = X(t)*beta(t)   +EPS(t)   (measurement equation)
?   beta(t)  =  T *beta(t-1) +eta(t)    (transition   equation)
?   R*beta(t)=r                         (linear constraints)

FREQ A; SMPL 63 99;
? Data reading section
SK=0; r=0; ON=1; NO=-1;
LOAD(NROW=72, NCOL=1) B0;          ? read the initial value of parameter.
LOAD(NROW=72, TYPE=DIAGONAL) V0;   ? read the initial variance of parameter.
                                   ?Harvey recommends very large value k for k*Id matrix of prior variance.
                                   ? See "Time Series Models" 1981.
? We do NOT randomize Linear constraints, i.e. Var[eps2(t)]=0.
? Reference: Theil, Principles of Econometrics, 1971. Mixed estimator. In Capter 6.
LOAD(NROW=36, TYPE=DIAGONAL ) H;
? Crude coding, I DISLIKE it, but it can not be avoided when using TSP.
? KALMAN is a TSP procedure for recursive (update) process. This process can be coded easily with any language.
KALMAN(BPRIOR=B0, VBPRIOR=V0, VMEAS=H,PRINT,SMOOTH)
  y1 y2 y3 y4 y5 y6 y7 y8  r r r r r r r r r r r r r r r r r r r r r r r r r r r r
  (measurement equation : Demand system     artificial measurement equation: linear constraints(symmetry condition) )
  |    C   x1 X2 X3 X4 X5 X6 X7 X8          (First equation of demand system)
       SK SK SK SK SK SK SK SK SK            (SK is set equal to 0)
       SK SK SK SK SK SK SK SK SK
       SK SK SK SK SK SK SK SK SK
       SK SK SK SK SK SK SK SK SK
       SK SK SK SK SK SK SK SK SK
       SK SK SK SK SK SK SK SK SK
```

SK SK SK SK SK SK SK SK SK

SK SK SK SK SK SK SK SK SK
C x1 X2 X3 X4 X5 X6 X7 X8
SK SK SK SK SK SK SK SK SK
SK SK SK SK SK SK SK SK SK
SK SK SK SK SK SK SK SK SK
SK SK SK SK SK SK SK SK SK
SK SK SK SK SK SK SK SK SK
SK SK SK SK SK SK SK SK SK

(omitted)

SK SK SK SK SK SK SK SK SK (8-th equation of demand system)
SK SK SK SK SK SK SK SK SK
SK SK SK SK SK SK SK SK SK
SK SK SK SK SK SK SK SK SK
SK SK SK SK SK SK SK SK SK
SK SK SK SK SK SK SK SK SK
SK SK SK SK SK SK SK SK SK
C x1 X2 X3 X4 X5 X6 X7 X8

? symmetric conditions one block for each restriction.

SK SK ON SK SK SK SK SK SK (first Symmetry condition)
SK NO SK SK SK SK SK SK SK (SK=0, ON=1, NO=-1)
SK SK SK SK SK SK SK SK SK
SK SK SK SK SK SK SK SK SK
SK SK SK SK SK SK SK SK SK
SK SK SK SK SK SK SK SK SK
SK SK SK SK SK SK SK SK SK
SK SK SK SK SK SK SK SK SK

(omitted)

SK SK SK SK SK SK SK SK SK
SK SK SK SK SK SK SK SK SK
SK SK SK SK SK SK SK SK SK
SK SK SK SK SK SK SK SK SK
SK SK SK SK SK SK SK SK SK
SK SK SK SK SK SK SK SK SK
SK SK SK SK SK SK SK SK ON
SK SK SK SK SK SK SK NO SK ;

? Results saving.

UNMAKE @STATE COL1-COL72; UMAKE @SMOOTH SCOL1 - SCOL72;

WRITE(File = "file name.xls") COL1 - COL72 ; WRITE(File = "file name.xls") SCOL1 - SCOL72; **(End of program)**

IV Explaining Pricing Conduct in a Product-Differentiated Oligopolistic Market: An Empirical Application of a Price Conjectural Variations Model

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Most previous empirical studies of imperfectly competitive markets have assumed that all firms within the industry supply a homogeneous product and use quantity as a strategic variable. This framework is basically a generalization of the Cournot model. In this case, there is only one demand function and one common price generated in the market. Examples of such empirical studies include: Appelbaum; Azzam and Pagoulatos; Bhuyan and Lopez; Iwata; Karp and Perloff; Lopez; Schroeter; Suzuki, Lenz, and Forker; Liu, Sun, and Kaiser.

However most imperfectly competitive industries are characterized by multiple differentiated products that compete with each other based on price as the strategic variable rather than quantity. As such, a separate market demand function and unique price exists for each brand, and the brands are incomplete substitutes with each other. In such cases, a product-differentiated oligopoly model with price as the strategic variable, or a generalized Bertrand model should be applied. Several previous studies have developed and applied the Bertrand-type model to various industries which include: Cotterill; Cotterill, Putsis and Dhar; Cotterill and Putsis; Liang (1987,1989); Peterson and Cotterill; Vickner and Davies.

This paper applies a two-product Bertrand-type linear model to the Japanese dairy sector to gain insights on the pricing conduct for beverage milk products made from fresh milk and reconstituted milk.[1] The model is similar to one that was originally developed by Liang (1989). The analysis includes some statistical tests to determine whether these Japanese dairy firms have consistent pricing behavior. Japanese milk and reconstituted milk products are chosen for our analysis because many observers have pointed out that increases in the consumption of reconstituted milk products have resulted in a decrease in the demand for domestically produced raw milk in Japan. While a competitive relationship between milk and reconstituted milk is expected, there currently is little empirical evidence of this documented in Japan.[2]

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[1] Unlike the United States, where virtually all beverage milk products are made exclusively from fresh milk, Japanese beverage milk products are made from either reconstituted milk or fresh milk.

[2] An exception to this is a recent study by Kinoshita et al.

Theoretical Model

In this section, the conceptual model used in this study is derived, and the assumptions are listed. The model is an n-product generalization of Liang's original two-product form model. Consider an imperfectly competitive market composed of n firms each supplying one differentiated product in the market. Since each product is differentiated, the model presented below is composed of n demand functions for each product i (i=1, ...,n), and n price-reaction functions for each firm i (i=1, ...,n) .

To ensure empirical tractability, the demand function for i is expressed in a linear form[3] as:

(1) $q_i=a_i+b_ip_i+\sum_{j\neq i}(c_{ij}p_j)+d_iy \quad$ for i and j=1, ..., n, i≠j.

where q_i is firm (product) i's quantity supplied/demanded, p_i is product i's price, p_j is substitute product's price, y is income, and a_i, b_i, c_{ij}, and d_i are parameters. Other variables affecting q_i are omitted here to simplify the presentation of the conceptual model, but are incorporated into the empirical model that follows.

Firm i's profit maximization problem using price (p_i) as a strategic variable is:

(2) $\max_{p_i} [p_iq_i-C_i]$

where C_i is firm i's cost. The first order condition is expressed as:

(3) $q_i+p_i(dq_i/dpi)-MC_i(dq_i/dp_i)=0$

where MC_i is firm i's marginal cost or $dC_i/dq_i=MC_i$. Firm i's conjectural variation is defined as its perception of how rival firm j will respond to firm i's price change. Mathematically, firm i's conjectural variation, cv_{ji}, is defined as dp_j/dp_i. Using this, dq_i/dp_i in equation (3) can be written as:

(4) $$\frac{dq_i}{dp_i} = b_i + \sum_{j\neq i} c_{ij}cv_{ji}$$

Solving (3) for p_i yields the following price reaction function, R_i for firm i:

(5) $$p_i = \frac{-a_i - \sum_{j\neq i} c_{ij}p_j + [b_i + \sum_{j\neq i} c_{ij}cv_{ji}]MC_i - d_iy}{2b_i + \sum_{j\neq i} c_{ij}cv_{ji}}$$

The difference in retail and wholesale (manufacturer's) price should be taken

[3] More flexible and complicated forms other than the simple liner specification make it impossible to derive an explicit form for the price-reaction function in the cross equation restraints and identify conjectures. For more discussion on functional forms for demand, see Liang (1987).

into account in specifying the pricing conduct by the manufacturers. Assuming that p_i is the retailer's price and the retailer's margin ratio is m_i, firm i's wholesale price is equal to $(1+m_i)^{-1}p_i$. Then, firm (manufacturer) i's profit maximization problem can be rewritten as:

(6) $\max_{p_i} [(1+m_i)^{-1}p_iq_i-C_i]$

or

(7) $\max_{p_i} [p_iq_i-(1+m_i)C_i]$

and firm i's price-reaction function R_i, (5), can be rewritten as:

(8) $$p_i = \frac{-a_i - \sum_{j\neq i} c_{ij}p_j + (1+m_i)[b_i + \sum_{j\neq i} c_{ij}cv_{ji}]MC_i - d_iy}{2b_i + \sum_{j\neq i} c_{ij}cv_{ji}}$$

This price-reaction function represents the manufacturers' behavior.[4]

Using equation (4), firm i's perceived or conjectured own-price elasticity, e_i, can be defined as:

(9) $e_i=(dq_i/dp_i)(p_i/q_i)$,

$=[b_i+\sum_{j\neq i}(c_{ij}cv_{ji})]\ (p_i/q_i)$,

$=b_i(p_i/q_i)+\sum_{j\neq i}[c_{ij}(p_j/q_i)cv_{ji}(p_i/p_j)]$,

$=e^{ow}_i+\sum_{j\neq i}(e^{cr}_{ij}e^{cv}_{ji})$.

Equation (9) shows that e_i is composed of three types of elasticites: (1) e^{ow}_i (partial own-price elasticity), (2) e^{cr}_{ij} (cross-price elasticity), and (3) e^{cv}_{ji} (conjectural variation elasticity).

If there is no interdependency among firms, e_i is equal to e^{ow}_i. However, oligopolistic firms must recognize e_i as a value in which e^{cr}_{ij} and e^{cv}_{ji} as well as e^{ow}_i are incorporated. The sign of e^{ow}_i is negative, e^{cr}_{ij} is usually positive, and e^{cv}_{ji} can be positive or negative. When $e^{cv}_{ji}<0$, firm i conjectures that p_j will move in the opposite direction of changes in p_i. Therefore, in absolute value, e_i will be larger than e^{ow}_i. Larger absolute values for e^{cr}_{ij} and e^{cv}_{ji} generate a larger absolute value for e_i, when $e^{cv}_{ji}<0$. On the other hand, when $e^{cv}_{ji}>0$, firm i conjectures that p_j will move in the same direction of changes in p_i. Therefore, in absolute value, e_i will be smaller than e^{ow}_i. Larger absolute values for e^{cr}_{ij} and e^{cv}_{ji} generate a smaller absolute value for e_i, when $e^{cv}_{ji}>0$.

In addition, when two firms' pricing behavior are consistent (i.e. firm i's estimated

[4] Our model does not account for retailers' strategic behavior in determining retail margins. If this type of behavior does occur, the model may derive biased estimates of conduct parameters for the manufacturers.

conjecture corresponds to firm j's observed price reaction), firm i's constant conjectural variation, ccv_{ji}, is determined by the condition:

$$(10) \quad cv_{ji} = \frac{\partial R_j}{\partial p_i} = \frac{-c_{ji}}{2b_j + c_{ji}cv_{ij}} \quad \text{for i and j=1,2, i}\neq\text{j. ,}$$

and is defined by:

$$(11) \quad ccv_{ji} = \frac{-b_i b_j + \sqrt{(b_i b_j)(b_i b_j - c_{ij}c_{ji})}}{b_j c_{ij}} \quad \text{for i and j=1,2, i}\neq\text{j. ,}$$

(Liang (1989), page 37-38).

Data and Empirical Model

This study uses scanner data obtained from Nikkei Quick Information, Inc. The data consists of weekly observations over a two-year period (April 1997 to March 1999) for one of the largest national supermarket chains in Japan. The data includes weekly weighted average price and quantity sold for each item and number of customers. Since previous studies have found weather to be an important variable particularly for beverage milk consumption (e.g., Watanabe, Suzuki, and Kaiser), we also include the following variables: maximum and minimum temperature, average temperature, humidity, precipitation, and number of daylight hours.

Because the data are collected for each store rather than by customer, individual customer attribute data (e.g., income, household size, age, job, education level) were not available for this study. However, weekly store sales values for milk and related products were used as proxies for customers' expenditure data. Weekly store sales values for milk, reconstituted milk, soda, fruit juice, yogurt, and cheese were included in the milk-related expenditure basket for customers, because they were considered to be the most important substitutes of beverage milk products.

The data set does not include advertising expenditures or any indicators for sales promotion. However, assuming that the store increases its advertising for the item (e.g., the store's advertising booklets inserted in newspapers) during the discount-sale days of the item, an indicator variable can be constructed as a proxy for advertising intensity. In the model, advertising indicator variables are equal to 1 for the week when the item is sold at a discount price, and zero otherwise. The advertising indicator variables for own and rival's items were included in demand function for each item to estimate own and cross effects of advertising.

In order to focus on the competition between fresh milk and reconstituted milk products, the most popular (based on largest market share) item was selected from each of the fresh milk and reconstituted milk product categories. For fresh beverage milk, the supermarket's private label

whole milk (3.5% fat content, 1 liter) was used (hereafter referred as FRESH). For reconstituted beverage milk, a national label reconstituted low-fat milk product with added calcium (1 liter) was used (hereafter referred as RECONST). The market share of each item in each category is 53.3 percent and 28.3 percent, respectively.[5]

One store of the largest national supermarket chain in Japan was selected for our analysis. It has a 12,780 m^2 selling area and a parking capacity for 900 cars. It is located in Tokyo. We specified the firm's profit maximization condition for each of the selected two items in the store, rather than considering the firm's total profit. This approach was deemed reasonable based on evidence presented at recent confidential hearings, which indicated that manufacturers usually look at the profitability of the most popular items in each section of the supermarket for product mix evaluations.

Average variable costs per product unit were used as a proxy for marginal costs. Average variable costs (or marginal costs) fluctuate in response to changes in major input prices. The cost figures and assumptions were based on evidence presented at recent confidential hearings involving a manufacturer's data (confidential source). The two year average cost figures obtained from the manufacturer were 147 yen per liter for FRESH and 135 yen per liter for RECONST. Based on these average levels, a weekly marginal cost data series was constructed by adjusting these two-year averages in proportion to the fluctuations in major input prices. The weekly change in producer raw milk prices was used as the weekly adjuster for FRESH marginal costs. Weekly import prices (CIF) of nonfat dry milk was used as the weekly adjuster for RECONST marginal costs.

Retailer margins were also obtained from the confidential hearing. The retailers' margin ratio for the private label product (FRESH) was 12.5 percent. The retailers' margin for the national label product (RECONST) was set at 17.0 percent.

The empirical model is composed of the following four equations.

FRESH demand equation:

$q_1=c_1(1)+ c_1(2)p_1+c_1(3)p_2+c_1(4)expr+c_1(5)temp+c_1(6)ad_2,$

RECONST demand equation:

$q_2=c_2(1)+ c_2(2)\ p_2+c_2(3)p_1+c_2(4)expr+c_2(5)temp+c_2(6)ad_1,$

FRESH price-reaction function R_1:

[5] Inclusion of only two products in the analysis may result in estimation bias. However, it is not possible to include more than two products in our conjectural variations model. Since the market share of the two products is relatively high, the extent of the potential bias is likely minor.

$$p_1 = \frac{-c_1(1)}{2c_1(2)+c_1(3)c_1(7)} + \frac{-c_1(3)}{2c_1(2)+c_1(3)c_1(7)} p_2 + \frac{1.125[c_1(2)+c_1(3)c_1(7)]}{2c_1(2)+c_1(3)c_1(7)} MC_1$$
$$+ \frac{-c_1(4)}{2c_1(2)+c_1(3)c_1(7)} expr + \frac{-c_1(5)}{2c_1(2)+c_1(3)c_1(7)} temp + \frac{-c_1(6)}{2c_1(2)+c_1(3)c_1(7)} ad_2,$$

RECONST price-reaction function R_2:

$$p_2 = \frac{-c_2(1)}{2c_2(2)+c_2(3)c_2(7)} + \frac{-c_2(3)}{2c_2(2)+c_2(3)c_2(7)} p_1 + \frac{1.17[c_2(2)+c_2(3)c_2(7)]}{2c_2(2)+c_2(3)c_2(7)} MC_2$$
$$+ \frac{-c_2(4)}{2c_2(2)+c_2(3)c_2(7)} expr + \frac{-c_2(5)}{2c_2(2)+c_2(3)c_2(7)} temp + \frac{-c_2(6)}{2c_2(2)+c_2(3)c_2(7)} ad_1,$$

where

1 subscript = item 1 or FRESH,

2 subscript = item 2 or RECONST,

q_1 and q_2 = items 1 and 2's weekly quantities (liter) sold per 1,000 weekly visiting customers,

p_1 and p_2 = items 1 and 2's weekly weighted average prices (yen/liter),

expr = customers' weekly expenditures (1,000 yen) per 1,000 weekly visiting customers,

temp = weekly average temperature in Tokyo,[6]

ad_1 and ad_2 = advertising indicator variables equal to 1 for the week when items 1 and 2 were sold at a discount price for more than five days and otherwise 0,[7]

MC_1 and MC_2 = items 1 and 2's marginal costs,

$C_\bullet(\bullet)$ = estimated coefficients (see Table 1).

Results

The above simultaneous four-equation system was estimated using the Three Stage Least Squares (3SLS) method. Because the Durbin-Watson statistics indicated serial correlation of error terms for the two price-reaction functions, a first-order autoregressive model was applied for them, and the estimated serial correlation coefficients were significant at the one percent level. After the adjustment, the Durbin-Watson statistics fell in the range between 2 and 2.5 for all equations.

Estimated coefficients are shown in table 1. Critical levels shown by p-values indicate that all of the own- and cross-price coefficients ($c_\bullet(2)$ and $c_\bullet(3)$) were significant at the one percent level.

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[6] Other weather factors were omitted because they were strongly correlated to each other.

[7] Advertising indicator variables for own items were omitted because they were strongly correlated to own price variables.

Regarding the other demand coefficients for FRESH, the expenditure coefficient ($c_1(4)$) was significant at the 5 percent level, but the temperature coefficient ($c_1(5)$) and the advertising indicator coefficient ($c_1(6)$) were not significant. In the demand equation for RECONST, the expenditure coefficient ($c_2(4)$) was not significant, while the temperature coefficient ($c_2(5)$) and the advertising indicator coefficient ($c_2(6)$) were significant at the 5 percent level. The advertising indicator coefficient indicates that more advertising for FRESH would decrease demand for RECONST. The critical level of the conjectural variation coefficient for FRESH ($c_1(7)$) was 22.3 percent, which indicates that firm 1's conjecture was not significantly different from zero. On the other hand, the conjectural variation for RECONST ($c_2(7)$) was significant at the 1 percent level. These results suggest the existence of interdependency among firms is statistically supported. That means the original Bertrand model, which assumes zero conjectural variations for all firms, is inappropriate for our empirical analysis.

Elasticities were calculated based on the sample means shown in table 2. The absolute value of e^{ow}_i (-6.665 and –9.187) may be large compared with U.S. price elasticities for food items. However, they are quite comparable to estimates from a recent study in Japan by Kinoshita et al. (2000). The reason why the estimated e^{ow}_i for brand levels in this study are much larger than previous estimates based on aggregate market data is because the present results reflect brand level competition, which is not true in the case of aggregate category data. These estimates support the Japanese retailers' contention that fluid milk is a much more elastic product than what previous studies have found.

The signs of both e^{cr}_{ij} are positive, and the magnitude of cross-price effects for FRESH is smaller than for RECONST (2.254 and 7.186). This result means q_i moves in the same direction as the change in p_j, i.e., a 1 percent reduction in the price of RECONST will result in a decrease in demand for FRESH by 2.254 percent; and 1 percent reduction in the price of FRESH will result in a decrease in demand for RECONST by 7.186 percent.

The value of e^{cv}_{ji} for FRESH is not significantly different from zero, while the value of e^{cv}_{ji} for RECONST is significant and positive (0.498). As shown earlier in equation (9), a perceived own-price elasticity (e_i), is composed of a partial own-price elasticity (e^{ow}_i), a cross-price elasticity (e^{cr}_{ij}), and a conjectural variation elasticity (e^{cv}_{ji}). Therefore, the absolute value of e_1 is equal to e^{ow}_1 because e^{cv}_{21} is zero, while the absolute value of e_2 is smaller than e^{ow}_2 because of the positive e^{cv}_{12}. The positive estimate has the interpretation that firm 2's conjecture of the effects of changes in p_2 on q_2 will be "lessened" by cross-price effects generated through firm 1's price reaction.

Thus, e_1 is larger than e_2 in absolute value, while the average price for FRESH (item 1) is much lower than the price for RECONST (item 2) (168.0 and 191.8 yen/liter). This is consistent with

the price discrimination practice of charging higher prices for more price- inelastic markets. If we use the conventional partial own-price elasticity, we cannot reasonably explain this situation because e^{ow}_1 is smaller than e^{ow}_2 in absolute value.

The estimated conjectural variations were tested to determine whether they represent consistent pricing behavior. Recall that consistent behavior means that firm i's estimated conjecture corresponds to firm j's observed price reaction. Mathematically, consistent pricing behavior can be examined by testing the following two null hypotheses:

(12) $c_1(7)=-c_2(4)/[2c_2(3)+c_2(4)c_2(7)]$, and

(13) $c_2(7)=-c_1(4)/[2c_1(3)+c_1(4)c_1(7)]$

If (12) and (13) both hold, then the conjecture is consistent. The test using Chi-square statistics showed that the p-value was 21.2 percent for the first null hypotheses (condition 12), and 4.8 percent for the second null hypotheses (condition 13). While the first null hypothesis could not be rejected, the second null hypothesis was rejected at the 5 percent level. Hence, the consistent pricing behavior could not be statistically supported. This result implies that one should be careful concerning the assumption of consistent pricing behavior in building models.

Conclusions

In this paper, we applied a generalized Bertrand-type model to the Japanese dairy market to gain insights on firms' pricing conduct regarding beverage milk products made from fresh milk and reconstituted milk. This model provides more detailed insights of pricing conduct in product-differentiated oligopoly markets than previous studies that have assumed all firms within the industry supply a homogeneous product and use quantity as a strategic variable.

Our empirical results, based on weekly scanner data, revealed that a key assumption of the original Bertrand model was violated. Specifically, the results indicated that the assumption that firms set prices independent of their rivals' reactions was rejected. That is, there is interdependency among firms in strategic price behavior. This result means that the original Bertrand model was inappropriate for our empirical analysis.

In addition, the estimated model resulted in substantially more elastic own-price elasticities than previous estimates in Japan based on aggregate market data. The more elastic results (relative to the aggregate data studies) reflect the brand level competition that is captured in our more micro-level data. These estimates support the Japanese retailers' contention that fluid milk is a more price elastic product than what previous studies had found. Incorporating estimated price conjectures into the model resulted in considerable discrepancies between partial and perceived own-price elasticities. The result shows that a firm's price conjecture can be an important factor in

determining the firm's perceived own-price elasticity. Consequently, an approach using perceived (or conjectured own-price) elasticities rather than traditional partial own-price elasticities may improve analyses of firms' conduct in an oligopolistic market.

Finally, the estimated conjectural variations were tested to determine whether they represent consistent pricing behavior. Consistent behavior means that firm i's estimated conjecture corresponds to firm j's observed price reaction. We found that consistent pricing behavior could not be statistically supported. This result implies that one should be careful concerning the assumption of consistent pricing behavior in building models.

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Table 1 Estimated Coefficients

	Estimate	p-value
$C_1(1)$	565.039	0.000
$C_1(2)$	-4.562	0.000
$C_1(3)$	1.344	0.000
$C_1(4)$	0.487	0.015
$C_1(5)$	-	-
$C_1(6)$	-	-
$C_1(7)$	-24.392	0.223
$C_2(1)$	44.362	0.035
$C_2(2)$	-0.747	0.000
$C_2(3)$	0.666	0.000
$C_2(4)$	-	-
$C_2(5)$	0.179	0.014
$C_2(6)$	-8.238	0.009
$C_2(7)$	0.437	0.003

Note: Dash (-) means that the variable was omitted because the estimated coefficient was insignifficant at the 5 percent level.

Table 2 Sample means, Elasticities, Price reaction and Consistent conjectures

		FRESH (Item 1)	RECONST (Item 2)
mean p_i	: item i's average price (yen/liter)	168.0	191.8
mean q_i	: item i's average quantity sold (liter/1,000 customers)	115.2	15.6
e_i	: perceived own-price elasticity	-6.665	-5.608
$e^{ow}{}_i$	: partial own-price elasticity	-6.665	-9.187
$e^{cr}{}_{ij}$	: cross-price elasticity	2.254	7.186
$e^{cv}{}_{ji}$	: conjectural variation elasticity	0.000	0.498
r_{ij}	: firm i's price reaction	0.147	0.553
cv_{ji}	: firm i's conjecture	0.000	0.437
ccv_{ji}	: consistent conjectural variation	0.479	0.159

V The Simulation Analysis of the Influence on Japanese Industries Due to the Increase in Imports of Farm Products and Processed Foods

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1. Introduction

Imports of inexpensive farm products and processed foods from abroad are rapidly increasing in Japan recently. This increase in imports of farm products made the price of domestic products sluggish and became a serious problem as a factor to worsen the management of domestic farmers. In April 2001, the Japanese government finally invoked a general safeguard (emergency restriction of imports) against three items, that is, Welsh onions, shiitake mushrooms, and rushes to protect domestic agriculture.

As key factors in the increase in imports of farm products, the following is pointed out:

a. Factors inside agriculture such as,
   1) The price of domestic farm products is comparatively high compared with that of imported products.
   2) The amount of supply of domestic farm products is unstable.
   3) The capacity of supplying from domestic agriculture decreased.

b. Factors outside agriculture such as,
   1) Quality of imported farm products improved (because the dealers in development and import made efforts, etc.).
   2) Strategies for decreasing the cost and selling inexpensively by introducing inexpensive imported farm products (by food makers and distribution dealers).

The imported farm products are roughly divided into those directly consumed almost without processing, and those consumed as raw materials for processing in other industries. The increase in inexpensive farm products and processed foods gives consumers the benefit of the decrease in price, but makes domestic farmers suffer from the decrease in demand for domestic farm products and in price as well.

On the other hand, the influence on the food industry is more complicated. For food manufacturers, the increase in imports of inexpensive farm products leads to the decrease in cost. However, the increase in imports of inexpensive processed foods leads to the decrease in demand for domestic processed foods that much. If food manufacturers keep using farm products made of comparatively expensive domestic raw materials, processed foods produced out of them become expensive, which leads to a defeat in price competition with the imported products. Therefore, food manufacturers are often required not only to make efforts to decrease the cost, but also to choose from the following:

1) To differentiate products clearly with expressing what domestic raw materials are used.
2) To raise a degree of dependence on raw materials for imported farm products. Or,
3) To expand overseas seeking for farm products of inexpensive raw materials and labor power.

However, choosing the latter two results in the decrease in demand for domestic farm products anyway. The increase in imports of farm products is closely related with the amount of domestic production of agriculture and the food industry in such a way.

This paper first presents an analysis model using an Input-Output Table in the next section, after grasped the actual conditions of rapid increase in imports of farm products, assumes and analyzes the influence on the amount of domestic production in each industry due to the increase in imports of farm products and processed foods, by studying some cases. As well as the influence on the price of domestic products due to the increase in imports of inexpensive products is taken up using the Input-Output Table (1995).

2. The Analysis Model

The Input-Output analysis has been applied to various problems and achieved a lot of results. Even when limited to agriculture in Japan, many problems have been analyzed using the Input-Output Table [1]. For instance, to grasp the industrial structure and to solve the factors in structural change targeted on agribusiness. As well as to calculate the influence on agriculture and the food industry due to a change of the given matters, such as setting of an exclusive fishery zone, the increase in imports, a change of the price of imported products, and the improvement of technology. Also to calculate the influence on the economy of Japan and the United States due to the opening of a market for rice, to analyze the relevance of economy between various regions and all-Japan using Interregional Input-Output Table and to compare the industrial structure of Japan and other countries.

Several models have been developed as an Input-Output model. There are two models, a competitive import type and a non-competitive import type as to dealing with the imported products. In this paper, these two models are used separately according to the problem.

For instance, the models are assumed as follows: 1) A competitive import type, to analyze the influence on domestic industries due to the increase in imports of farm products, considered the present situation that quality of the recently imported farm products has increased remarkably enough to substitute for domestic products. 2) A non-competitive import type, to analyze the influence on the price of domestic products due to the decrease in price of imported products, considered its characteristics.

The competition import type is expressed as (1), assuming that X is a column vector of total domestic products in each industry, A is a matrix of the input coefficient, F is a column

vector of domestic final demand, E is a column vector of the sum of exports, and IM is a column vector of the sum of imports.

$$AX+F+E-IM=X \quad \cdots(1)$$

In this case, it is usually assumed that the amount of imports in one industry changes in proportion to the total sum of intermediate demand and domestic final demand for the corresponding product to obtain the coefficient of imports. In this paper, however, analyzed how differently the influence on domestic agriculture and domestic industries varies when the increase in imports of the equal sum occurred, either for the final consumption or for raw materials. Therefore, it is not possible to approach to this kind of problem in a previous way to deal with the coefficient of imports.

That is why two types of the coefficients of imports, mj1, the coefficient of imports for intermediate demand, and mj2, the coefficient of imports for final consumption, are introduced in this paper.

It is assumed that the sum of imports of raw materials demanded intermediately as raw materials for other industries is in proportion to the sum of intermediate demand of the corresponding industry. As well as assumed that the sum of imports of the final consumption destined for final consumption is in proportion to the sum of domestic final demand. These coefficients of imports are obtained by the equations (2) and (3):

mj1, the coefficient of imports for intermediate demand

=the amount of imports for intermediate demand in the j industry

/ the total of intermediate demand ···(2)

mj2, the coefficient of imports for final consumption

=the amount of imports for final consumption in the j industry

/the sum of domestic final demand ···(3)

When I is an identity matrix, and M_1 and M_2 are matrixes of the coefficients of imports assuming that mj1 and mj2 are respectively on a diagonal and the other factors are all zero, the equation (1) is expressed as follows:

$$X-AX+M_1AX=(I-(I-M_1)A)X=(I-M_2)F+E \quad \cdots(4)$$

In the equation (4), if a matrix value of the coefficient of imports for intermediate demand increased by ΔM_1, assuming that domestic final demand, exports, and the coefficient of imports for final consumption are unchangeable, and imports of farm products and processed foods for raw materials are increased, total domestic products in each industry changes by ΔX of the equation (5). With this ΔX, the influence on domestic industries due to the increase in imports of raw materials is calculated as follows:

$$(I-(I-(M1+\Delta M_1)A))(X+\Delta X)=(I-M_2)F+E \quad \cdots(5)$$

Similarly, if a matrix value of the coefficient of imports for final consumption increased by ΔM_2, assuming that domestic final demand, the sum of exports, and the coefficient of imports of intermediate demand are unchangeable, and imports of farm products or processed foods for final consumption increased, total domestic products in each industry changes by ΔX of the equation (6):

$$(I-(I-M_1)A)(X+\Delta X)=(I-(M_2+\Delta M_2))F+E \quad \cdots(6)$$

An equilibrium price model is expressed in the equation (7)[2], assuming that P is a column vector of the price of domestic products, P^m is a column vector of the price of imported products, V is a column vector of gross value added, $A^{(d)T}$ is a transposed matrix of a technical coefficient matrix of domestic products, $A^{(m)T}$ is a transposed matrix of a technical coefficient matrix of imported products, and I is an identity matrix:

$$P=A^{(d)T}P+A^{(m)T}P^m+V \quad \cdots(7)$$

In this equation, assumed that gross value added is fixed. When arranged using an inverse matrix, the equation (8) is obtained. A price change ΔP that a price change of imported products ΔP^m influences on domestic products is calculated by this equation (8).

$$(P+\Delta P)=(I-A^{(d)T})-1\ A^{(m)T}(P^m+\Delta P^m) \quad \cdots(8)$$

3. The Trend of the Import of Farm Products in Recent Years

Table 1 shows the trend of imports of farm and marine products and processed foods in Japan. When reviewing the whole trend first, the total sum of imports of farm and marine products including non-foodstuffs increased as large as 2.8 times in about twenty years from 1980 to 1995. A growth rate of recent years from 1985 to 1990 and from 1990 to 1995 is higher than that from 1980 to 1985.

When reviewing each item of these twenty years, the sum of imports is most increased in marine products (5.47 times), followed by livestock-raising products (4.61 times) and farm products (2.38 times). In farm products, the sum of imports in other arranged foods including spices and alcohol, vegetables and their prepared items, and fruits and their prepared items greatly increased almost equal to or more than that of marine and livestock-raising products (4.73 to 6.52 times) in these twenty years. On the other hand, in items such as grain and grain milling, sugar and sugary products, oils and fats for raw materials, and oils and fats,

which become materials of other foods, the sum of imports is sluggish or decreases (0.56 to 1.16 times).

As in the above, the sum of imports of farm products and processed foods on the whole, and also in many items, is rapidly increasing recently. However, in farm products and processed foods which become material of other products, the sum of imports is sluggish in some cases. Therefore, a growth rate of the sum of imports greatly differs in each item.

Table 2 shows that for what use imported farm products and processed foods are destined using the Input-Output Table. In farm products and processed foods, some items, such as fruits, flour milling, noodles, bread, confectionery, alcohol and non-alcohol, have a higher rate of final consumption. While some other items, such as edible crops, sugar, oils and fats, and seasoning, which become material for other foods, have a higher rate of processing.

Therefore, Table 2 shows a ratio of imported products for processing (not for final consumption) in comparison with that of domestic products.

First in the total of the sectors, a ratio of imported products for processing is 87.8% in crops (that of domestic products is 55.3%), 59.8% in the total of livestock-raising products and marine products (74.0%), and 59.7% in the total of processed foods (27.3%). As a whole, a ratio of processing is remarkably high in imported products than in domestic products.

When reviewed each item, in all of them except vegetables, fruits, livestock-raising, and fisheries, a ratio of processing is high in imported products. Especially items such as vegetables, edible crops, inedible crops, processed livestock-raising products, sugar, oils and fats, seasoning, and frozen foods, keep a high value of more than 86%. It is safe to say that most of the imported products are for processing.

Now, checking a share of the imported products in the sum of processing of farm products and processed foods in Table 2. A share of the imported products is as high as 56.5 to 65.5% in wheat, edible crops, processed marine products, and processed farm products. In these items, the imported products are used as raw materials for processing more than domestic products. However, when excluding these items, a share of the imported products is as low as less than 40%.

Similarly, a share of the imported products in the sum of final consumption, it is slightly high as 21.9 to 37.0% in wheat and barley, livestock-raising, and processed farm products. When excluding these items, it is quite low as less than 10% in many items.

In this way, a share of the imported products is much lower in farm products and processed foods for final consumption than in those for processing, and domestic products have a very high share.

The above share of the imported products is reviewed in the sum of money. Considering the actual conditions that in general imported products are inexpensive than domestic ones, a share of imported products in quantity becomes slightly higher than shown in Table 2. Attention must be paid to this point.

These are characteristics of imported farm products and processed foods in various destinations (shipment) totaling the values of the Input-Output Table horizontally. By analyzing the Table vertically, it is possible to grasp cost components of the input from each industry.

The food manufacturing industry is generally said that a ratio of the cost of raw materials is high, and a ratio of gross value added, including such as profit, is low. Table 2 definitely shows that a ratio of the cost of raw materials in farm products is 40 to 50% (51.0% on average) in many items. While a ratio of the cost of raw materials in processed foods is slightly low as 48.8% in alcohol and non-alcohol, but in other sectors considerably higher as 60 to 70% (61.5% on average) than that of the agriculture sector.

Needless to say, farm products and processed foods are produced not only by inputting raw materials only from agriculture and the food manufacturing industry, but also by inputting production factors such as energy, machinery, and facilities from other industries. Related with this point, Table 2 shows a cost ratio of input factors necessary to produce one unit of farm products and processed foods. It shows that a cost ratio of the input factors from other industries is 17.8 to 35.9% (28.1% on average).
While that of the agriculture sector and the food manufacturing sector is 7.0 to 63.7%. Though the difference in items is big, a ratio is not so high as 31.3% on average.

Among them, a ratio of the input cost of factors by the imported farm products and processed foods is slightly high as 13.4% in sugar, oils and fats, and seasoning. Excluding these, a ratio of the input cost of factors is 2.9 to 8.8% in every item of processed foods, and a very low value of less than 1.0% in all items of farm products.

This suggests even if the import of inexpensive farm products rapidly increases, (as long as reviewing the industrial classification of this size), there is a fair possibility that domestic price is not influenced greatly.

4. The Result and Examination of the Simulation Analysis

i) How the increase in imports influences on domestic industries

In this section, "The Input-Output Table focused on Agriculture, Forestry, Fisheries, and Food Industry (1995)" by Association of Agriculture & Forestry Statistics is used as the data (attached a floppy). In this Input-Output Table, industries are subdivided into 104 sectors. Here united them to 20 sectors shown in Table 3 (and added eating and drinking places) to use in the following analysis.

First assumed the sum equivalent to 10% of the present sum of imports of farm products (355.6 billion yen) occurred in the following four cases:

1) The import increased in farm products for processing (Case 1)

2) The import increased in farm products for final consumption (Case 2)

3) The import increased in processed foods for processing (Case 3)

4) The import increased in processed foods for final consumption (Case 4)

Obtained the coefficient of imports in the equation (2) when Cases 1 and 3 occurred, and in the equation (3) when Cases 2 and 4 occurred. Substituted the coefficients of imports obtained in this way respectively for the equations (5) and (6). Then calculated in each equation the changed sum ΔX of total domestic products in each industry, when the increase in imports occurred in each case. Table 3 shows the calculated ΔX in a ratio of decrease (in minus %) of total domestic products.

The increase in imports of this size very likely occurs in reality. The conditions related with the coefficient of imports in each sector ($0 \leqq mj1$ and $mj2 \leqq 1$) are completely met.

In each industry that assumed the increase in imports occurred in each case, set the coefficient of imports in each industry[3] so that the sum of imports increases in proportion to the current sum of imports, and the total sum of imports becomes 355.6 billion yen in each case.

In general, when the import increased in farm products and processed foods, imported products substitute for domestic products, and total domestic products decrease that much. This decrease in total domestic products has the first influential effect that demand for other industries decreases, and derives this influential effect as the second, the third, and so on. The result of calculation in Table 3 is equilibrium values of these derived effects. From this result of calculation, it is possible to point out as follows:

1) When the import of farm products or processed foods increased, the total domestic products of each industry decreased by 0.069 (Case 1) to 0.077 (Case 2) than the values of 1995. This is approximately twice as large as the assumed sum of the increase in imports (1.95 times on average). From this, by the increase in imports of farm products and processed foods, not only total domestic products decrease following the substitution of imported products for domestic products, but also the minus derived effect of nearly the same sum occurs to domestic industries.

2) Seeing from the size of the sum decreased in total domestic products, even if the same sum, the increase in imports of farm products for final consumption has more influence on the agriculture sector than those for processing. On the contrary, the increase in imports of processed foods for material has a little more influence on the food manufacturing industry than those for final consumption.

3) In each sector, when the import of farm and marine products for processing increased, a ratio of decrease in total domestic products is high in sectors such as edible crops (total domestic products decreased by 17.92% of the present value), crops for feed and forage (6.69%), potatoes and pulses (6.68%), and livestock-raising (3.10%). On the other hand, when the import of farm products for final consumption increased, a ratio of decrease in total domestic products is high in livestock-raising (7.12%) and fruit trees (5.51%).

Similarly, when the import of processed foods for material increased, a ratio of decrease

in total domestic products is high in processed farm products (5.33%), processed marine products (3.92%), sugar, oils and fats, and seasoning (2.26%). On the other hand, when the import of processed foods for final demand increased, a ratio of decrease in total domestic products is high in processed farm products (7.31%) and processed marine products (4.26%).

In this way, the sectors influenced by the increase in imports of farm products, or processed foods greatly varies depending on either for processing or final demand.

4) Regardless of use, the influence on the food manufacturing industry due to the increase in imports of farm products, as well as the influence on domestic agriculture due to the increase in imports of processed foods, are very small (because a ratio of decrease in total domestic products of each sector is less than 1.0%). However, only when the import of processed marine products increased, there is the mutual relevance between fisheries and processed marine products that total domestic products of fisheries decreased by 2.16 to 2.34%.

5) Processed foods with characteristics of final consumption such as flour milling, noodles, bread, confectionery, frozen foods, alcohol and non-alcohol, even if the import both for final consumption and intermediate demand increased, total domestic products are hardly influenced (a ratio of decrease is less than 1.0%).

ii) How the decrease in price of imported products influences on price of domestic products

Table 4 shows the items of which price decreases by more than 0.1% and its value by calculating the influence on price of domestic products when that of imported products decreased by more than 10% with the above equation (6). To calculate the influence on price of domestic products when that of imported products decreased by 20%, double the values of Table 4 from the assumption of a linearity.

From this table, for instance, when the imported price of edible crops decreased by 10%, the domestic price of feeds, fertilizers, tobaccos, and that of oils and fats of plants and animals, and seasoning decreased by 0.56% and 0.52% respectively.

Similarly, when the imported price decreased by 10% in fisheries, livestock-raising, sugar, oils and fats, and seasoning, and in potatoes and pulses, the domestic price decreased by 0.71% in processed marine products, 0.66% in processed livestock-raising products, 0.48% in sugar, oils and fats, and seasoning, and 0.42% in sugar and oils and fats respectively.

In this way, when the imported price of farm products and processed foods decreased by 10%,

1) Even if the domestic price decreased in some processed foods, a ratio of decrease is not big.
2) The domestic price of farm products is hardly influenced, except that the domestic price of animals decreased (0.38%) due to the decrease in the imported price of inedible crops.

Attention must be paid that the result of the calculation above slightly changes depending on the industrial classification. For instance, when subdivided the industrial classification of Table 4 and selected the flour milling industry and the industry of oils and fats of plants and animals. When the imported price of wheat, potatoes and pulses, and edible crops decreased by 10%, the domestic price of flour milling, oils and fats of plants and animals, and oils and fats of plants and animals decreased by 1.77%, 2.05%, and 1.61% respectively.

This means, for instance, assumed that a certain farm product is imported in quantity and inexpensively. Even if the influence on the domestic price is determined to be small as a larger industrial sector, it is quite likely that the domestic price badly decreases in the said item and other related items. It is necessary to pay attention to this matter.

Related with this point, calculated the influence on the domestic price when the imported price of all farm products and processed foods, not a specific item, decreased by 10%. The number of the items with the domestic price decreased by more than 0.10% increased to 11 items and 9 items respectively. Also a ratio of decrease in price is quite high in each item. From this point, when the price of imported products decreased in several items, not a specific item, at the same time due to a change of the exchange rate, it is very likely that the domestic price decreases greatly.

However, the result of calculation in Table 4 shows even if the imported price of farm products and processed products decreased, the influence on the domestic price is not so severe (especially on farm products).

This is greatly influenced by a ratio of the cost of raw materials and that of the input of imported products. As already shown in Table 2, a ratio of the cost of raw materials in crops is lower than that of processed foods, and a ratio of the imported products in the cost of raw materials is very low.

On the other hand, in processed foods, although a ratio of the input cost of imported farm products and processed foods is slightly high, the sum of the input of production factors from other industries is bigger than that from agriculture and the food manufacturing industry. Therefore, even if the price of imported products of farm products and processed foods decreased, the domestic price is not much influenced on the whole.

However, when reviewing each item, in processed foods such as sugar, oils and fats, seasoning, processed livestock-raising products, and processed marine products, a ratio of the cost of raw materials is relatively high. A ratio of the imported products (farm products and processed foods) in the cost of raw materials is also slightly high. Therefore, the decrease in the imported price of farm products and processed foods results in the decrease in the cost of raw materials, which makes the price of domestic products decrease to that extent.

5. In Conclusion

In this thesis, grasped the actual conditions of the increase in imports of farm products and processed foods, and calculated and analyzed the influence on domestic industries and the domestic price due to the increase in imports to get some useful pieces of knowledge.

However, there are several problems such as to grasp a yearly change of the industrial structure by the Some Years Link Input-Output Tables, and to analyze mutual relevance between the agriculture sector and the food manufacturing industry based on the more detailed industrial classification. Those problems still remain to be analyzed in future.

1) A case that analyzed the problem of agriculture and the food industry in Japan using the Input-Output analysis is reviewed, for instance, by Ueji, T. [1] and Ohga, K [2], and is recorded in Ministry of Agriculture, Forestry and Fisheries of Japan Minister's secretariat eds. [3] as a reference.

2) To lead this equation, referred to pp. 88- to 95 of Ministry of Agriculture, Forestry and Fisheries of Japan Minister's secretariat eds. [3].

3) From simulation of Table 3, excluded wheat and analyzed others because the increase in stock is a big minus value, and the total of final demand is a minus value as well.

Reference

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[3] Ministry of Agriculture, Forestry and Fisheries of Japan, Minister's secretariat eds., "Economic Analyses using Input-Output Table – The Present Condition of Agriculture, Forestry, Fisheries and Food Industry of Japan", Association of Agriculture & Forestry Statistics, 1990.

Table 1 The trend of imports of farm and marine products

(Unit: The actual figures are in $ million)

	1980	1985	1990	1995	1998 (figures)
Total of farm, forestry and marine products	100	99	190	284	215(56,871)
Farm products	100	105	168	238	216(25.871)
Grain and grain milling	100	89	103	116	108(4,737)
Fruits and arranged items	100	171	322	473	385(2,711)
Vegetables and arranged	100	130	298	596	576(3,003)
Sugar and sugary items	100	22	48	56	41(570)
Luxury foods	100	103	116	198	183(1,968)
Other arranged foods	100	94	439	652	678(3,539)
Oils and fats $ these for raw materials	100	91	101	113	116(2,329)
Livestock-raising products	100	143	300	461	328(9,325)
Marine products	100	146	330	547	393(13,274)

Notes : "The Agro Trade Handbook", JETRO

Table 2 A ratio of the cost structure of destinations and foods of imported farm products and imported processed foods

(1995, Unit: %)

	A ratio of destinations for processing		A share of imported products		A ratio of the cost of raw materiales	A ratio of cost Component	
	Imported Products	Domestic products	for processing	for final consumption		input from other industries	input from agriculture and the food industry (Import)
Rice and grain milling	97.3	58.0	0.3	0.0	66.8	19.6	47.3 (0.0)
Wheat and barley	101.7	104.2	59.4	37.0	52.7	31.7	20.9 (-)
Potatoes and pulses	94.1	65.1	39.1	7.0	40.1	26.6	13.6 (-)
Vegetables	18.8	30.6	2.0	3.7	33.4	26.4	7.0 (0.2)
Fruit trees	29.6	39.2	12.2	17.6	30.2	20.0	10.3 (-)
Edible crops	96.1	56.6	65.5	9.1	47.2	31.8	15.4 (0.2)
Inedible crops and others	98.2	71.6	27.3	1.7	39.7	25.7	14.0 (1.0)
Livestock-raising	56.5	74.1	17.1	31.2	81.4	17.8	63.7 (1.0)
Marine	71.6	74.8	12.7	14.6	39.2	28.2	11.1 (1.0)
Processed livestock-raising products	90.8	26.7	16.5	0.7	75.3	28.3	47.0 (8.4)
Processed marine products	58.1	14.5	56.5	13.7	68.8	27.0	41.9 (8.8)
Flour milling, noodles, and bread	30.3	22.3	2.6	1.7	61.3	31.1	30.2 (5.8)
Processed farm products	52.6	17.2	59.8	21.9	66.7	35.7	31.0 (4.4)
Sugar and seasoning of oils and fats	96.0	56.9	13.5	0.9	70.9	37.8	33.1 (13.4)
Frozen cooking foods	86.3	33.3	10.0	0.9	62.1	30.5	31.6 (5.3)
Alcohol and non-alcohol	39.3	27.1	7.9	4.7	48.8	35.9	13.0 (2.9)
Total of crops	87.8	55.3	18.4	3.7	51.0	22.8	28.2 (0.3)
Total of livestock-raising and marine	59.8	74.0	15.7	26.6	67.4	21.3	46.1 (1.0)
Total of processed foods	59.7	27.3	18.8	5.6	61.5	32.2	29.3 (6.3)

Notes: 1) Used the data from "The Input-Output Table focused on agriculture, forestry, fisheries, and the food manufacturing industry (1995)", Association of Agriculture & Forestry Statistics

2) Excluded feeds, fertilizers, and tobaccos from the total of processed foods for destinations

Table 3 A ratio of decrease in the sum of total domestic products when the import increased by 355.6 billion yen in farm and marine products or processed foods

(Unit: %)

	The import increased in farm and marine products		The import increased in processed foods	
	Intermediate demand	Final consumption	Intermediate demand	Final consumption
Rice and grain milling	0.11	0.08	0.08	0.09
Wheat and barley	0.30	0.64	0.24	0.37
Potatoes and pulses	6.69	1.18	0.92	0.31
Vegetables	0.10	1.09	0.31	0.35
Fruit trees	0.78	5.51	0.26	0.37
Edible crops	17.92	2.00	0.63	0.37
Inedible crops	4.93	1.34	0.10	0.06
Livestock-raising	3.10	7.12	0.35	0.08
Marine	1.63	1.87	2.16	2.34
Processed livestock-raising products	0.01	0.01	1.15	0.21
Processed marine products	0.02	0.02	3.92	4.26
Flour milling, noodles, and bread	0.00	0.01	0.14	0.45
Processed farm products	0.00	0.00	5.33	7.31
Sugar and seasoning of oils and fats	0.05	0.10	2.26	0.45
Frozen cooking foods	0.09	0.01	0.79	0.24
Alcohol and non-alcohol	0.00	0.01	0.48	1.08
Feeds, fertilizers, and tobaccos	0.63	1.27	0.08	0.03
Mining and manufacturing industries	0.02	0.02	0.03	0.03
Commerce and service industry	0.02	0.02	0.03	0.03
Total domestic products of agriculture	2.081	2.339	0.431	0.380
Total of processed foods	0.021	0.018	1.336	1.334
Total domestic products	0.069	0.077	0.076	0.075

Notes: 1) 355.6 billion yen is equivalent to 10% of the current sum of imports of farm products.

2) Omitted the sector of eating and drinking places because the increase in imports does not influence on it.

3) By the increase in imports, total domestic products of each sector decrease.

Table 4 The influence on the domestic price of farm products and processed foods when the imported price decreased by 10%

The decrease in price of the imported products	The items influenced by the decrease (a ratio of decrease in price, %)
Rice and grain milling	
Wheat and barley	Flour milling and noodles(0.25)
Potatoes and pulses	Sugar oils and fats(0.42) Frozen foods(0.10)
Vegetables	
Fruit trees	Processed farm products(0.21)
Edible crops	Feeds and fertilizers(0.56) Sugar oils and fats(0.52) livestock-raising(0.16) Alcohol and non-alcohol(0.14)
Inedible crops and others	Livestock-raising(0.38) Feeds and fertilizers(0.18) Marine(0.13) Inedible crops(0.13)
Livestock-raising	Livestock-raising processing(0.66) Frozen foods(0.16) Eating and drinking places(0.14)
Marine	Marine processing(0.23) Fisheries(0.11)
Processed livestock-raising products	Livestock-raising processing(0.21)
Processed marine products	Marine processing (0.71) Eating and drinking places(0.17) Frozen foods(0.15)
Flour milling, noodles, and bread	
Processed farm products	Processd Farm products(0.22)
Sugar and seasoning of oils and fats	Sugar oils and fats(0.48) Feeds and fertilizers(0.12)
Frozen cooking foods	Flour milling and noodles(0.12)
Alcohol and non-alcohol	Sugar oils and fats(0.98) Livestock-raising processing(0.81)
Farm and marine products	Flour milling and noodles(0.42) Livestock-raising(0.38) Frozen foods(0.38) Processed farm products(0.31) Marine processing(0.25) Eating and drinking places(0.25) Alcohol and non-alcohol(0.16) Fisheries(0.13) Inedible crops and others(0.13)Marine processing(0.73) Sugar oils and fats(0.54) Flour milling and
Processed foods	Noodles(0.37) Eating and drinking places(0.33) Frozen foods(0.30) Livestock-raising processing(0.27) Processed farm products(0.26) Feeds and fertilizers(0.17) Alcohol and non-alcohol(0.16)

Notes: 1) Described the items only of which price decrease by more than 0.1%, and omitted other items of little influence less than that value.

2) Included inedible crops and agricultural services, etc. in farm and marine products in this table.

VI How Consumers Obtain Food Safety Information

- A Case of Identified Animal Transaction System in England: preliminary mimeo -

Masakazu Nagaki
(Tsukuba University)

1. How do we Obtain Food Safety?

1) The difficulties of judging the food safety

Food safety is one of the important commodity quality components. In the market competitive economy, food safety should be reflected to the market price. Then, low food safety products will disappear. However, food safety is significantly different concept from traditional quality standards and, at least, two essential problems may be underlayed;

(1) the difficulty of the measurement, and

(2) the difficulty of judgments.

Corresponding to the first problem, the development of 'Identified Food Marketing Chain' is being advocated. The latter may be caused by that the concept is one of subjective matters depending on the individual preference. Addition to this, the problem recently seems to be a worldwide political issue after GMO products had become available. There is no absolutely reliable study report which leads to the conclusion that GMO is harmful (or not harmful) to human being, although ecological damage is easily anticipated and these dis-ordering natures may consequently have diverse effects to human being.

2) Who guarantees the food safety

There seems to be some reasoning that food safety should be realized as a social role and, therefore, it may be am important public service government provides.

(1) Food safety is not merely a kind of commodity qualities. Food safety issue directly concerns to the health and life of consumers. Therefore, an authorized agency must intervene to some extents.

(2) Food safety is not observable. Individual consumer has no way to see the degree to what extents the commodity guarantees safety when he/she buys it. In other words, 'the asymmetoricity of information' generally exists in transaction between producers and consumers.

(3) In a market economy, there is no limitation of commodity flow both in the

special horizon and time horizon. Global-standard measurements and treatment procedures are desirable.

3) Why recently does society stress the recognition of the food safety?

Food production technology is advancing with high potential biotechnology innovations and food diversification according to consumer preferences. These may be classified in to;

(1) Particularly, recent consumers' interest to organic food,

(2) Unexpected disease infestations and accidental event's occurrences. BSE and O-157 are the examples recently occurred in Japan.

(3) The third is rather caused by uncontrolled outside food producers and processors. Atomic energy plant accident and high toxic dioxide content at producing areas have been experienced recently in Japan. These accidents damage more than concerned products because of the kind of 'rumor damage' which mostly result in producers' economic losses.

(4) Finally, free trade became a basic policy rule after the government agreed and accepted WTO rules. The volume and kind of imported food are expanding in the market and, thus, consumers became aware of the commodity safety.

2. Cow Identification System in the UK

The author visited the UK in 2000 for the field study to understand in detail about The Cattle Identification Information System. The system is regarded and accepted as a key component of the identified chain marketing system in the UK. In deed, the UK became one of the most advanced countries in establishment of so-called 'The Traceability' of the food animal after many BSE infested cows had found, particularly during the past decade. The author visited MAFF and one of Local Agricultural Department offices in Worcester. The followings are the summary of a field survey.

1) The roles of MAFF District Department Office

Worcester District Office is the office serves for 5 counties in the district where 700,000 ha of farmland are being cultivated by about 20,000 farm households. Major roles of the office are as follows;

(1) Consumer services

a) Supervise food marketing activities from the fair competition viewpoint.

b) Maintenance and improvement activities for the food safety.

c) Institutional assistances for accomplishment of efficient food marketing.

d) Monitoring and protection activities for environmentally sound agriculture and food industry sectors.

(2) Services to farm households and rural spaces

a) Executing various subsidy programs under EU-CAP administration.

b) Executing various subsidy programs of Non EU-CAP Scheme.

c) Monitoring and maintenance concerning environmental problems in the rural area (farmland, forestry, water quality, wild animals, etc.)

d) Education and extension activities concerning to the environmental issue and policy program.

One of the major daily activities is the animal identification program.

2) The UK Cattle ID System

The UK Cattle ID System for the milk cow and beef cattle is an essential government managing DB system which started under the legislation named BARIMO (The Bovine Animal Record, Identification, and Movement) in 1995. This is re-legislated and called BCMS (British Cattle Movement Service) since September 1998 when the content was enhanced.

The main elements of Cattle Identification are:

(1) Physical identification (Ear Tagging)

(2) Documentation (Cattle Passports)

(3) Farm Records

Formerly Local Veterinary Public Health Center issued and has attested both herd ID and cow ID numbers. However, after the BARIMO legislation, huge and detailed computer processing system was introduced where ETAS (Ear Tag Allocation System) is placed in the core part of the system.

3) Physical Identification by Ear Tagging : Short history

(1) Prior to 1995, cattle were identified by tagging or distinguishing marks (e.g. tattoos).

(2) Herd marks were allocated by local Animal Health Offices.

4) BARIMO-1995

The Bovine Animals Order (Records, Identification and Movements Order: BARIMO) introduced a centralized Ear Tag Allocation System (ETAS)) in 1995. Each

herd in the UK was allocated with a unique herd mark and, thus, Unique Cattle Identification (UCI/example:UKZG0124). All livestock farms have to receive the Herd No. Also, each animal born must be identified with a unique tag comprising of:

a) Country Identifier - 'UK'

b) County Identification number

c) Herd Mark - One or two letters & four numbers

d) Unique Animal Number - Five numbers

(1) Double Tagging

Compulsory Double Tagging was introduced for all animals born since January 1, 1998. Animals are now retaining the same identity throughout their lives.

(2) Numeric Tagging

EU Member States were required to introduce numeric identification codes by the January 1, 2000.

(3) From January 17, 2000, all new tags issued in the UK will bear numeric codes.

(4) Producers may use up existing stocks of alphanumeric tags until June 30, 2000.

(5) Numeric tags must be used for all calves born from July 1, 2000.

(6) Herd Marks

a) All existing alphanumeric head marks have been replaced with numeric herd marks.

b) Producers have been informed of their new herd marks.

c) The herd mark remains with the holding.

(7) Timeshares for Tagging

From January 1, 2000, calves must be tagged within the following time scales:

a) Calves born to dairy herds: apply one tag within 36 hours;
apply second tag within 20 days.

b) Calves born to other herds: apply both tags within 20 days.

(8) Ordering Ear Tags

Producers are restricted to ordering no more than a year supply of Ear Tags. There are 12 MAFF authorized Ear-Tag manufacturers. When producer orders Ear Tags, he is automatically sent application forms to apply for the passports for those animals.

5) Documentation: Cattle Passports

(1) Cattle Passports

Compulsory Cattle Passports were introduced in July 1996. These were issued by the local Agricultural Department offices in England, Wales and Scotland. Producers were required to manually record all movements on the Cattle Passport. Any animals

born or imported since Journey 1, 1996 has been ineligible for human consumption unless accompanied by a Cattle Passport.

(2) British Cattle Movement Service (BCMS)

The British Cattle Movement Service (BCMS) came into operation on the September 28, 1998. All producers in England, Wales and Scotland must apply to BCMS for passports. BCMS issue cheque book style passports.

(3) BCMS Passports

BCMS are notified of every movement of an animal either:

a) by completion of a movement card; or

b) by electronic notification.

BCMS have a full record of each animal's movements and can determine which animals with new-style passports are present on any holding at a given time.

6) Farm Records

For each animal a producer is required to record:

a) Ear Tag number

b) Breed

c) Date of Birth

d) Sex

e) Identity of Dam

f) Details of movements on or off the holding.

Producers can use the Herd Register to keep a running total of the number of animals on their holding.

7) How to maintain the traceability

(1) What livestock farms and traders have to do

a) Keep cow ID information--Lifetime Passport System.

b) When BSE and/or other specified epidemics are found, the farms have to reports at once by the route of the local veterinarian office -> domestic animal public health center -> BCMS.

(2) What government do

Staffs of BCMS visit livestock farms of 10 percent in the registration farms every year, and check whether the individual is correctly registered.

(3) Effectiveness – Global System

The new EU-wide coding system has been introduced in all EU member countries since .

Numeric Tag

1

BCMS

- BCMS issue cheque book style passports, and maintain the old-style passports.

2

Ⅶ An Econometric Analysis of Japanese Consumer Preferences for HACCP and Eco Labeled Milk

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1. Introduction

The food safety of milk is an issue of concern for Japanese consumers because of food poisoning affair of dairy sector in Japan. Food poising broke out by processed milk and milk beverage produced by Osaka plant of Snow Brand Milk Products Co. Ltd, and developed into huge scale accounting to 13,420 people fell ill. Damages for financial conditions of dairy farmers were negligible, but Japanese consumers have become very anxious about food safety of milk and shifted from processed milk and milk beverage to raw milk. This issue not only raised concern about the attention to the food safety but also resulted in criticism the argument whether present HACCP system was appropriate as a certification of the food safety.

In the sector of dairy farming, "Manure treatment law" is scheduled to apply to dairy farmers in 2004. This law was enacted to conserve the environmental natural resources and recycle manure as fertilizer. As a consequence of this regulation, dairy farmers are going to be prohibited from stacking manure without storage facility. Although many of dairy farmers have to improve their manure treatment systems, some farmers balance in their choice because of alternative manure treatment systems have additional investment costs.

Dairy sector in Japan faces such issues with changing consumer's consensus. In this paper, we estimate Japanese consumer willingness-to-pay (WTP) for milk using a variety of quality variables such as the HACCP label and/or the Eco-milk label. Using these empirical WTP estimates, we draw conclusions about possible effects of providing information about food

safety with labeling. Survey results indicate that Japanese consumers place a greater monetary value on milk with the HACCP label and/or the Eco-milk label than on non-labeled milk. These results have important implications for the dairy sector in Japan attempting to reduce production costs.

This study focuses on two objects:

1) To evaluate Japanese consumer willingness-to-pay (WTP) for milk with the HACCP label and/or the Eco-milk label.

2) To assess how consumer characteristics affect the WTP for milk with these labels.

2. Impact of Food Poisoning in the Dairy Sector and Manure Treatment Regulation

1) Impact of the food poisoning outbreak in the dairy sector in Japan

On June 27, 2000, food poising resulting from processed milk and milk beverage produced by Osaka plant of Snow Brand Milk Products Co. Ltd, developed into huge scale affecting 13,420 people.

The cause of the outbreak was Skimmed Milk Powder (SMP) contaminated with enterotoxin of *Staphylococcus aureus* produced by Taiki plant of Snow Brand (located at Taiki town in Hokkaido Prefecture). This SMP is partly used as raw material for processing.

The Ministry of Agriculture, Forestry, and Fisheries (MAFF) took emergency measures in cooperation with the Ministry of Health and Welfare (MOFA), Prefectural governments, dairy associations and Snow Brand as follows;

a) Measures for improvement of sanitation management and risk management system for dairy processors,

b) Measures aimed at promoting consumption and advertising reliability of milk and dairy products,

c) Measures designed to improve the reallocation of raw milk collection/delivery, alleviating the growing difficulties of contract retailers to secure steady production and distribution.

Following the outbreak, the raw milk consumption which had been in declining trend for a long time, increased drastically, on the contrary those of processed milk and milk beverages consumption have declined drastically, mainly because;

a) processing milk was kept at a distance from consumers, and

b) other dairy processors were forced to shift to milk production which is less time/cost consuming in order to make up for the shortage of drinking milk caused by halt of production in Snow Brand plants.

The financial impact in conditions of dairy farmers was negligible, because;

a) reallocation of raw milk collection/delivery was carried out smoothly as a result of the measures taken by MAFF,

b) Snow Brand paid for increasing cost of transportation arising from reallocation of raw milk collection/delivery, and

c) raw milk production for drinking use was increased due to the shift of consumption from processed milk to raw milk.

In the context of the outbreak, following three demands were raised from consumers to the government.

(1) Revision of the HACCP approval system

It is clear that the duties fixed in the HACCP system based on Food Sanitation Law had not been observed before the outbreak, the reliability of the system being questioned. To improve the application of the system and to strengthen monitoring and guidance, MOFA took following measures;

a) An assessment Committee was set up to facilitate advise for the application of HACCP,

b) On site surveillance for approval and follow up monitoring carried out by officers of MOFA were strengthened.

c) Raw milk production for drinking use was increased due to the shift of consumption from processed milk to raw milk.

d) Seven Regional Health and Welfare Administration Office was established and Food Sanitation Inspectors were posted.

(2) Guidelines were made for the recycling process of drinking milk

Through the process of making the cause clear, it was unveiled that the recycle of drinking milk was carried out generally by the dairy processors. This fact was received with exception, and many criticisms such as that the recycling of drinking milk should be prohibited were pointed out by consumers. MOFA held a committee of intellectuals for considering recycling of drinking milk, and published a report indicating that dairy processors' association shall make specific guidelines on this issue by December 2000. Following this report, Japan dairy Industry Association made their voluntary guidelines and required, its members being required to observe the guidelines in May 2001. The contents are as follows;

a) The volume to recycle should not exceed 0.5 percent of annual production of drinking milk (product weight basis) by each plant.

b) When recycling milk beverage for the production of milk beverage, non recycling day should be designated once or twice a week in order to restrict a frequency of the recycle.

c) The product for recycling should

i) spare more than half of the shelf life, "consumption period" or "quality keeping period", which was set by themselves, and

ii) be limited to what is kept under control in the plant.

d) The product for recycling should also take a sanitation test.

(3) Drinking milk labeling

The revision of drinking milk labeling was also pointed out by consumers, and its improvement was requested.

2) Impact of manure treatment regulation on dairy farming

In the sector of dairy farming, "Manure treatment law" is scheduled to apply to dairy farmers in 2004. This law was enacted to conserve the environmental natural resources and recycle

manure as fertilizer. Under the regulation dairy farmers are going to be prohibited from stacking manure without storage facility. The details of regulations are as follows:

a) The constitution of manure management standard by the minister of MAFF.

b) The manure management by livestock farmer according to manure management standards.

c) The advisory and the directive by the prefectural governor.

The manure management standard consists mainly in:

a) The ban on stacking manure without the storage facilities. The storage facilities are required to be impermeable in order to avoid the leaking of manure into the subsoil.

b) The checking on the storage facilities periodically.

c) The record of the quantities of manure produced and disposed in each facility.

Although many of the dairy farmers have to improve their manure treatment systems, some farmers reluctant their choice because of alternative manure treatment systems have additional investment costs. Hokkaido, the northernmost island of Japan, has the biggest share (43%) of milk production. Not only milk but also dairy manure is outputted and amounts to 20% of total livestock manure in Japan. As a result, people in Hokkaido have become very anxious about drinking water pollution by dairy manure. Hokkaido government reported that only 8 percent of dairy farmers have manure treatment system according to the standard (Hokkaido [3]). Iwamoto et al. reported that Hokkaido dairy farmer's agricultural income would diminish between 65% and 83%, if the alternative manure treatment systems were introduced (Iwamoto et al. [5]).

3. Methods

Because market-level data on sales of milk with label versus non-label of HACCP and Eco-milk (ecolabel) is unavailable, collection of primary data was necessary. A mail survey was developed and questionnaires ware sent to consumers in Obihiro city. The survey

contained a choice experiments (CEs) in which consumers made choices between three types of milk with varying levels of quality keeping period, price, and labeling/non-labeling of HACCP and Eco-milk.

1) Choice Experiments and Previous Study

The CEs is a type of conjoint analysis developed in psychology in 1960s. Since it was introduced in the marketing research literature in 1970s, CEs has been frequently used in environmental, marketing, and transportation literature to predict consumer choice by determining the relative importance of various attributes in consumers' purchasing decisions. With this methodology, quality parameters used to describe choices faced by respondents can be varied relatively easy. Underlying this approach is the assumption that consumers derive utility of the attributes embodied in a good, rather than deriving utility from the good itself (Lancaster [8]).

CEs has several advantages over typical CV methods. First, the CE is appealing because it is based on random utility theory (See Ben-Akiva and Lerman [1] about RUT). Second, CEs is more general than typical CV methods because it allows for multi-attribute valuation and permits the measurement of trade-offs between numerous attributes. Third, CEs allows adding an option "I would not buy any of them" to choice set.

Previous studies using CEs or conjoint analysis for food safety or quality of food include Sato et al. [13], Manalo et al. [10], Kuperis et al. [6], Quagrainie et al. [12], Unterschultz et al. [15]. Sato et al. [13] analyzed Japanese consumer preferences for the safety of rice. Manalo et al. [10] used CEs to examine the impact of providing safety assurances in the form of inspection information and source information on consumer preferences for oyster in the U.S. Northeast. Kuperis et al. [6] analyzed consumer preferences for recombinant somatotrophin (rBST) treated milk in Canada. Quagrainie et al. [12] used CEs to examine the potential effect of identified product origin and selected demographics on consumer choice of red meats in western Canada. Unterschultz et al. [15] evaluated Korean attitude towards Canadian beef

relative to competing beef from the U.S. and Australia using CEs.

2) Milk Attributes and Attribute Levels

In our survey, consumers were asked to make a choice between three types of milk, each described by three quality variables and one price variable, in a set of eight questions. An information sheet, included with the survey, described each of the three quality variables: quality keeping period, and labeling/non-labeling of HACCP and Eco-milk. The price variable was included to provide a monetary valuation of the variations in the other attributes. Respondents were also allowed to indicate that they would not buy any of three types of milk. The attributes of price and quality keeping period were included in the analysis because of their importance in the consumer milk purchasing decision. Quality keeping period and price have been identified as the most important palatability attribute in milk (Sawada et al. [14]). The attributes of HACCP and Eco-milk labels were also added to the CE because they were the primary variables of interest in this study. Quality keeping period is defined in the fair competition regulation by the Fair Trade Commission in Japan, and HACCP certification is accepted by the Ministry of Health, Labour and Welfare. Eco-milk label is a virtual label on this study, and is assumed that the label is defined as a certification of abidance under the Manure Treatment Law (will be applied in 2004). A sample CE question is shown in figure 1 and table 1 indicating the different levels of each attribute.

3) Profile Design

The profile (choice) design is one of the most important aspects CEs. Although orthogonal designs appear to be widely used, Huber and Zwerina propose "utility balance" which means balancing the utilities of the alternatives offered in the choice sets as an criteria of choice design. Market choice set tend to be utility-balanced through competition, therefore utility balance may serve a dual role of increasing both the efficiency and the realism if a choice experiment (Huber and Zwerina [4]). Zwerina et al. [16] show a computerized search strategy, which created a statistically efficient choice design with anticipated model parameters, using

algorithm proposed by Kuhfeld et al. [7]. In this study, we adopted the method of Zwerina et al. [16] using estimated parameters of pretest samples as prior information.

4) Choice Experiment Model

The theoretical basis of choice behavior in CEs is random utility theory (RUT). According to RUT, the nth respondent is assumed to obtain utility U_{in} from the ith alternative. U_{in} is assumed to be comprised of two parts as follows:

$$U_{in} = V_{in} + e_{in}, \quad (1)$$

where V_{in} represents objective components and e_{in} represents an error component, which captures the effects of omitted or unobserved variables. Therefore, the probability of respondent n choosing alternative i is:

$$P_{in} = \text{Prob}\,(V_{in} + e_{in} > V_{jn} + e_{jn}) \text{ for all h in Choice set C, } i \neq j \quad (2)$$

If the error components are assumed to be independently and identically alternatives (IIA) and distributed according to an extreme value (Gumbell) distribution, the conditional logit model:

$$P_{in} = \exp(V_{in}) / \Sigma \exp(V_{jn}), \quad (3)$$

is obtained. The location parameter is commonly normalized 0, and the scale parameter is normalized to 1.

In this study, we estimated the model, which contains respondent characters as cross effect,

$$V_{in} = \Sigma_{k \in C} \beta_k X_{ik} + \Sigma_{k \in C} \Sigma_{h \in N} \gamma_{kh} X_{ik} S_{hn}, \quad (4)$$

where S_{hn} represents characteristics of nth respondents, X_{ik} represents attributes of the ith alternatives and β_k, γ_{kh} are parameters. Respondent character variables have to be estimated interactively because they are invariant across the alternatives in a choice set.

The conditional logit model required the assumption of Independence of Irrelevant Alternatives (IIA). One of the major sources of the IIA violations is heterogeneity in preferences. In this case, one expects that inclusion of respondent character variables in the model may mitigate inaccuracies due to IIA violations (Louviere [9], Blamey et al. [2]).

4. Results

In December 2000, 300 questionnaires were mailed in Obihiro City, situated in the east of Hokkaido. Initially, post cards were sent to recruit individuals to complete a mail questionnaire. The questionnaires were sent to respondents who agreed to complete the questionnaires with a milk coupon as a reward. Remainder cards ware sent after two weeks. This mail survey was based on the method of Mangione [11]. Mailing lists were obtained from a constituent list in Obihiro City. After adjusting for undeliverable surveys, response rate was 34.9%. Summary statistics are reported in table 2. 70.2% of the woman who respond to the questionnaire were housewives. This is because we requested that the individual who did most of the grocery shopping for the household complete the questionnaire. Average age of respondent was 46 years old, very similar to average age in Obihiro City. Average respondent income and the household size were also similar to those of salaried in Obihiro City.

1) Conditional Logit Estimates

Table 3 reports the estimates of equation 4. The value of ρ^2 adjusted is 0.296. The coefficient for the price attribute was, as expected, negative, and was satisfied statistically significant at 1% level. The results for this model provide how characteristics of respondents affect the probability of choice.

The coefficients for the interaction of Income with Quality Keeping Period, HACCP label, and Eco-milk label were positive as expected and significant. The interaction of Income with Price was negative and significant.

The coefficients for the interaction of Weekly expenditure for milk with Quality Keeping Period, and HACCP label were negative as expected and significant. The interaction of Weekly expenditure for milk with Price was positive and significant. The interaction of Weekly expenditure for milk with Eco-label was negative and not significant.

The coefficients for the interaction of Child with Quality Keeping Period, and Eco-milk label were positive as expected and not significant. The interactions of Child with HACCP label and

Price were negative and not significant.

The coefficient for the interaction of Confidence for HACCP with HACCP label was positive as expected and significant. The interaction of Confidence for HACCP with Quality Keeping Period was positive as expected and not significant. The interactions of Confidence for HACCP with Eco-milk label and Price were negative and not significant.

The coefficient for the interaction of Attention to HACCP label with HACCP label was positive as expected and significant. The interaction of Attention to HACCP label with Eco-milk label was positive as expected and not significant. The interactions of Attention to HACCP label with Quality Keeping Period and Price were negative and not significant.

The coefficients for the interaction of Need for Ecolabel with Eco-milk label and Price were positive as expected and significant. The interactions of Need for Ecolabel with Quality Keeping Period and HACCP label were negative and not significant.

2) Simulations

Using the estimated model above, two simulations were conducted comparing non-labeled milk with HACCP labeled milk and Eco-milk labeled milk. The results are shown in Table 4 and Figure 2.

To estimate the value of the milk with HACCP label and Eco-milk label, we increase the price of the HACCP labeled milk until the level of utility for non-labeled milk is identical. In other words, we chose the price level, PHACCP, such that V_{ij} *(HACCP)* = V_{ij} *(non-label)*. $P_{non\text{-}label}$ is fixed at 150 yen. The difference in prices (PHACCP - Pnon-label) between the two simulated milks can be viewed as the value of the HACCP label to the representative consumer. The representative consumer was defined that the income = 6.61 million yen (average in respondents), average "weekly expenditure for milk" = 487 yen, the dummy of "Confidence for HACCP system", "Attention for HACCP label", "Need for Ecolabel" = 0. The same procedure was followed to estimate the value for the milk with Eco-milk label.

Table 4 demonstrates the required prices of the HACCP labeled and/or the Eco-milk labeled

milk to equalize probability of choice with the non-labeled milk (150 yen) for the representative consumer. The price of the HACCP labeled milk should be 158 yen (5% increase), if the non-labeled milk was retailed with HACCP label. Retailed with the Eco-milk label, the price should be 169 yen (12% increase). We also estimate the value of HACCP label and Eco-milk label obtained by Contingent Valuation Method (CVM). The average CVM estimate of the HACCP label is 164 yen (9% increase), and the median estimate of the HACCP label is 168 yen (12% increase). The average CVM estimate of the Eco-milk label is 164 yen (9% increase), and the median estimate of the Eco-milk label is 160 yen (7% increase).

Figure 2 indicates required prices of the HACCP labeled milk to equalize the probability of choice with the non-labeled milk (150 yen) in the parametric varying Weekly expenditure for milk. This result shows how changes of Weekly expenditure for milk affect the preferences of consumers. As Weekly expenditure for milk increases, the required price of the HACCP labeled milk decreases. This means that the heavy user evaluated the HACCP label lower than the light user.

5. Conclusions and Implications

In this study, a "Choice Experiments" was conducted to reveal the Japanese consumers preference for milk retailed with HACCP and Eco-milk label.

The main results from our empirical study are as follows:

1) In the case of the non-labeled milk was retailed with HACCP label, the price should be 158 yen (5% increase), if. On the other hand, the price of milk with the Eco-milk label should be 169 yen (12% increase).
2) As Weekly expenditure for milk increases, the required price of the HACCP labeled milk decreases. This means that the heavy user evaluated the HACCP label lower than the light user.

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Table 1. Milk Attributes and Attribute Levels in the Conjoint Survey

Milk Attribute	Attribute Levels
Freshness	① 5 days before expiry date ② 6 days before expiry date ③ 7 days before expiry date ④ 8 days before expiry date
HACCP Label	① non-labeled ② labeled
Eco-Milk Label	① non-labeled ② labeled
Price	① ¥140/litre ② ¥145/litre ③ ¥150/litre ④ ¥155/litre ⑤ ¥160/litre

Table 2. Comparison of the demographic characteristics of sample and Obihiro residents

	Sample	Obihiro
Age of respondent (average)	45.9	46.3[b]
Gender (female rate)	59.4%	51.5%[b]
Rate of housewife in female responden	70.2%	
Size of Household (average)	3.09	2.3[b]
Size of Salaried household (average)		3.32[a]
Household Income (average)	¥ 6.61 million	
Salaried household Income (average)		¥ 6.5 million[a]
Weekly expenditure for milk (average)	¥ 487	

Souce: a) *National Survey of Family Income and Expenditures 1995*, Statistics Bureau, Japan. b) *Population Census 1994*, Obihiro city.

Table 3. Conditional Logit Estimates

Variable	Definition	Coefficient[a)]	t-value
BD	Freshness of a milk(These values range form "5 days before expiry date" to "8 days before expiry date")	0.001	(0.007)
BHACCP	HACCP Label(1 if labeled, 0 otherwise)	-0.239	(-0.689)
BECO	Eco-milk Label(1 if labeled, 0 otherwise)	-0.084	(-0.249)
BP	Price (¥/liter)	-0.035 **	(-2.595)
CRID	Income × Freshness	6.542E-08 **	(3.695)
CRIH	Income × HACCP Label	1.639E-07 **	(4.205)
CRIE	Income × Eco-milk Label	1.487E-07 **	(4.200)
CRIP	Income × Price	-3.975E-09 **	(-3.919)
CRMD	Weekly expenditure for milk × Freshness	-5.124E-04 **	(-3.155)
CRMH	Weekly expenditure for milk × HACCP Label	-9.759E-04 **	(-3.087)
CRME	Weekly expenditure for milk × Eco-milk Label	-1.313E-04	(-0.426)
CRMP	Weekly expenditure for milk × Price	3.254E-05 **	(3.420)
CRCD	Child[b)] × Freshness	2.315E-01	(1.709)
CRCH	Child × HACCP Label	-2.189E-02	(-0.080)
CRCE	Child × Eco-milk Label	5.039E-02	(0.186)
CRCP	Child × Price	-2.778E-03	(-0.328)
CRHCD	Confidence for HACCP[c)] × Freshness	0.062	(0.491)
CRHCH	Confidence for HACCP × HACCP Label	1.209 **	(4.799)
CRHCE	Confidence for HACCP × Eco-milk Label	-0.256	(-1.024)
CRHCP	Confidence for HACCP × Price	-0.012	(-1.560)
CRSD	Attention to HACCP Label[d)] × Freshness	-0.088	(-0.746)
CRSH	Attention to HACCP Label × HACCP Label	1.183 **	(4.888)
CRSE	Attention to HACCP Label × Eco-milk Label	0.439	(1.842)
CRSP	Attention to HACCP Label × Price	-0.009	(-1.338)
CRED	Need for Ecolabel[e)] × Freshness	-0.171	(-1.433)
CREH	Need for Ecolabel × HACCP Label	-0.051	(-0.208)
CREE	Need for Ecolabel × Eco-milk Label	1.022 **	(4.250)
CREP	Need for Ecolabel × Price	0.005	(0.705)
ASC	Alternative Specific Constant	7.787 **	(6.352)
n(Choice Set)		768	
L(0)		-1,064.7	
L(β)		-721.685	
ρ^2		0.322	
adjusted ρ^2		0.296	

Note: [a)] "*" indicates that parameter is statistically significant at the 5% level and "**" indicates significance at the 1% level. [b)] 1 if respondent has child, 0 otherwise. [c)] 1 if respondent confide HACCP system, 0 otherwise. [d)] 1 if respondent pays attention to HACCP label when purchasing, 0 otherwise. [e)] 1 if respondent needs Ecolabel, 0 otherwise.

Table 4. The Results of Simulation: Required Willingness-to-Pay to equalize probability of choice with the status-quo

	status-quo	Willingness-to-Pay Estimate		
Freshness	8 days before expiry date	8 days before expiry date	8 days before expiry date	8 days before expiry date
HACCP Label	non-labeled	labeled	non-labeled	labeled
Eco-Milk Label	non-labeled	non-labeled	labeled	labeled
Price (unit:¥/liter)	***150*** ***(100)***	158 (105)	169 (112)	177 (118)
CVM Estimates (unit:¥/liter)	***150*** ***(100)***	med. WTP 168 (112)	med. WTP 160 (107)	—
		ave. WTP 164 (109)	med. WTP 164 (109)	—

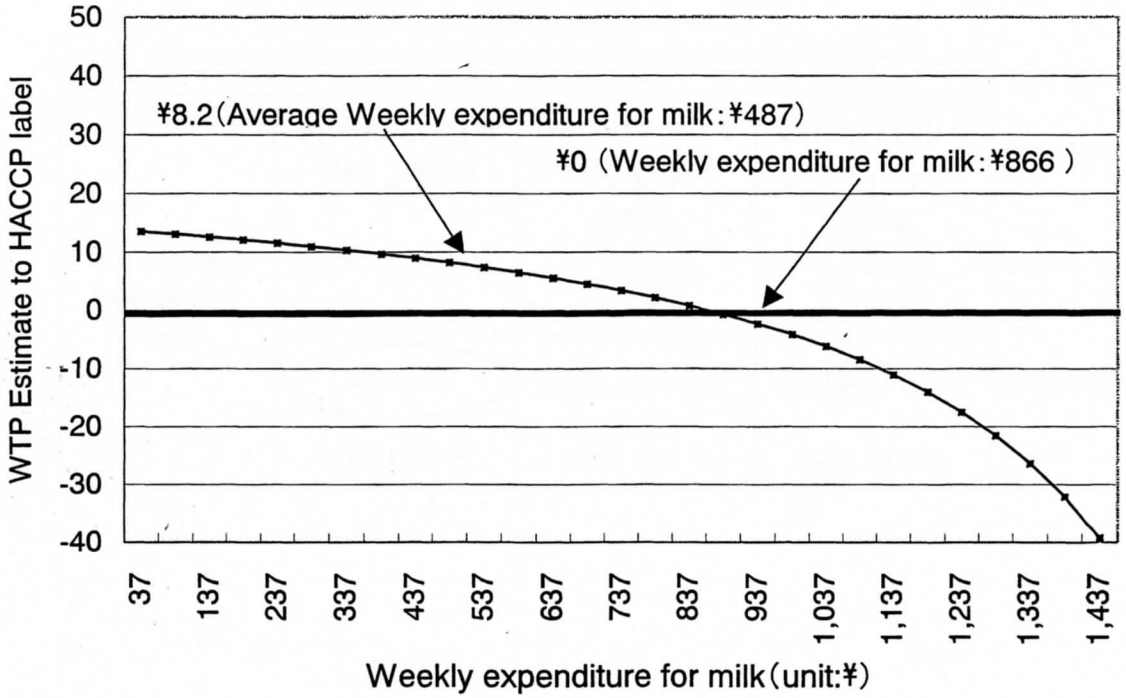
Note: Respondent characters are fixed on 1) income = ¥ 6.61 million, 2) No-child, 3) Average weekly expenditure for milk = ¥ 487, 4) Dummy of "Confidence for HACCP system", "Attention for HACCP label", "Need for Ecolabel" = 0.

Figure 1. The Example of the Choice Set

Which would you buy if the 3 types of milk listed below were available? (CIRCLE ONE)

	1	2	3	4
Freshness	**5** days before expiry date	**6** days before expiry date	**6** days before expiry date	
HACCP Label			(non-labeled)	I would not buy any of them
Eco-Milk Label	(non-labeled)	(non-labeled)	Eco-Milk	
Price	¥ 145 /liter	¥ 155 /liter	¥ 140 /liter	

Figure 2. The effect of weekly expenditure for milk on Willingness-to-Pay estimete to HACCP label



Note: Respondent characters are fixed on 1) income = ¥ 6.61 million, 2) No-child, 3) Average weekly expenditure for milk = ¥ 487, 4) Dummy of "Confidence for HACCP system", "Attention for HACCP label", "Need for Ecolabel" = 0.

Ⅷ Food Safety Chain Using IT

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1. Introduction

In Japan, many troubles related food safety having been occurred after another. GMO corn mixing, succeeding alien substance mixing, poisoning by milk contaminated with staphylococci, foot-and mouth disease, dioxin, E. coli O157 ([1]), etc., there are too many cases of this trouble to count. On the very time, cows infected with BSE (mad cow decease) are found. Consumers became to show keen concern in food safety and suspect their reliance on food industry. Governmental reaction, however, was one step behind as usual. It strengthened consumers' anxiety about food safety. This anxiety is stemmed from the insufficiency of information disclosure.

As for safety, we can inspect and confirm it scientifically. While confidence in consumers is the problem in consumers' mind depends on how much information offered. In other words, we can say, safety is the issue in the world of *things*, but confidence is the issue in the world of *information*. When a cow infected BSE found, governmental and municipal officers declared that they tried to avoid the damage of stockbreeders not consumers. This announcement aroused consumers' hostility. Many papers have reported the damage of decreasing beef consumption as the damage due to rumors in the streets. For consumers, anxiety is not merely a rumor, it is just reality in their minds. We have to recognize anew that assuring safety and confidence in consumers' mind is the issue on quite different dimensions. People concerned of food safety both in government and industry do not understand this fact. To build confidence in consumer's mind, it is needed to provide reliable information continuously. It is just the informational issue.

To ensure food safety, it is the most popular way to implement HACCP system. Although even implementing HACCP system, confidence in consumers' mind may not be build, because consumer do not rely HACCP system itself and the commodities produced at HACCP plant at present. They already know that contamination issue of milk, above mentioned, have broken out with milk produced at HACCP plant. Due to this outbreak of poisoning, HACCP system has lost its reliance in Japan.

To build confidence in consumers' mind, supplier has to introduce one more system, i.e.,

traceability system. Now Japanese government has started to grant subsidies to improve food safety. One of these subsidies is for development of traceability systems. To trace every stage of food marketing channel that they are passed through and to assure safety are critical to build confidence in consumers' mind. Traceability is just the issue of information. All the parties concerned food industry need to make up a complete food safety chain with offering every information related food safety to acquire reliance upon consumers again. In this paper, we consider the food safety chain using IT.

This paper is organized as follows: firstly we consider the difference of safety and confidence in consumer's mind, then we introduce both HACCP system and traceability system, next we propose our idea of complete traceability system and food safety chain using IT, at last we point out some problems to diffuse this food safety chain in whole food industry.

2. Safety and Confidence

Usually they think that assuring safety and building confidence is the same thing. We think, however, these are quite different matter. In general, people concerned food industry believe that assuring food safety scientifically is all they needed to build confidence in consumers' mind. We should consider these issues, safety and confidence, separately.

Safety issues of foods depend on biological, physical and chemical problems can be confirmed scientifically and evaluated objectively. It is merely an issue related *things*. To assure safety of food is not so difficult and complicated. In every stage of food chain, if all parties implemented a safety assuring system, such like HACCP, contaminated food would have been excluded from the whole food marketing chain. So no consumers must have been poisoned or harmed with food. While to build confidence in consumer's mind is just a mental issue. We have no tool to measure and evaluate it scientifically and objectively for each consumer. In other words, it is just the informational issue what and how information should be provided to build confidence in consumer's mind. We still have not so much knowledge under what condition consumers feel confidence in food, how much and what kind of information is needed to build consumers' confidence. It is rather hard to build confidence than assure safety. We only understand that strength of confidence in consumers' mind change with the volume of information provided.

Many people concerned food industry believe that to ensure food safety scientifically is directly related to consumer's confidence. In Japan, corresponding outbreak of BSE, government introduced BSE screening test, and declared that with this test the beef

marketed is assured its safety. Immediately after the introduction of this test, the Minister of MAFF appeared in a TV news program, and he ate beef to appeal safety of beef. Many consumers ought to have watched the program, but they did not increase their beef consumption at all. We have to conclude that the show had no effect. No one trusted Minister's performance. He did not provide the appropriate information that consumers requested to consume beef without any anxiety. It is not enough to build up confidence only to assure safety but providing relevant information. To assure safety and to build confidence is just a quite different thing. Minister could not understand this. Now we should recognize safety and confidence is not the same matter.

3. Safety Assuring System – HACCP –

At first we introduce the most popular safety assuring system, HACCP. Hazard Analysis and Critical Control Points (HACCP) system is the internationally accepted tool that has to be implemented and used to assure that all the significant food safety hazards are appropriately controlled. HACCP is based on identify and control potential problems before they happen. Traditional food safety inspection programs react to problems and correct hazardous conditions after they occur. Contrary HACCP system is designed to anticipate problems before they occur. It enables all the trade parties concerned food safety, such like producers, processors, transporters, retailers, etc., to identify the foods and processes that are most likely to cause foodborne troubles. To develop HACCP system, they have to identify the critical control points (CCPs) in food production ([2]). A CCP is an operation (practice, preparation, step or procedure) in the flow of food that will prevent, eliminate, or reduce hazards to acceptable levels. The most of commonly use CCPs are cooking, cooling, reheating, and hot/cold holding. For each CCP, critical limits, upper limit or lower limit, defined scientifically, and when these boundaries are exceeded, a hazard may exist or could develop. A well-defined critical limit makes it easier to determine when limit has not been met.

To ensure food safety HACCP system should include system to monitor and control of the CCPs. HACCP system should also establish corrective action to be taken when monitoring indicates is not under control and procedures for verification to confirm that the system is working effectively. Moreover HACCP should establish documentation concerning all procedures and records appropriate to these principles and their application.

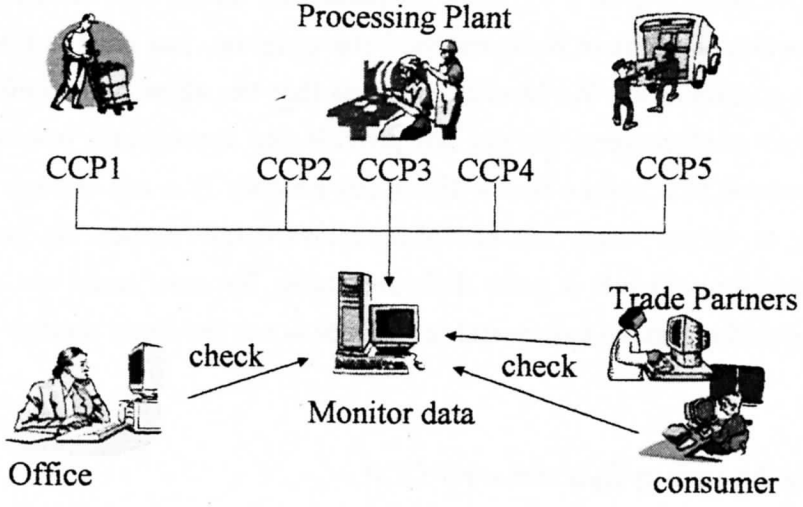

Fig 1 Safety Assuring System -HACCP-

Strict operation of HACCP system enables concerned parties to ensure food safety. Of course, in Japan, many plants have already implement HACCP, and unfortunately a poisoning outbreaks at one of these implemented plants. We think that the reason why HACCP did not function well as a safety assuring system is in the fact it did not disclose the information of monitoring result both internal and external. With implementing HACCP, information concerned on safety are all collected and documented. If monitoring data was disclosed internally (Fig 1), some employee or executives easily find out the hazard, and stop operation. They could stop these contaminated products to market. Furthermore if they disclosed these information to consumers, consumers easily understand how safe the commodities are, and trust their safety. Disclosure of the monitoring result helps to build confidence in consumer's mind. Of course good manufacturing practice (GMP) of employees is the most basic requirements. And to establish business moral in food industry is also prerequisite. With any effective system, if employees do not work under GMP rule, food safety is just only an idea. HACCP plan is a good system to assure food safety, however, it cannot build confidence with itself. HACCP system functions well only after disclosing all the information related safety as a part of food safety chain.

4. Traceability System and Identify System

As mentioned above, to build confidence is an issue of information. Consumer rely

commodities only after the information related safety are disclosed and having a chance that they can easily access the information anytime they like. Growing manner, transport method, store condition, raw materials, etc., consumer like to know all these information to understand whether commodities they consumed are safe or not.

After BSE outbreak, Japanese government introduced BSE screening test to every beef cattle slaughtered, and they declared all the beef marketed would be safe. With this test, however, we can only understand the beef is not contaminated with BSE.

Now some traceability systems are being developed and beginning feasibility test. We introduce the system for beef cattle developed by JA ZENNOU briefly (Fig 2.) JA ZENNOU (National Federation of Prefectural Economic Organization, national organization of agricultural cooperatives,) develops and implements the system to open the information of history of every beef cattle.

At first, breeder attaches ear tag with ID number issued by MAFF. This ID will move with calf until it slaughtered after growing into beef cattle. When cattle slaughtered, ID is attached to carcass on barcode label, and it moves with carcass. And the slaughterhouse issues certification of passing BSE screening test, breeder stores this information with the information on breeding. Usually beef are sold in chunk or slice, and sometimes beef are processed into hum, etc. In this case processor or retailer attach ID on the commodities.

If some accident occurred, consumers put ID into their PC, they can easily trace to the breeding ranch, and get the information how the cattle are bred. They can find also slaughterhouse where the cattle slaughtered, result of screening test. This system will well perform as an identify system but traceability system. Because with this system we can know only origin, i.e., breeder, slaughterhouse, and the result of BSE test, we never know the information of whole chain, where it processed, how it has been stored. Although this system enables us to verify the origin, it cannot assure safety. From this viewpoint, BSE is an exceptional case that need not inspect safety at every stage of food chain. Beef once passed the BSE screening test never be infected with it. BSE is serious issue but remarkably simple to avoid damages. To verify origin is not the same matter to assure safety.

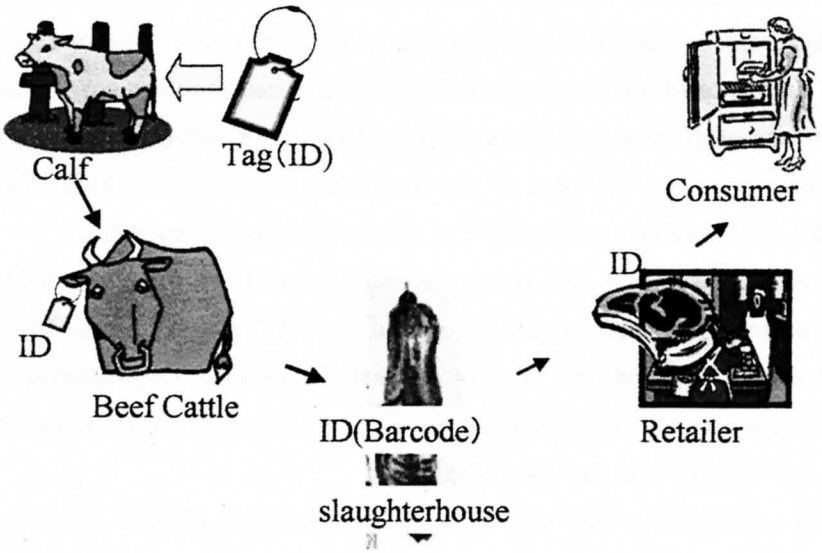

Fig 2 "Traceability" System for Beef

We know there are many risks that beef may be contaminated and become a cause of foodborne illness. Even with this system we cannot understand if the beef was contaminated with some microbes/pathogens except BSE. At the same time several traceability systems are being developed with and without governmental subsidies, however almost all of them are merely systems to identify origins such like a system mentioned above. Of course to know origin is basic interest for consumers, however, they also like to know how to deal them at every stage in food supply chain until they reach the tables. If they could not know all the information related food safety, they do not rely them at all. They will never purchase the products once issued again. Because the anxiety in their minds has never been eliminated without providing appropriate information.

Contamination of food may occur in every stage of food supply chain, from field to table. Tracing procedure should be started where the accident took place. We always become aware occurrence of accident after consumption. In other words, no one consume contaminated food, no accident takes place. Start point of trace always should be consumption spot. We cannot recognize the system mentioned above as a traceability system but an origin identify system. This system will fail to build a confidence in consumer's mind.

Another system for processed food is now being developed with governmental subsidy. This system intend to disclose HACCP monitoring information to trade partners, however, also this is not complete due to the lack of traceability from consumption spot

to production spot. The systems above introduced might fail to build confidence due to the lack of function, safety assuring or complete traceability.

5. Complete Traceability System

Of course food safety issue is always occur at the final stage of food chain, i.e., consumption stage. So tracing procedure always has to be started from consumption stage. In other words, we start tracing procedure from the commodities at the store, such like a pack of cut lettuce, chunk or slice of meat, canned juice, etc. From the consumption spot we should to trace to origin, lettuce field, ranch or stock farm, orchard of grapefruits, etc. Moreover we have to trace along the distribution channel, where they are temporally stored, where they processed. However many traceability systems already developed enable only to identify origin not every stage that commodity passed through like mentioned above.

Many food products change their styles in supply chain, it generate another problem. At every stage in food supply chain, traceability system has to enable to identify every commodity. For example, grower ship lettuce in a carton box. Then in some plant, lettuce are cut, packed and shipped to another plant. Then cut lettuce are mixed with cut onion and cucumber, etc., to be marketed as salad pack. Traceability system has to identify all these commodities at each stage, sometimes lettuce in a carton box, sometimes in a salad pack on the shelf. And in the case of processed food traceability system should enable to identify all raw materials from the final commodities if needed.

We propose a plan to develop complete traceability system using IT (Fig 3.)

The uniqueness of our idea is in the way of manage information of each commodity includes raw materials with ID number, and the way of manage the detailed information that they are managed at each job site, farm, ranch, processing plant, transport terminal, distribution center, etc. Separation of *things* and *information* enables us to realize this idea. We think it is efficient to develop safety assuring system and traceability system separately. Traceability system should concentrate to trace commodities from the table to field or plant and identify the people/company who dealt them. If we could identify them, we can easily request to disclose the detailed information related safety. And if farmers/processors open these information on inter net, we can access the information directly. Safety assuring system performs efficiently when it is operated at each job site using the system developed corresponding the specific operation and commodities.

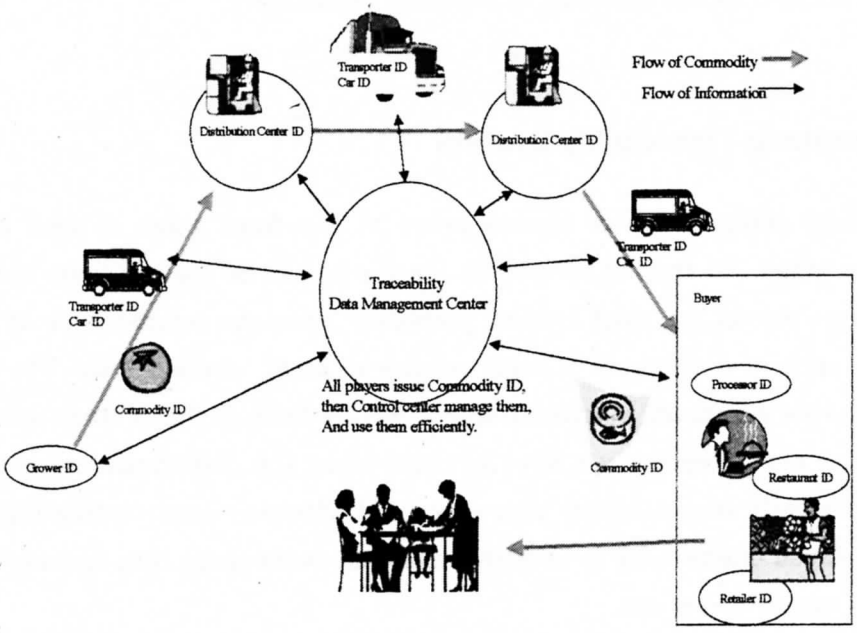

Fig 3 Concept of Trace-ability System

To identify every commodity, all the commodities have their own ID. Contrary if all commodities have had their own ID, we can easily reach to the producing site. More over at every stage in food chain if they conveyed commodity ID they dealt to data management center (DMC) with their own ID, we can easily trace the channel that commodities passed through. To trace along supply chain, we need not so much information, we need IDs of commodities and dealers and the date of something happen additionally on the commodities.

Traditionally this kind of information is delivered with commodities. Information flows on barcode label or some devices like it. Recently 2-dimentional barcode is developed, and using this much more information put into the barcode label. However barcode has a limit from the nature of it, barcode label is just the *thing* itself and they should be delivered with commodities. Many foods change their styles during they are distributed as mentioned above. Barcode label should be renewed each time when commodity style changes. To put on new barcode label so many times is time and cost wasting. Indeed barcode is the easiest device when commodities may not change their styles to identify producers. Unfortunately foods change their styles many times in supply chain.

IT enables us to separate *things* and *information*. Using barcode, even 2-D barcode, we cannot realize the advantage of separation. Today we need not to deliver information attached with commodities, and we now can exchange information and have them jointly. Using IT we can reduce the cost of providing and exchange information at

remarkably law than ever.

We propose using inter net as a device to convey information. Now Internet is ubiquitous tool in the world, and can access with mobile devices.

We show the data flow little in details. At first DMC issues ID for each party respectively. Growers/producers registered commodity IDs when they ship it with their ID. Commodity ID is registered with following items to identify them, producer/grower ID, commodity name, date of registration, lot number, etc. Transporter, of course also has its ID, register commodity ID they transport with its ID, and the date. DMC stores the information relates the original commodity ID. If we need to identify the transporter, we only need to access DMC and search information. In the same way, when some traders deal the commodity, they will convey the information to DMC with their own ID and date. Thus relational database for tracing procedure is build. Structure of the database is very simple. It forms like an index of the book (Fig 4.)

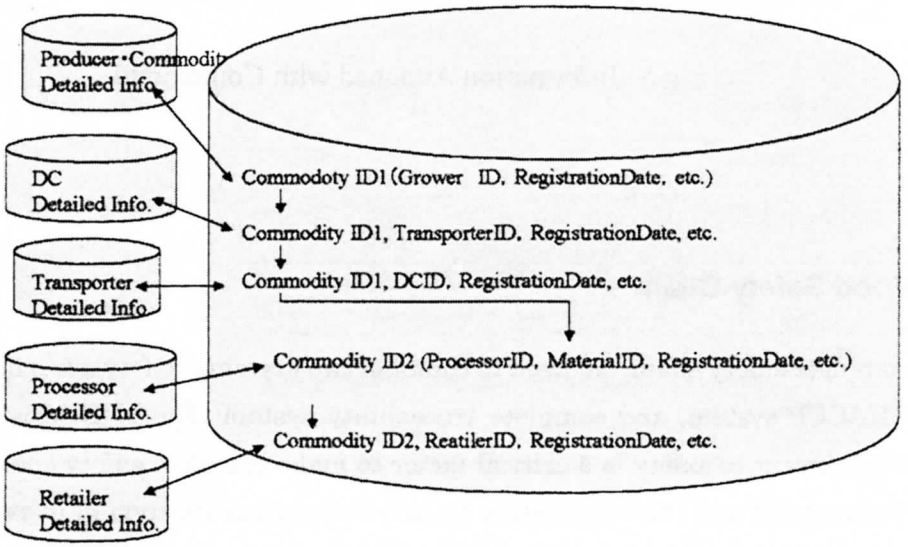

Fig 4 Structure of the Database managed by Control Center

And each party attached the minimum information on barcode label (Fig 5.) The information put in label is only commodity ID. No other information needed to identify the commodity and trace back through supply chain. Other information on food safety is managed by each party at each job site respectively, growers store what chemicals used, transporter stores how they treat commodities, processors store what raw materials used, etc. On this way detailed information is managed at each job site, then the cost of operating this system may become remarkably law.

Of course to assure accuracy and truth of information is another problem. However once

some party deceived consumer, it lost confidence and never continue business. We expect no parties dare to deceive consumers at the risk losing the confidence.

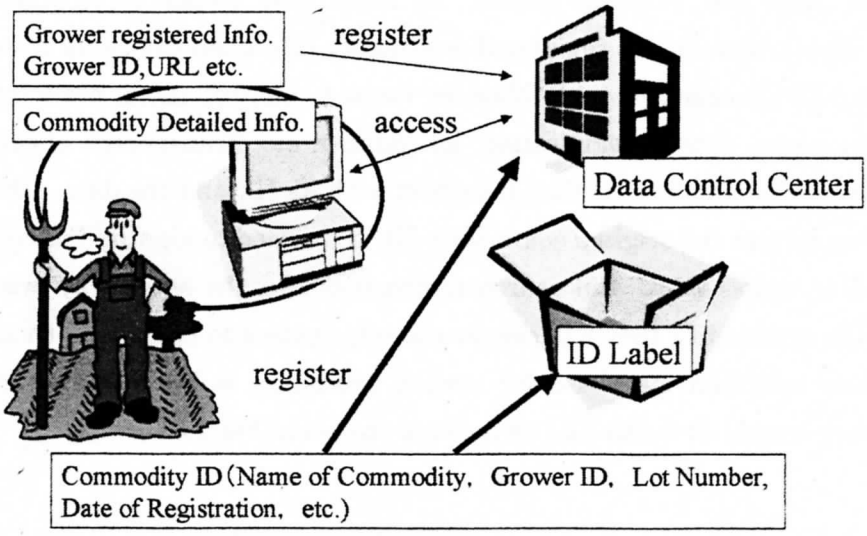

Fig 5 Information Attached with Commodity

6. Food Safety Chain

To make complete safety chain, we need to combine two systems, safety assuring system, such like HACCP system, and complete traceability system (Fig 6.) Disclosure of all information relevant to safety is a critical factor to make complete safety chain. Safety assuring information and the information on how the commodity treated in every stage of food supply chain are prerequisite to build confidence in food.

In the figure if some consumers felt anxiety to consume food. They soon claim to DMC with commodity ID (ID2.) In this case, Commodity ID2 is an ID of canned drink. Consumers search along data tree to the retailer, and then they check how they store drink in the store. If no evident of risk found out, consumers seek further along the data tree and found the processor, they find out many information of HACCP at processors website. Processor keeps the monitoring records on HACCP system. To open this information, processor force every employees to follow HACCP rule rigidly. At the processors site no hazard found out, consumers seek other parties' site till some potential risk found out.

Once this safety chain established, all parties try to keep every operations and

commodities safe. If an accident took place, consumers easily understand why they provide problematic products. It directly affects company's reliability and soon they lost their confidence. In Japan, SNOW BRAND milk has not been recovered lost sales before the poisoning outbreak at its HACCP plant. Losing confidence in consumers threaten the existence of company immediately.

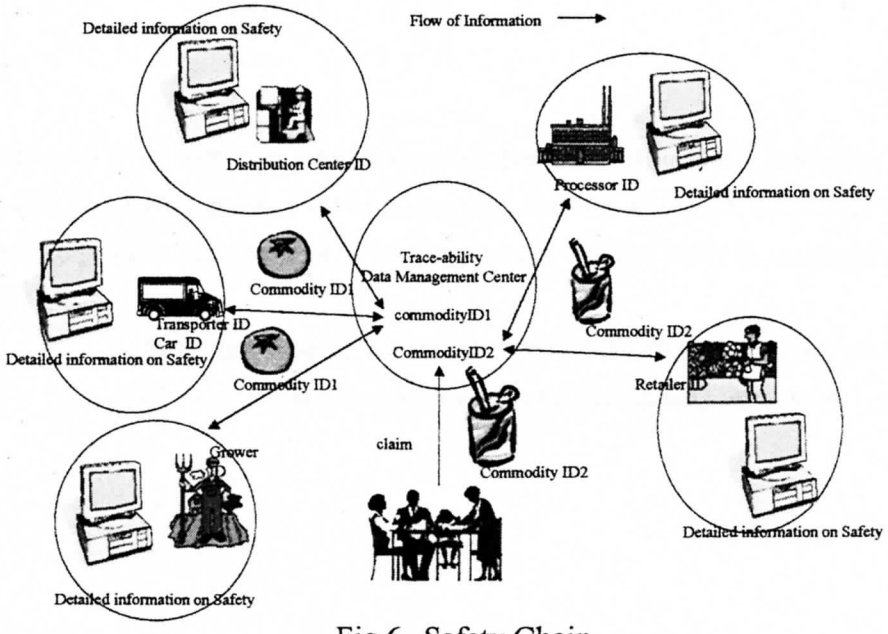

Fig 6 Safety Chain

7. Implications: How to Establish the Food Safety Chain

To make traceability system there are many problems to be solved. At first, all the party concerned food chain should participate the system. If some party in supply chain did not participate it, system cannot function as a complete traceability system. It always stops to trace the flow of commodities there. How to force all the party to implement this system is just the most important problem. Some super market chains already requests their trade partners to introduce HACCP system ([3] .) They also request to provide the information to secure traceability. However in many countries retailers has not so strong power to force every parties implement this system. If retailers request to introduce this system the system will be soon diffuse, and consumers enjoy safer food.

We have to add one more problem, how to avoid a registration of false statement. To avoid registration of false information, the system has to equip some rule. Suspension or prohibition of using the system is most effective, if many parties related food supply chain participated the system. We think government support is necessary. And the law

to force retailers taking responsibility of foodborne accident is needed. Governmental regulation is not always the best way to resolve economic issue. However food safety is the concern of all relevant parties and national issue. All the people can enjoy the benefits of this system. So at least government should grant to develop the system and give a boost to implement the system.

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Ⅸ Labor-force Participation of Women and Food Consumption of Households

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1. Introduction

The basic employment practice which was practiced during the post-war period where husbands specialize in outside employment, wives specialize in housework, and corporations guaranteeing a life-long employment, now has been disrupted. The firm promise made to husbands and wives, by corporations is no longer trusted as there has been a lost in confidence as the standard of lifestyle changes. Although there is a growing tendency of less gender stereotyping in household tasks and wider recognition today than in the past, women still carry out almost all domestic chores. In the present situation, employment of women has changed as the male-oriented employment practice has weakened.

Meanwhile, the household expenditure for food consumption has been stagnant in recent years. The expenditure ratio of foodstuffs for homemade meals to total food expenses is decreasing, though the rest such the proportion of expenditure for convenience foods (cooked foods, fast foods, and so on) and eating out is increasing. This trend of food consumption by households is called *outsourcing of meals*, and it shows the process, which substitutes homemade meals with convenience foods and eating out. It also shows that domestic food preparation has replaced housework with purchasing goods and services in the market. Therefore, the outsourcing of meals can be considered to be replacement activities for the market goods and services, and involves changes in time used for housework.

The purpose of this study is to clarify the influence of changes in women employment upon food consumption. In addition, changes in family size take up as an important related factor.

In the next Section, the situations of the outsourcing of meals and changes in time spent for housework are taken into account. In Section 3, the framework of this study is shown. In Section 4, the causes of changes in household food consumption are analyzed empirically. In Section 5, implications of the analysis are presented.

2. Outsourcing of Meals and Time Used for Housework

(1) Outsourcing of Meals

The indicator of outsourcing meals is denoted in Table 1. It shows the expenditure ratio of convenience foods (cooked foods, fast foods, and so on) and eating-out to total food expenses, and the ratio goes up as the degree of outsourcing of meals

increases. The ratio is calculated from the data of *the Annual Report on the Family Income and Expenditure Survey* by the Statistics Bureau, Ministry of Public Management, Home Affaires, Posts and Telecommunications.

The Engel coefficient, defined as the expenditure ratio of food to total expenditure, decreased 5.3 point from 29.8% to 24.5% in the duration of 15 years from 1980 to 1995, and the proportion of food expenses has decreased with the ascension of earnings. The ratio of convenience foods expenses to total food expenses rises 3.5 point from 5.5% to 9.0%, and the expenditure ratio of eating out has also risen to 4.2 point from 14.0% to 18.2%. Then, the indicator of outsourcing of meals where the combination ratio of the two mentioned above is up to 7.7 point from 19.5% to 27.2%.

(2) Time used for Housework

Next, an outline of time used for housework is observed. The statistics as follows, report on the individual time usage; *the Survey on Time Use and Leisure Activities* by the Statistics Bureau, Ministry of Public Management, Home Affaires, Posts and Telecommunications, and *the Japanese Time Use Survey* by the NHK Broadcasting Culture Research Institute. These statistics may have a certain limitation on the time usage for household activities because the relation between an individual and a household is not defined so clearly. However, actually the case of housework has no problem since husbands' contribution to housework is only about 10 minutes or less a day on average; thus, even if the duration of housework by wives might be regarded as the total amount of time for housework, the contribution by husbands do not make much difference practically.

In order to verify this fact, the duration of housework time in a day by husbands and wives is presented in the Table 2. The table surveys on time spent for housework per day in a double-income household (both the husband and wife have jobs), and a single-income household (the husband is working but the wife is not). It also classifies whether a couple are living together with other family members or not. When a wife is employed, the items in the table are divided by the wife's working hours of 35 hours a week as to differentiate between full-time work and part-time work.

In the upper table, there is approximately 2.6 times difference between the time used for housework by a wife. Approximately 126 minutes of housework time are spent in a household composed of only a couple of husband and wife and where the wife works for 32 hours or more per week, and approximately an average of 327 minutes are spent in a household where the husband and wife live with their children and parents while at the same time the wife is not working.

As a wife spends time working outside the home, her time spent for housework decreases. Similarly, in case of a small size family, which only consisted of the couple, the time used by the wife for housework has becomes shorter.

Next, although the housework offered to be done by a

husband in the lower table strongly depends on his wife's contribution, husbands' provision is only 11 minutes at the maximum. This means that a wife still carries out almost all of the domestic chores.

Then, the Figure 1 shows the time-series transition of housework time per day by adult women. The data from 1970 to 2000 are quoted from *the Japanese Time Use Survey*. According to the Figure, it turns out that the duration of housework time has been decreasing monotonically. Actually, the time spent for housework has been decreasing in the past 30 years from approximately 50 minutes to 273 minutes (4 hours and 33 minutes) in the year 2000 and from time spent of 322 minutes (5 hours and 22 minutes) in 1970.

On the other hand, the Figure 2 illustrates the rate of married women's employment as reported by the *Annual Report on the Labor Force Survey*. The data are calculated as a ratio of the number of employed-worker who are married women, however the ratio does not include women who were working in the agriculture and forestry sector. It has been going up to 36.5% in 2000 from 13.7% in 1965.

(3) Family Size

A time-series transition of family size from the data of the *Annual Report on the Family Income and Expenditure Survey* is shown in the Figure 3. The *household* term defined by the survey indicates *a family who are living-together, which shares a common budget*. Similarly, the *husband as the head of household is working for a business corporation, a public office, a school, a factory, a store, and so on* is called *worker's household* in the survey

The average number of persons per family has been decreasing from 3.90 persons in 1970 (a decrease of0.44 persons in 30 years) to 3.46 persons in 2000.

In recent years, the *Population Census* points out that a single-person household has been increasing and this has been depressing the average family size. However, since the *Annual Report on the Family Income and Expenditure Survey* is carrying out survey for two or more persons' households, family size has become bigger from that of the *Population Census*. According to the definition, the decrease proportion of the family size is different between the two statistics, but both statistics are similar as long as the family size has a tendency to become small.

3. Model

In order to show the framework is based on the above, the functions and constraints are explained. Then, the influence of changes in the job opportunity and family size upon household food consumption is discussed.

(1) Functions

1) Household Production Function;

$$X_G = g\left(T_H, X_F; K(n) \right) \qquad (1)$$

Supposedly a quantity of homemade meals (X_G) is a function to working hours (T_H), foodstuffs for homemade meals (X_F), and durable goods such as a microwave oven and a rice cooker $K(n)$. At this time, the size of durable goods $K(n)$ is assumed to be constant as long as the family size (n) does not change. This means that the family size determines the size of durable goods. Since the services from the durable goods is one of the inputs for household production, $K(n)$ is regarded as a quasi-fixed factor of production.

2) Household Utility Function

$$U = U(X_G, X_O, X_M, T_L) \qquad (2)$$

The household utility is a function of the variables which are quantities of homemade meals (X_G), convenience foods and eating out (X_o), other purchased goods (X_M), which collapse into one composite good, and demand for leisure (T_L).

(2) Constraints

When a household consumes the above goods for its utility maximization, it is also consuming *time* spent for leisure. Then, a household must determine how many hours should be allotted for leisure, in addition to the optimum amount of goods consumption.

Since the time endowment of a family (T) is constant, the increase in leisure means that the time allocated to other activities decreases automatically; for example, if employment working hours decrease because of the increase in leisure hours, the earnings from working would also decrease. In this case, the price of leisure is equivalent to the wage rate of employment. In addition, because the quantity of homemade meals is contained in the utility function, the time spent for cooking is also needed. As a result, the available time of a household (T) is allocated to employment working hours (T_E), housework hours (T_H), and leisure (T_L), respectively.

The productivity of housework may affects the households' time allocation and the earnings from employment may also change. Consequently, in order to maximize the utility, the constraints households face are the next three.

Time constraint: $T = T_E + T_H + T_L \qquad (3)$

Budget constraint: $p_O X_O + p_M X_M + p_F X_F \le wT_E \qquad (4)$

Technological constraint: $X_G = g(T_H, X_F; K(n)) \qquad (5)$

Then, the following constraint is derived from (3) and (4).

$$p_M X_M + p_O X_O + p_F X_F \le wT_E = w\{T - (T_H + T_L)\}$$

$$\Leftrightarrow p_M X_M + p_O X_O + p_F X_F + wT_H + wT_L \le wT \qquad (6)$$

In this framework, only the variable of available time (T) is given exogenously, and the time allocation among the variables of T_E, T_H, and T_L is determined at the optimum level of utility maximization. At this time, the earnings from employment work (wT_E) are the budget for purchasing the foodstuffs for

homemade meals ($p_F X_F$), convenience foods and eating out ($p_O X_O$), and other purchased goods ($p_M X_M$). The budget constraint (wT) consists of the above three components, and the opportunity costs of housework (wT_H) and leisure (wT_L).

(3) Optimization

Under the constraints (5) and (6), the derived demand function of foodstuffs for homemade meals (X_F) is obtained by solving the following maximization problem.

$$\max_{X_M, X_O, X_G, T_L} U(X_M, X_O, X_G, T_L)$$

$$s.t.\ g(T_H, X_F; K(n)) - X_G = 0, \qquad (7)$$
$$p_M X_M + p_o X_O + wT_H + p_F X_F + wT_L \le wT$$

Then, the demand function is derived as follows;

$$X_F = d(wT, p_M, p_O, p_G, w, p_F, n) \qquad (8)$$

In addition, under the family size (n) being constant, the household production function $g(\bullet)$ is assumed to be homogeneous of degree one about the time spent for housework (T_H), and foodstuffs for homemade meals (X_F). Under this assumption, the dual variable cost function $C(\bullet)$ can be defined as the price of foodstuffs for homemade meals (p_G) is equal to the following average costs at the optimum point.

$$p_G = C(w, p_F; K(n), X_G)/X_G = c(w, p_F; K(n)) \qquad (9)$$

By substituting the above relation for the demand function (8), the demand function of foodstuffs for homemade meals is obtained.

$$\begin{aligned} X_F &= d(wT, p_M, p_O, c(w, p_F; K(n)), w, p_F, n) \\ &= d(wT, p_M, p_o, w, p_F, n) \end{aligned} \qquad (10)$$

(4) Wage Rate Effects on Time Usage

It is considered that an ascent of the opportunity cost of homemade meals resulted from a rise in the wage rate of employment. As a result, the outsourcing of meals develops as a process to substitute market goods for domestic products due to the production cost of homemade meals goes up.

When the wage rate rises, a priori could not be decided whether the time for employment and housework increases or not. It depends on the sum of the two effects, the substitution effect and the income effect. Anyway, a rise in the wage rate leads to the increase in the cost of domestic production. A rise in the price evaluation of domestic production from an increase in the cost causes a change in the relative price between market goods and domestic products. Because of the gradual cost, a household reduces the amount of products from domestic

production and purchases market goods at a relatively lower price to make up for the lack of the products.

Consequently, a rise in the wage rate brings about a substitution of market goods for domestic products. At the same time, employment working hours has to increase to prepare for the growing demand of market goods. Therefore, the effect of a rise in the wage rate is an increase in market purchased goods and employment working hours and a decrease in domestic products and time for housework.

(5) Family Size Effects on Time Use

The reduction in family size (n) gives some incentives to adjust the size of durable goods $K(n)$ to a household, and other household production function is shifted below. This means that a reduction in family size produces a decline in the efficiency of domestic production. Therefore, the effect of a reduction in family size is also an increase in market purchased goods and employment working hours and a decrease in domestic products and time spent for housework.

4. Empirical Analysis

(1) Hypotheses

The hypotheses derived from the above framework are as follows;

Hypothesis I : According to a rise in the wage rate, convenience foods and eating out are substituted for homemade meals because the opportunity cost of housework goes up.

Hypothesis II : According to a reduction in the family size, convenience foods and eating out are substituted for homemade meals because the efficiency of domestic production falls and the opportunity cost of domestic cooking per person goes up.

(2) Empirical Analysis

To test the two hypotheses, the demand function (11) derived in the previous section is estimated. The Data for the estimation is quoted from the statistics below.

The Annual Report on the Family Income and Expenditure Survey, and *the Annual Report on the Consumer Price Index* published by the Statistics Bureau, Ministry of Public Management, Home Affaires, Posts and Telecommunications report the data of households' food expenditures, family size, consumer price indices. Because of the restrictions of data availability, the quantities of homemade meals and eating out are calculated as the expenditures evaluated by fixed prices, by dividing the expenditures by corresponding price indices.

The Monthly Labour Survey published by the Minister's Secretariat, Ministry of Health, Labour and Welfare gives the data of monthly cash earnings and working hours of employees. The wage rate is calculated as the cash earnings per one hour, by dividing monthly cash earnings by monthly working hours.

Duration of 16 years from 1980 to 1995, the demand function (11) estimates by the ordinary least square method for regression analysis.

$$\begin{aligned}\log X_F = {} & \alpha_1 \times \log(P_F / cpi) + \alpha_2 \times \log(P_O / cpi) \\ & + \alpha_3 \times \log(wT / def) + \alpha_4 \times \log(w / cpi) \\ & + \alpha_5 \times \log(n) + \beta_1 \times TD_{80} + \beta_2 \times TD_{90}\end{aligned} \quad (11)$$

The variables of X_F and P_F are the quantity and price of foodstuffs for homemade meals, P_O is the weighted average price of convenience foods and eating out, *cpi* shows the consumer price index as a proxy of the price of other purchased goods, wT is the full income (the maximum earnings), which is obtained that the wage rate multiplies with the available time, *def* means the deflator of wT, w means the wage rate, n denotes the family size (the number of persons per household), TD_{80} and TD_{90} are the dummy variables of the 80s and the 90s, respectively.

The theoretically expected sign conditions are as follows; the parameters of α_1 and α_4 should be negative, α_2, α_3, and α_5 should be positive. Since α_1 is the parameter of the relative price of foodstuffs for homemade meals to other purchased good, it should be negative as long as foodstuffs is non-Giffen goods. α_2 Is positive if there is a substitution relation between homemade meals and convenience foods and eating out, because α_2 is the cross-price elasticity of these two items. α_3, Which is regarded as the income elasticity or the total expenditure elasticity, is positive as long as foodstuffs for meals is a normal goods. Finally, α_4 is negative if the hypothesis I is supported and α_5 takes grater than one if hypothesis II is accepted.

Actually, X_F is calculated that the food expenses, which does not include liquors, convenience foods, snacks, beverages, and eating out, divides by the corresponding price (P_F). The price P_F takes a weighted average of the consumer price indices, excluding liquors, convenience foods, snacks, beverages, and eating out. The CPI (the Consumer Price Index) is regarded as the price of other purchased goods (*cpi*). The wage rate (w) is the earnings (total cash earnings per regular employee) divided by working hours (total hours worked per regular employee). The full income (wT) calculates that the wage rate multiplies with the available time of household. Then, the monthly available time, for example, shows the available time per person (24 hours times 30days) times the number of persons per household, which excludes dependents because the opportunity costs for the dependents are assumed to be zero. The deflator of full income (*def*) generates as the weighted average of the wage rate (w) and food and other prices (P_F, P_O, and *cpi*).

(3) Estimation Results

The estimation results of the demand function of foodstuffs for homemade meals by (11) are presented in Table 2. The

estimation shows a successful fit to the demand function because the $\bar{R}^2$, which means the R^2 statistic adjusted to account for degree of freedom, is 0.97. In addition, the autocorrelation of disturbances is expected to be ignorable since the Durbin-Watson statistic takes 2.22.

The estimated parameter of each variable is as follows; the own price elasticity of foodstuffs demand (α_1) is -0.57, the cross price (convenience foods and eating out) elasticity of foodstuffs demand (α_2) is 0.86, the income (it means *full income*) elasticity of foodstuffs demand (α_3) is 0.20, the wage elasticity of foodstuffs demand (α_4) is -0.56, and the family size elasticity of foodstuffs demand (α_5) is 1.52, respectively. All the above parameters are statistically significant at the 10 percent level form the t-test.

As it is mentioned above, the signs of own price (α_1) and income (α_3) elasticities, which are negative and positive, are satisfied theoretically under the expected conditions. The positive elasticity of cross price (α_2) shows that the homemade meals and the convenience foods and eating out are *substitutes* each other. Since the value of the income elasticity of 0.19 (α_3) is much less than one, foodstuffs for homemade meals consume as *necessities*.

In order to find out the relation between the two hypotheses and the estimation results, the parameters of wage (α_4) and family size (α_5) should be focused on. The negative sign of the wage elasticity (α_4) points out that the hypothesis I is acceptable; for instance, according to a rise in the wage rate, convenience foods and eating out are substituted for homemade meals. Moreover, because the family size elasticity (α_5) is positive and greater than one, the hypothesis II is acceptable; namely, according to a reduction in the family size, convenience foods and eating out are substituted for homemade meals.

From the above estimation results, it can be explained that the fact as outsourcing of meals, which has been pointed out in the years, is a very economical behavior by households for which saves costly homemade meals, and convenience foods and eating out replace homemade meals since the opportunity cost of homemade meal preparation has become high by a rise in the wage rate and because of the shrinking size of the family.

5. Summary and Conclusions

While the outsourcing of meals was intended to understand mainly the problem of women's choices so far, it has also rearranged in theory from the viewpoint of microeconomics. The outsourcing of meals can be proved to be a replacement by the market goods and services.

It can be also understood that changes in wage rate and family size played significant roles.

The estimation results by the household demand model show a good fit. In addition, each estimated parameter has satisfied theoretically the expected sign conditions. Then, attention was paid to the variables of wage rate and family size whether

the two hypotheses are accepted or not. The two hypotheses, which point out that outsourcing of meals is developed by a rise in the wage rate and the shrinking family size, are supported.

Though it is affected by the business cycle, job opportunity for women has been better as the male-oriented employment practice has relatively been weakened and a double-income household is expected to be continually increasing.

On the other hand, the services to support the household production fall behind in Japan. The quantity supplied for the services in which a market place substitutes also run short, therefore it is costly. Thus, asking for converting a national consciousness into a consumer-friendly society from a society of the conventional corporation priority today. In the current condition where a great portion of the domestic affairs are still being carried out by women, the state of women employment and food consumption must offer the important question for a future society.

Table 1 Indicator of Outsourcing of Meals (percent)

Year	Engel Coefficient	Ratio of Convenience Food	Ratio of Eating out	Indicator of Outsourcing of Meals
1980	27.8	5.7	11.2	16.9
1985	25.7	6.5	12.9	19.4
1990	24.1	8.2	14.8	23.0
1995	22.6	9.5	15.8	25.3
2000	22.0	11.0	17.0	28.0

Source: *Annual Report on the Family Income and Expenditure Survey* Statistics Bureau, Ministry of Public Management, Home Affairs,Posts and Telecommunications.

Table 2 Housework Hour by Husband and Wife per Day
(Minutes, Weekly Average)

Housework by wife (minutes)

	Both husband and wife have jobs		Only husband has a job
	Wife's working hours; More than 35 hours	Wife's working hours; Less than 35 hours	
Household of a couple only	117	176	262
Household of a couple with children	173	244	302
Household of a couple with children and parents	167	261	321

Housework by husband (minutes)

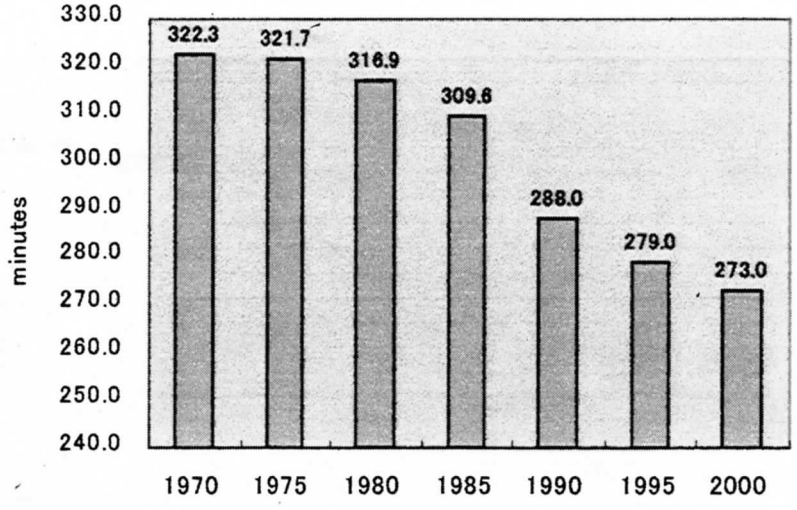
	Both husband and wife have jobs		Only husband has a job
	Wife's working hours; More than 35 hours	Wife's working hours; More than 35 hours	
Household of a couple only	11	7	8
Household of a couple with children	10	6	5
Household of a couple with children and parents	10	8	5

Source: *Survey on Time Use and Leisure Activities*
Statistics Bureau, Ministry of Public Management, Home Affaires, Posts and Telecommunications.

Table 3 Estimation Results

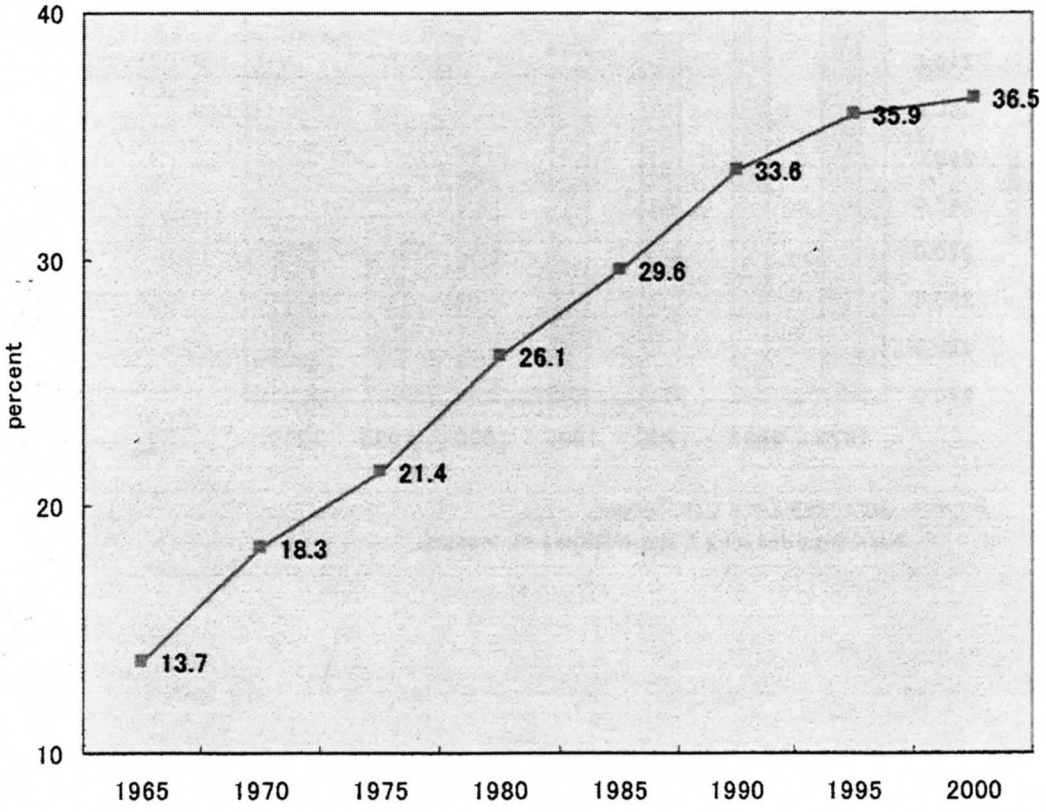
Parameter	Estimation Result	t-Statistic
α_1	-0.575	-1.75
α_2	0.864	1.76
α_3	0..196	0.83
α_4	-0.555	-2.26
α_5	1..522	2.00
β_1	2.281	1.28
β_2	2.294	1..28
$\overline{R}^2$	0.973	-
D.W.	2.216	-

Figure 1 Housework Hours per Day by Adult Women (Weekly Average)



Source: *Japanese Time Use Survey*,
NHK Broadcasting Culture Research Institute.

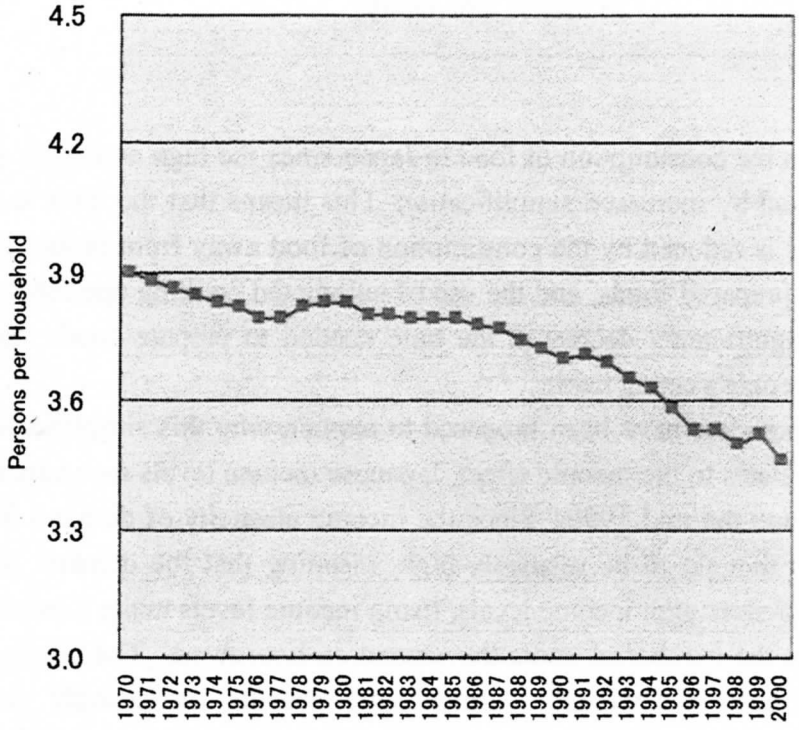
Figure 2 Parrticipattio ratio of Employment Work by Married Wimen (percent)



Source: *Annual Report on the Labour Force Survey*
Statistics Bureau, Ministry of Public Management, Home Affaires, Posts and Telecommunications.

Note: number of employment workers /population of 15 years old and over

Figure 3 Time-series Transition of Family Size (Worker's Household, All Japan)



Source: *Annual Report on the Family Income and Expenditure Survey* Statistic Bureau, Ministry of Public Management, Home Affaires, Posts and Telecommunications.

X Food Demand and Outsourcing of Housework

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1. Introduction

The trend in the consumption of food in Japan since the high economic growth period is characterized by increased simplification. This means that the labor and time required for cooking is reduced by the consumption of food away from home (FAFH), the consumption of prepared foods, and the use of automated cooking appliances. This simplification has significantly decreased the time needed to prepare foods, and as a result has changed people's eating habits.

Several hypotheses have been proposed to explain why this simplification has occurred. The first relates to the income effect. Japanese income levels rose consistently between the 1950s and the mid 1990s. Since the income elasticity of demand for food away from home is thought to be relatively high, meaning that the demand for food away from home increases with income levels, rising income levels make it possible for consumers to reduce the number of hours they spend on housework. The second is the rise in opportunity costs for women. Women have become increasingly active in post-war Japanese society. Consequently, the opportunity costs for women's labor have risen. The increase in opportunity costs for women who work the majority of the hours spent on household chores have been a factor in the decrease in the time spent on these household chores. A third hypothesis is the technological progress that has been made in cooking implements and their subsequent widespread use. New household appliances, such as refrigerators and microwave ovens, are constantly being released, and are being used in more households as prices decrease. It is assumed that the increase in productivity in household chores has contributed to the simplification of food preparations.[1]

The purpose of this paper is to examine the above hypotheses, and to identify the factors that have caused this simplification of eating habits.

The problems typically associated with such an empirical analysis were encountered in this study. That is, conventional demand analysis assumes a commodity demand and the separability of the labor supply. This assumption means that the wage rate has to be excluded from the estimation formula. However, this is not realistic.[2] If it can be assumed that the wage rate of women's labor has some effect on food demand, the assumption of the separability of labor supply and other assets is not correct. This

paper investigates this issue by proposing a demand system that includes the wage rate variables.

Ever since Becker's work in 1965, several leading studies have been conducted on food consumption and household labor based on household production theory.[3] However, while many of these have focused on FAFH, few have presented the kind of comprehensive analysis conducted in this study that focused on the causes behind the outsourcing of housework in food consumption.

2. The Outsourcing of Housework in Food Consumption

The activities required to consume food in the home can be summarized as follows: (a) purchase of ingredients (shopping), (b) cooking, (c) consuming the food (eating), (d) clean-up, and (e) others (learning cooking techniques, menu planning, etc.). Outsourcing food consumption means exchanging these actions for other products or services. If one calculates the opportunity costs involved in activities (a) through (e) and express them as a percentage of the total food consumption expenditures, it is possible to ascertain the degree to which food consumption is being outsourced.

However, the problems involved in calculating opportunity costs are determining limitations relating to the availability of data and figuring out how to evaluate the opportunity costs per unit of time for each behavior. The "National Time Use Survey" conducted by the Japan Broadcasting Corporation (NHK) provides a breakdown of the time people spend on different behaviors. The survey has been conducted on a quinquennial basis since 1960 by having subjects record their activities for an entire day in 15-minute increments and it enables us to ascertain the amount of time spent on the activities listed above, in which (a) is categorized as "shopping," (b) and (d) as "cooking", and (c) as "eating." There is no corresponding criteria for (e). The "shopping" criteria indicates the time spent on shopping for all items. Since it was not possible to separate the time spent only on grocery shopping, the time necessary for food consumption is defined for the purposes of paper as only of the time required for (b) cooking, (c) eating, and (d) clean-up.

The opportunity costs per unit of time for each activity used to be set subjectively by each person. However, since there are significant individual differences in the evaluation of eating-related activities, it is difficult to set a common standard. In this study, the opportunity costs per unit of time were set as follows. Cooking (b) and clean-up (d) are at the part time wage rate, while eating (c) is a zero opportunity cost per unit of time. Usually the time required for cooking and clean-up are carefully divided, and the opportunity costs for these are significantly lower than the evaluation of steady labor. Also, it is believed that the time required for eating in itself produces an effect, but since it is impossible to objectively evaluate that effect, the opportunity cost was set

at zero.

Table 1 shows the shares in food consumption expenditures for each category, including the calculated opportunity costs. According to the table, the categories whose share of total expenditures tended to increase from 1963 to 1997 were the opportunity costs, eating out, and eating prepared foods, with a significant increase in opportunity costs. The share of expenditures for all other categories decreased.

To what factors can the increase in the share of the time required for food consumption accounted for by opportunity costs be attributed? Table 2 shows the time required for food consumption, the real opportunity costs, and the real part time wage rate. The time required for food consumption has decreased consistently since 1970, and in 1995 had decreased to 77% of the time required in 1970. As is clear from this table, the reason that opportunity costs are rising even though the time required for food consumption is decreasing is the significant increase in the wage rate. These facts suggest that the substitution effect is functioning, but a careful investigation must be based on demand system estimates.

Figure1 shows the proportion of prepared foods and FAFH to the total food consumption expenditures by annual income level. It suggests that while the proportion of FAFH tends to rise with income levels, the same trend does not occur for prepared foods. Looking only at the cross-sectional data, we find that FAFH can be characterized as a superior good, but demand system estimates are needed to conduct a more thorough discussion of this point.

The prevalence of cooking implements that save on household labor may be considered a factor in promoting the outsourcing of food consumption. Figure 2 shows the rate of diffusion of typical cooking implements such as refrigerators and microwave ovens. Refrigerators had already come into widespread use before 1960, and by 1970 they had reached market saturation. Microwave ovens gained popularity in the early 1970s, and reached saturation in the 1990s. It is extremely interesting to analyze the correlation between the widespread use of these kinds of cooking appliances, and factors mentioned earlier such as income levels and wage rates. It is also fascinating to determine how the use of such implements has contributed to the outsourcing of food consumption.

3. Model Specification

As stated earlier, this study focused on food consumption processes, such as the time required to prepare a meal and the cooking methods employed in the process. Becker's household production theory can be effectively applied to this type of analysis. By looking at the series of processes related to food consumption as the production activities of "non-market commodities," it is possible to analyze the effects of inputs

such as labor, capital, cooking implements and electrical appliances.

First, suppose that the household production function related to food consumptions is as in (1)

$$Z = f(q_i;k) \qquad i=1,2,....,n \qquad (1)$$

where Z is a vector of non-market commodities produced by food consumption, q_i(i=1,2, ..., n-1) is the consumption of food i, q_n is the time required for food consumption, and k is a vector of capital inputs. By combining foods, which are market goods, and q_n, the time required for food consumption, (1) expresses the production of Z, non-market goods, obtained by eating. The variable k is introduced to account for the effects that the distribution of cooking implements has on increasing the efficiency of household production. Subject to (1), it is possible to minimize the short-run cost related to food consumption as expressed in (2).

$$\min \qquad x = \sum_i^n p_i q_i \qquad (2)$$

Here, x is the full income with regard to food consumption, p_i(i=1,2, ..., n-1) is the price of q_i(i=1,2, ..., n-1), and p_n is the opportunity cost of q_n. The solution is the cost function shown in (3).

$$x = c(p_i, u(z); k), \qquad i=1,2,...,n \qquad (3)$$

where u( ) denotes a utility function. The cost function C is concave and linearly homogeneous in prices, and convex in outputs.

Marshallian demand function of the food and the time required for food consumption can be derived using Shepherd's lemma.

$$q_i = \partial c / \partial p_i = q_i(p, u(z); k), \text{ i=1,2,...,n} \qquad (4)$$

The unique feature of these demand functions is that they include the consumer's opportunity cost as a dependent variable. As mentioned earlier, Japanese trends in food consumption in recent years suggest that a relationship exists between food consumption and consumer opportunity costs. Excluding this variable will bias the estimates, because the commodity prices may correlate with the consumer opportunity cost.

This study employs the almost ideal demand system (AI demand system) to obtain the estimates of the cost function. The log cost function of the AI demand system can be specified as

$$\log C = \alpha_0 + \sum \alpha_i \log p_i + \frac{1}{2} \sum_i \sum_j \gamma_{ij} \log p_i \log p_j + u\beta_0 \prod_i p_i^{\beta_i} \qquad (5)$$

However, here the cost function has been specified by excluding k. The variable k will be introduced when the demand system is estimated.

Using Shepherd's lemma, the estimating equations are derived in terms of budget shares:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log(c/P) \quad \text{i=1,2,...,n} \qquad (6)$$

Here w_i is the i^{th} expenditure share, and P is the price index defined by the following formula.

$$\log p = \alpha_0 + \sum_i \log p_i + \frac{1}{2} \log \sum_i \sum_j \gamma_{ij} \log p_i \log p_j \qquad (7)$$

The restrictions on the summations, $\sum_i \alpha_i = 1$ and $\sum_i \beta_i = 0$ homogeneity $\sum_j \gamma_{ij} = 0 \, (i = 1,....,n)$; and symmetry, $\sum \gamma_{ij} = \sum \gamma_{ji}$ for all i, j $(i \neq j)$ were imposed.

4. Estimation and Data

When applying actual time series data to the above model, we specify (6) as

$$w_{it} = \alpha_i + \sum_j \gamma_{ij} \log p_{jt} + \beta_i \log(c_t / P_t) + \phi_i k_t + \varepsilon_{it} \qquad (8)$$

where ε_{it} is the mean zero disturbance term. k represents the capital stock in food consumption.

The data used in estimating the demand system covers 35 years from 1963 to 1997. The food consumption quantity data are national and average household figures taken from the "Family Income and Expenditure Survey" conducted by the Statistics Bureau of the Management and Coordination Agency. Food products were divided into the following eight categories: (1) cereals: grains, bread, pasta, (2) seafood, (3) meat: fresh meat and meat products, (4) dairy products and eggs, (5) vegetables and fruit, (6) other foods: cakes and candies, oils and seasonings, beverages, (7) prepared foods, and (8) food away from home (FAFH). The price data is taken from the consumer price index survey, also compiled by the Statistics Bureau of the Management and Coordination Agency.

The time required for food consumption is derived from data from the "National Time Use Survey," and is calculated based on the definitions provided above. Because this survey is conducted every five years, figures are not available for every

year. Thus, data for years in which the survey was not conducted is derived using linear interpolation. This is an unavoidable measure due to the limitations of data availability. However, because the time required for food consumption declined in a linear manner during the analysis period, it is suggested that its use is acceptable. The opportunity costs for the time required for food consumption are derived using the part time wage rates from the Management and Coordination Agency's "Monthly Labor Survey."

The capital stock is calculated by determining the rate of diffusion of refrigerators and microwave ovens according to the "Consumer Confidence Survey," and applying the average annual prices to those figures.

Estimates were made using a model that does not include capital stock (Model I) and a model that does (Model II). We estimated the parameters of the demand system by the seemingly unrelated regression model (SUR). However, we identified a high autocorrelation in the disturbances, and subsequently corrected for it according to the method provided by Park (1967).[4]

5. Estimation Results

Tables 3 and 4 show the estimates of Models I and II, respectively. They show that the statistical goodness-of-fit is at a satisfactory level, and the autocorrelation problem has been improved.

Table 5 shows the price elasticity and expenditure elasticity of demand derived from the Model I.[5] There are no significant differences between the estimates calculated in Model 1 and Model 2. The own price elasticities of all the commodities except FAFH are negative. Though the value is positive for FAFH, it is not statistically significant.

The commodities with relatively high expenditure elasticities are meat, vegetables, and FAFH. The expenditure elasticity of cereals was negative. These estimation results are consistent with past studies of food demand in Japan, for example Sasaki(1993). The expenditure elasticity of time required for food consumption was a positive value of 0.515, but was still less than 1.

These estimation results can also be used to examine the separability of commodity demand and time required for food consumption. Separability can be confirmed by whether or not the compensated cross price derivatives with respect to wage rate and income effects are equal.[6] Table 6 shows these values and their corresponding asymptotic standard errors. According to these figures, the chi square test statistic showing the equalities of the compensated cross price effects of wage rate and income effects is sufficiently high, and the fact that they are both different is statistically proven. These results support the assumption in this study that commodity demand and the time required for food consumption are inseparable.

What kind of effects do changes in the opportunity costs of the time required

for food consumption have on the demand of each commodity? Table 5 shows that the commodity for which demand rises as opportunity costs rise, in other words, the commodity that acts as a substitute for the time required for food consumption, is prepared food. The commodities for which demand falls as opportunity costs rise, in other words, the commodities that act as complements to the time required for food consumption, are vegetables, FAFH, seafood, and meat. All of these complements, except for FAFH, require relatively long cooking times, and thus are largely consistent with the estimation results. It is interesting to note that the estimation results for prepared foods and FAFH are symmetrical. While prepared foods are consumed to save cooking time, the same cannot be said of FAFH. This may be related to changes in the position of FAFH in food consumption in Japan. FAFH was often popular among working people who ate lunch out rather than bringing a lunch from home, but since the high-growth period, the popularity of eating out has increased for the sake of having the family all together or enjoying a good meal. This suggests that the trend toward eating FAFH for the sake of saving time has decreased in recent years. This is confirmed by various surveys, including the Ministry of Agriculture, Forestry and Fisheries' "Food Consumption Monitoring Survey."

Expenditure elasticities were highest for meat, FAFH, vegetables, and seafood. In contrast, the expenditure elasticity of cereals was negative. These results are consistent with other leading studies.

The relationship between capital stock and each commodity can be confirmed by the sign of ϕ. Statistically significant negative values, that is, commodities for which an increase in capital stock caused a decrease in the share of expenditures, were cereals and the time required for food consumption. By contrast, statistically significant positive values, that is, commodities for which an increase in capital stock caused an increase in the share of expenditures, were prepared foods, FAFH, and dairy products. Given that dairy products became more popular in households when it became possible to preserve foods in electric refrigerators, and that the consumption of prepared foods increased when it became possible to easily reheat them in a microwave, the estimation results noted above make sense.

6. Conclusion

This paper presented a demand analysis model that did not assume a priori that the time required for food consumption and the demand for commodities were separable, and applied it to time series data from 1965 to 1997 in Japan. The model was based on household production theory, and used the AI demand system as its functional form.

Estimates of the demand system produced the following results. First, they

showed that the time required for food consumption and the demand for commodities are inseparable. Since the high-growth period that started in the 1960s, there has been a trend toward the simplification of Japanese eating habits, and these results suggest that this simplification is related to increases in labor opportunity costs during this time.

Second, the substitute and complementarity relationships between the time required for food consumption and each commodity were identified. Prepared foods are substitutes for time required for food consumption, while vegetables, FAFH, seafood, and meat are complements for time required for food consumption.

Third, the commodities with relatively high expenditure elasticities were meat, vegetables, and FAFH.

Fourth, increases in capital stock for cooking contributed to the decrease in the share of expenditures accounted for by the time required for food consumption, and to increasing the share of expenditures accounted for by prepared foods, FAFH, and dairy products.

Finally let us examine the background to the simplification that has characterized Japanese food consumption since the 1960s based on these findings. Simplification means reducing the amount of time required for food consumption by outsourcing household work. The specific content of that outsourcing, substituting it with prepared foods and FAFH, may be related to the increase in capital stock for cooking. According to the results of this study, substitutes for prepared foods and increases in capital stock are actually believed to help shorten the time required for food consumption. The share of expenditures accounted for by FAFH consistently increased over the period of analysis, but this was due more to the effects of income increases than to its ability to serve as a substitute for the time required for food consumption. In other words, increases in the share of expenditures accounted for by FAFH may be seen as evidence of another trend in Japanese food consumption during this time – sophistication.

Notes

1. Another possible factor could be changes in household composition. The demographics of Japanese families in recent years show that the number of household members per household has decreased and the household members have gotten older (decreasing numbers of children). Either of these trends may have promoted the simplification of food consumption. That is, the decreasing number of household members reduces the economies of scale in cooking, and may prompt people to eat out rather than cook at home. The aging of household members means an increase in the number of household members that have greater opportunities to eat out. Due to

limitations in the data, however, this study could not confirm the relevance of these factors.

2. Several studies have rejected the separability of labor supply and commodity demand. For example, see Abott and Ashenfelter (1976). Asano (1997) conducts an analysis using Japanese data from 1997 to 1990 and also ultimately rejects the notion of separability.

3. For example, Redman(1980), McCracken and Brandt (1987), Richards, Gao, and Patterson (1998), and Florkowski et al. (2000)

4. The treatment presented by Park is as follows; Estimate each equation in the system by OLS. For that equation, transform the data by the Prais-Winsten transformation to remove the autocorrelation. Using the transformed data, estimate the equation system by SUR.

5. The price elasticities are derived using the following equation. See Green and Alston (1990). $\eta_{ij} = -\delta_{ij} + \gamma_{ij} / w_i - \beta_i w_i / w_i$ where η_{ij} is the uncompensated elasticities of demand and δ_{ij} is the Kronecker delta (δ_{ij}=1 for i=j; δ_{ij}=0 for i≠j).

6. See Abbott and Ashenfelter (1976) and Asano (1997).

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Table 1. Shares in Food Consumption Expenditures

	Cereals	Seafood	Meat	Dairy Products	Vegetables	Other Foods	Prepared Food	FAFH	Opportunity Costs
					%				
1963	14.9	7.1	4.9	4.7	10.9	12.2	1.9	4.0	39.5
1970	8.6	6.8	5.2	3.9	10.2	10.4	1.8	4.6	48.5
1980	5.8	6.1	4.7	2.3	7.5	7.9	2.4	5.3	58.0
1990	4.8	5.5	4.1	2.0	7.2	7.9	3.4	6.5	58.7
1997	3.8	4.6	3.4	1.9	6.2	7.3	3.7	6.2	63.0

Table 2. Time and Opportunity Cost for Food Consumption

	Time for Food Consumption (hours)	Real Wage Rate (yen)	Real Opportunity Cost (yen)
1970	96.8	448	43,365
1975	91.9	696	63,973
1980	91.0	731	66,514
1985	86.8	758	65,799
1990	78.0	845	65,893
1995	74.5	967	72,006

Note. Wage rate and opportunity cost are deflated by CPI(1995=100).

Table 3. Parameter Estimates (Model I)

Commodity i =	1 Cereals	2 Fish	3 Meat	4 Dairy products	5 Vegetables	6 Other foods	7 Cooked foods	8 FAFH	9 Time for food
α_i	0.860	-0.390	-0.345	0.135	-0.622	-0.154	0.286	-0.338	1.570
	(7.947	(-3.765)	(-3.533)	(1.691)	(-6.085)	(-0.645)	(3.389)	(-2.762)	(6.851)
γ_{ij}									
j = 1	0.057								
	(6.63)								
2	0.005	0.020							
	(0.83)	(2.95)							
3	-0.002	-0.001	0.036						
	(-0.47)	(-0.220)	(6.096)						
4	0.012	0.000	0.005	0.017					
	(2.973)	(-0.096)	(1.315)	(4.364)					
5	-0.023	-0.012	-0.003	0.006	0.050				
	(-4.537)	(-2.957)	(-1.004)	(2.343)	(8.849)				
6	-0.003	0.026	-0.007	0.010	0.010	0.031			
	(0.361)	(2.874)	(-0.949)	(1.435)	(1.534)	(1.437)			
7	-0.010	0.001	-0.002	-0.013	0.022	0.004	-0.039		
	(-1.730)	(0.221)	(-0.360)	(-3.281)	(5.832)	(0.350)	(-4.642)		
8	0.008	-0.011	-0.013	-0.032	0.016	-0.418	0.005	0.103	
	(0.797)	(-1.395)	(-1.637)	(-4.611)	(2.741)	(-2.374)	(0.456)	(4.460)	
9	-0.049	-0.027	-0.013	-0.004	-0.066	-0.035	0.032	-0.033	0.195
	(-9.321)	(-5.244)	(-1.637)	(-0.961)	(-15.012)	(-3.077)	(5.645)	(-3.440)	(20.091)
β_i	-0.134	0.080	0.069	-0.018	0.123	0.046	-0.042	0.071	-0.195
	(-7.241)	(4.524)	(4.099)	(-1.308)	(7.051)	(1.114)	(-2.944)	(3.412)	(-4.967)
D.W.	1.566	1.697	2.080	1.325	1.861	-	1.612	1.763	1.376
R-squared	0.994	0.976	0.951	0.971	0.988	-	0.962	0.962	0.964

Note. The figures in parentheses are t-values.

Table 4. Parameter Estimates (Model II)

Commodity i =	1 Cereals	2 Fish	3 Meat	4 Dairy product	5 Vegetables	6 Other foods	7 Cooked foods	8 FAFH	9 Time for food
α_i	0.595	-0.511	-0.354	0.191	-0.629	0.082	0.274	-0.185	1.538
	7.845	-4.463	-3.500	4.671	-5.024	0.283	3.283	-2.072	7.024
γ_{ij}									
j = 1	0.075								
	(12.168)								
2	0.005	0.018							
	(1.121)	(2.563)							
3	0.008	-0.002	0.033						
	(1.936)	(-0.426)	(5.905)						
4	-0.004	-0.008	0.007	0.020					
	(-1.199)	(-3.212)	(2.100)	(6.488)					
5	-0.005	-0.008	-0.003	0.003	0.053				
	(-1.390)	(-1.879)	(-0.889)	(1.359)	(9.730)				
6	-0.014	0.029	-0.010	0.033	-0.002	0.031			
	(-1.645)	(2.868)	(-1.240)	(5.790)	(-0.236)	(1.155)			
7	-0.017	0.002	-0.002	-0.017	0.020	0.018	-0.041		
	(-3.111)	(0.356)	(-0.392)	(-4.982)	(5.261)	(1.747)	(-5.383)		
8	-0.026	-0.008	-0.027	-0.023	0.000	-0.042	0.013	0.191	
	(-3.467)	(-1.318)	(-3.866)	(-4.114)	(0.025)	(-2.819)	(1.504)	(10.110)	
9	-0.022	-0.028	-0.004	-0.011	-0.058	-0.041	0.025	-0.078	0.218
	(-4.275)	(-4.475)	(-0.751)	(-3.345)	(-10.550)	(-3.149)	(3.976)	(-8.240)	(18.246)
β_i	-0.074	0.104	0.072	-0.035	0.128	-0.002	-0.044	0.034	-0.183
	(-5.439)	(5.128)	(4.073)	(-4.764)	(5.767)	(-0.041)	(-2.931)	(2.071)	(-4.783)
δ_i	-0.066	-0.012	-0.008	0.033	-0.017	-	0.015	0.051	-2.8E-07
	(-9.847)	(-1.368)	(-1.228)	(8.789)	(-1.835)	-	(2.164)	(5.971)	(-1.814)
D.W.	1.559	1.697	2.434	1.550	1.761	-	1.675	2.152	1.450
R-squared	0.998	0.974	0.957	0.998	0.985	-	0.978	0.995	0.972

Note. The figures in parentheses are t-values.

Table 5. Estimates of Price and Expenditure Elasticity

	Price Elasticities								
i =	1	2	3	4	5	6	7	8	9
Commodit	Cereals	Fish	Meat	Dairy products	Vegetables	Other Foods	Prepared Foods	FAFH	Time for Food
j=1	−0.240	−0.034	−0.141	0.368	−0.315	−0.007	−0.182	0.018	−0.079
	−(2.501)	−(0.485)	−(1.675)	(3.249)	−(6.392)	−(0.082)	−(1.033)	(0.126)	−(4.871)
2	0.168	−0.831	−0.107	0.030	−0.204	0.192	0.133	−0.232	−0.029
	(2.48)	−(8.96)	−(1.26)	(0.28)	−(4.78)	(2.11)	(0.84)	−(1.93)	−(1.91)
3	0.064	−0.074	−0.485	0.163	−0.099	−0.085	0.024	−0.251	0.001
	(1.07)	−(1.13)	−(4.69)	(1.47)	−(3.01)	−(1.16)	(0.15)	−(2.01)	(0.06)
4	0.184	−0.041	0.039	−0.521	0.015	0.069	−0.344	−0.489	0.008
	(4.16)	−(0.92)	(0.65)	−(4.96)	(0.59)	(1.18)	−(2.87)	−(4.99)	(0.73)
5	−0.091	−0.259	−0.173	0.219	−0.661	0.045	0.803	0.116	−0.113
	−(1.76)	−(5.12)	−(3.17)	(2.98)	−(13.62)	(0.70)	(7.32)	(1.44)	−(7.89)
6	0.208	0.208	−0.250	0.324	−0.039	−0.780	0.257	−0.710	−0.031
	(2.23)	(2.01)	−(2.19)	(1.84)	−(0.67)	−(4.58)	(0.89)	−(2.98)	−(1.27)
7	−0.060	−0.020	−0.067	−0.342	0.169	0.018	−2.119	0.031	0.096
	−(0.92)	−(0.34)	−(0.82)	−(3.11)	(4.59)	(0.20)	−(8.28)	(0.21)	(6.47)
8	0.189	−0.203	−0.299	−0.838	0.067	−0.385	0.226	0.382	−0.048
	(1.76)	−(2.15)	−(2.25)	−(4.46)	(1.21)	−(2.53)	(0.75)	(1.18)	−(1.92)
9	0.048	−0.742	−0.641	0.085	−1.073	−0.457	1.465	−0.875	−0.321
	(0.42)	−(5.90)	−(3.80)	(0.37)	−(11.62)	−(2.22)	(6.19)	−(4.56)	−(5.59)
	Expenditure Elasticities								
	−0.469	1.996	2.125	0.513	2.140	1.390	−0.261	2.011	0.515
	−(2.31)	(9.06)	(7.74)	(1.38)	(13.23)	(3.97)	−(0.61)	(6.79)	(5.28)

Note. The figures in parentheses are t-values.

Table 6. Test of Weak Separability

	Cross price effect of wage rate		Income effect		Ratio(price/income)	
Cereals	−0.0254	(0.0027)	−0.0427	(0.0185)	0.5950	(0.2831)
Fish	−0.0144	(0.0027)	0.1604	(0.0177)	−0.0898	(0.0168)
Meat	−0.0058	(0.0025)	0.1295	(0.0167)	−0.0445	(0.0175)
Dairy products	−0.0020	(0.0021)	0.0188	(0.0136)	−0.1065	(0.0989)
Vegetables	−0.0339	(0.0023)	0.2311	(0.0175)	−0.1468	(0.0106)
Other food	−0.0177	(0.0057)	0.1624	(0.0409)	−0.1087	(0.0329)
Cooked food	0.0166	(0.0029)	−0.0088	(0.0144)	−1.8955	(3.1413)
Eating−out	−0.0171	(0.0050)	0.1420	(0.0209)	−0.1202	(0.0371)
Hours for food	0.1038	(0.0052)	0.2072	(0.0392)	0.5009	(0.1119)

Chi square test statistic = 504.48

Note. Numbers in parentheses are the estimated standard errors.

Fig.1. Percentages of Cooked Foods and Eating Out in Food Consumption (1997)

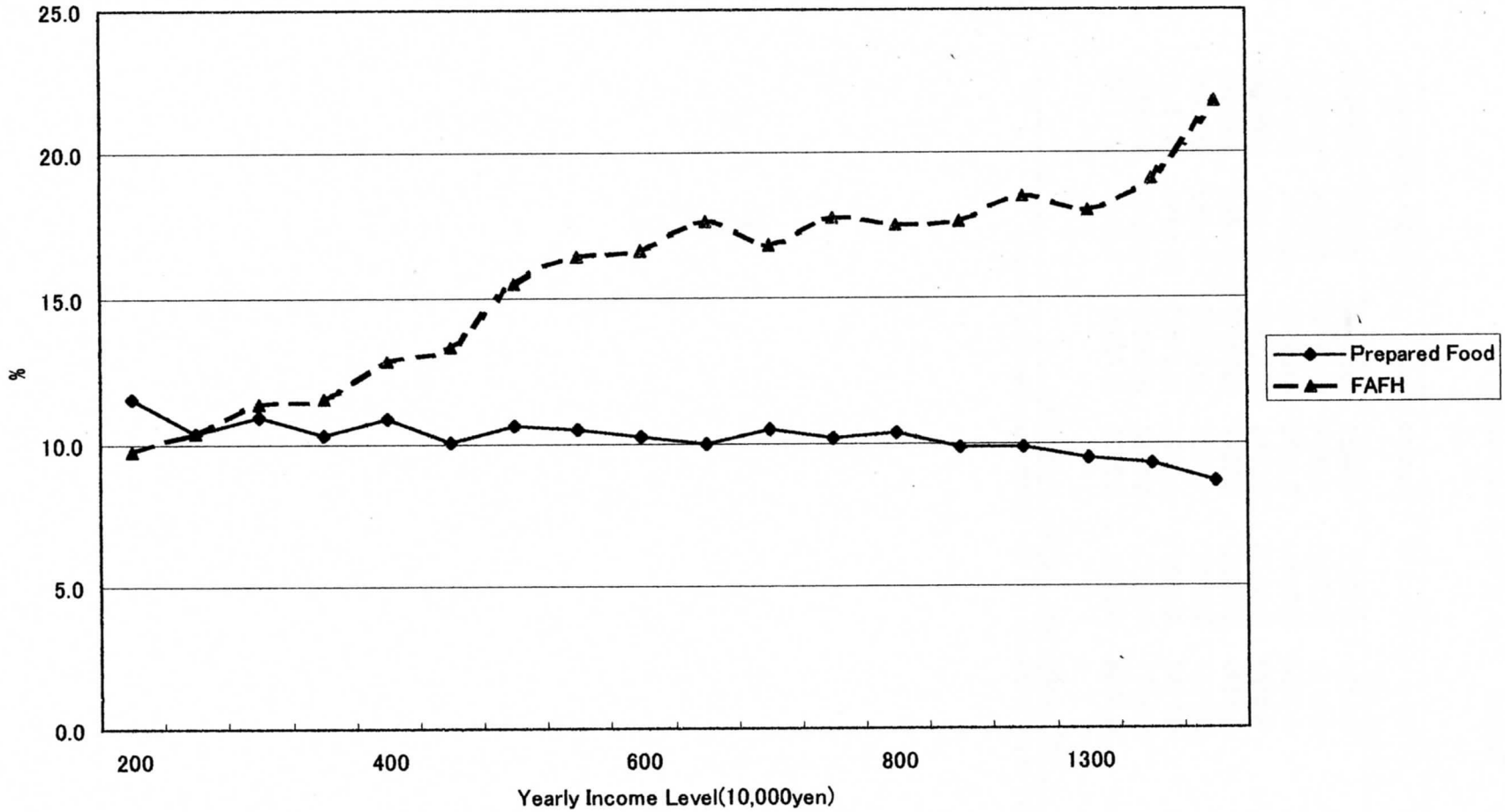
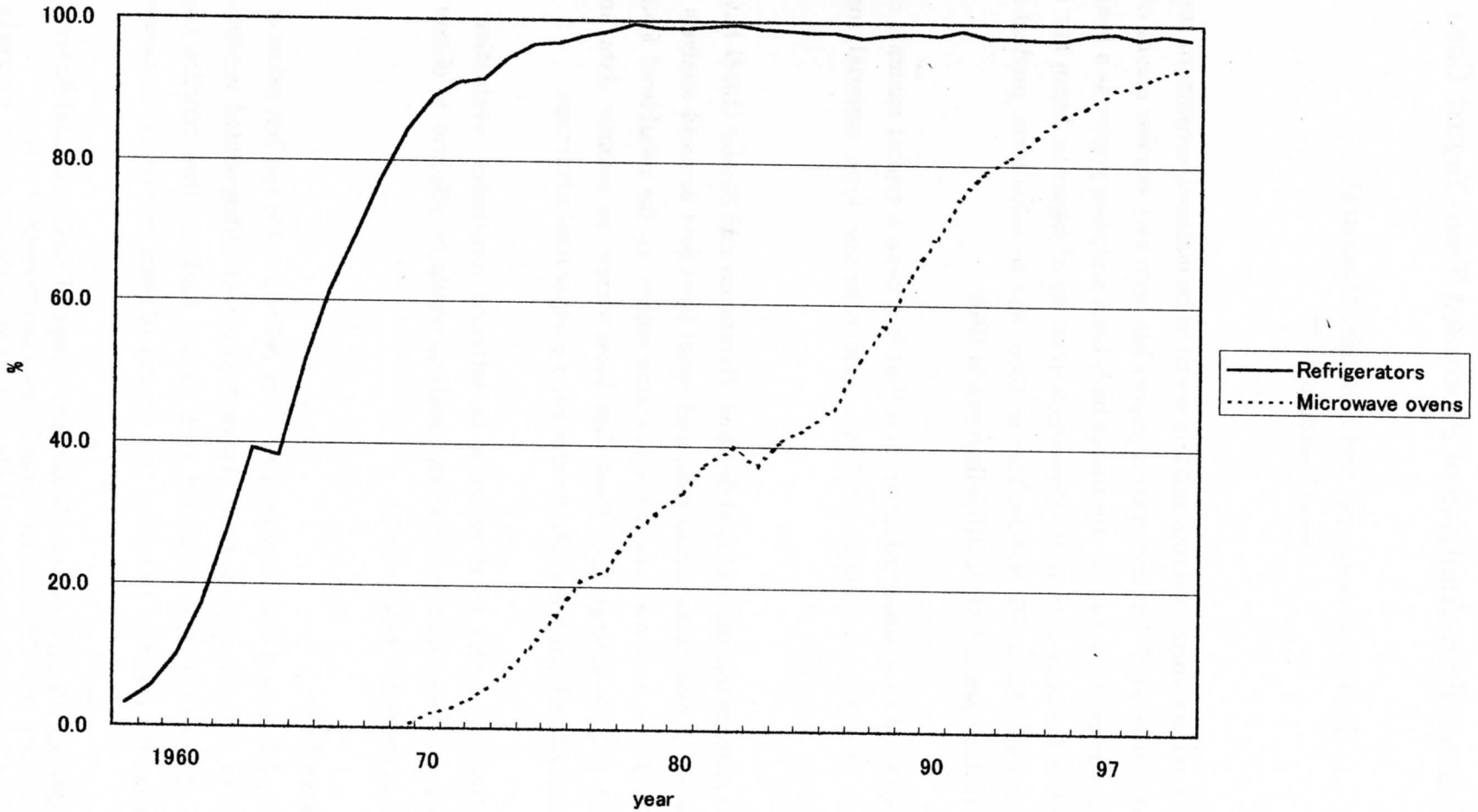


Fig.2. Rate of Diffusion of Cooking Appliances



XI Hedonic Price Analysis of Processed Food: Yogurt Case

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1. Introduction

In developed countries where food consumption seems to be matured, consumers' concern has been on health and healthy food[3]. For that reason, yogurt has been very popular among consumers as a healthy food in worldwide. Japanese consumers have been accepting yogurt as a healthy food, and their consumption has been increasing. Production quantity of yogurt in Japan has increased from 467 million liter in 1990 to 863 million liter in 1999, and in value term, product sales has expanded from 183 billion yen in 1990 to 310 billion yen in 1999.

Yogurt is considered as a processed dairy food that has been a typical example of product differentiation. One item of yogurt is different from others in its size, type, material, ingredients, additives, labels, package designs, etc.

As for the econometric study of food demand, Herrmann and Roeder (1998) have pointed some neglected issues of food demand analysis, and retail-level food demand analysis is among them. Especially in Japan, we have only a few research papers on the retail-level food demand. And also, it seems a little strange that there has been almost no scanner data analysis on retail-level food demand in Japan where electronics has a comparative advantage.

The main objective of this short paper is to estimate consumers' 'evaluation' of yogurt products using hedonic price functions. And the analysis would be effective to obtain a further insight to markets of processed food in Japan.

2. Theoretical Frame Work

Rosen (1974, p.34) argued that "Hedonic prices are defined as the implicit prices of attributes and are revealed to economic agents from observed prices of differentiated products and the specific amounts of characteristics associated with them". Hedonic price function captures the relationship between the observed price and the amount of each characteristic contained in the

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[3] See, for example, Schertz and Daft (1994), Strak and Morgan (1995) and Tokoyama and Egaitsu (1998).

commodity item, and generally defined as:

$$P = f(x_1, x_2, ...x_k) \quad \text{---------- (1)}$$

where P is observed price, x_1, x_2, ... x_k are the amount of the characteristics.

The partial differential of the hedonic price function (1), that is $\partial P/\partial x_i$, shows the shadow price of the characteristic x_i. This differential represents consumers' preference and we can make use of the information obtained from the hedonic price to construct marketing strategies.

In empirical analyses, researchers often use additional independent variables as shifters in equation (1) in order to capture factors affecting to the price. In this study, factors that may cause the price fluctuation are categorized into three groups: characteristics contained in the product; conditions of the store where consumers' buy the commodity; and timing of the buying behavior. The hedonic price function in this paper is defined as:

$$P = f[x(x_1, x_2, ...x_k), y(y_1, y_2, ...y_k), z(z_1, z_2, ...z_k)] \quad \text{---------- (2)}$$

where x_1, x_2, ... x_l are characteristics of the product,

y_1, y_2, ... y_m are store conditions,

z_1, z_2, ... z_n are timing of purchase.

The first category of the independent variables may contain two sub-categories: one is a characteristic of the yogurt such as amount of each nutrient content; and the other is the characteristics of the package and information supplied by the labeling. The second category contains store conditions as is store location, store size, and store type. The third one captures the price fluctuation along with time such as seasonal price variation. It is important to distinguish price fluctuation caused by characteristics of the commodity and that caused by store conditions or timing of purchase in order to understand consumers' preference and to construct an effective marketing policy. Hedonic price function defined as equation (2) is sufficient to decompose the price fluctuation. The differential of x_i $\partial P/\partial x_i$ shows the consumers' preference, $\partial P/\partial y_j$ shows the effect of store conditions, and $\partial P/\partial z_k$ shows the effect of timing. To construct an effective marketing policy, marketers should focus on the characteristic of which the implicit value is significantly positive.

3. Method and Data

The outline of this paper's method is as follows. Firstly researchers have a brainstorming meeting with some people (with my students in my case) to pick up the features of the yogurt products and their packages and so on that may be influential to consumers. Secondly, they estimate the hedonic price function.

The dependent variable P is defined as price per 100 grams. The prices may vary according to their weights, so the explained prices must be adjusted to the price for the same weights. To obtain

the standardized price, 100 grams has been chosen as the reference weight.

Independent variables are categorized into three groups as mentioned in the section 2 of this paper. The first category is characteristics of the commodity, which includes information offered by the package. These variables describe the nutrient ingredients, materials, and characteristics of packages such as with/without pictures. The variables in this category are:

UKCAL: calories [kcal/100gram of yogurt]
UPTG: protein [gram/100gram of yogurt]
UFG: fat [gram/100gram of yogurt]
UCSG: carbohydrate [gram/100gram of yogurt]
UCAMG: calcium [mg/100gram of yogurt]
NFM: non fat solid [%]
DMLK: made from fresh milk =1.
DFJ: use of fruit juice=1.
DNEID: description of nutrient facts=1.
DEPT: with a picture on the package=1.
DSETS: a set package with 2-3 products=1.
DYT1: plain yogurt=1.
DYT2: fruit (soft) yogurt=1.
DYT3: hard yogurt=1.
DPB: private brand=1.

The second category shows store conditions. However, in this study, the data have been obtained at only one store, so that we neglected the second category variables.

The last one is time of purchase. In this paper, I use daily data. The day-of-the-week dummy variables are used just to capture the weekly price fluctuations because the data may be affected by bargain sales on weekends. The variables are:

DW1: Monday=1.
DW2: Tuesday=1.
DW3: Wednesday=1.
DW4: Thursday=1.
DW5: Friday=1.
DW6: Saturday=1.
DW7: Sunday=1.

In hedonic price analysis, the functional form is not determined a priori. In general, researchers have estimated hedonic price functions in several functional forms and the most appropriate functional form has been chosen according to the performance of the estimation. This study follows the same procedure of the preceding researchers. Linear model, Semi-log Model, and

Double-log Model are estimated in this paper.

Finally, several hedonic price functions in three functional forms are estimated in this paper, changing sets of independent variables.

The main part of the data used in this study is scanner data of yogurt products from Kasai store of JUSCO in Tokyo from April 1997 to March 1999[4]. It contains sales and average prices for each product at daily basis. And for the data on package characteristics, the author assembled data by measuring the packages of each product. The sample size used in the estimation was 10,771.

4. Results and Discussion

Table 1 to Table 3 are the estimated hedonic price functions. Table 1 shows results of linear models in which every independent and dependent variables are not transformed. Table 2 shows results of semi-log models, and Table 3 shows results of double-log models.

These three tables show good fits and significant parameters in most of the estimated equations in these three models. Especially it should be stressed that most of the variables have coefficients with the same sign, even in deferent functional forms, and that means the estimates are robust and consistent enough to interpret the estimated results.

Considered the significance of the estimated parameters and easiness for interpretation, I will refer to equation 7 of the linear models hereafter.

The estimated model is:

$$P = 101.285^{***} + 0.074\,UKCAL - 30.216^{***}\,UPTG + 19.005^{***}\,UFG$$
$$(31.400)\quad (1.211)\qquad (-22.424)\qquad (16.146)$$
$$+ 0.138^{***}\,UCAMG - 4.035^{***}\,NFM - 0.679^{***}\,DFJ + 4.422^{***}\,DNEID$$
$$(18.472)\qquad (-6.603)\qquad (-2.554)\qquad (4.975)$$
$$- 34.291^{***}\,DEPT - 11.152^{***}\,DSETS + 98.341^{***}\,DYT2 + 70.323^{***}\,DYT3$$
$$(-24.167)\qquad (-27.492)\qquad (33.264)\qquad (27.657)$$
$$+ 35.854^{***}\,DPB + 0.434^{**}\,DW1$$
$$(19.848)\qquad (1.989)$$

$$R^2 = 0.8426$$

$$(): t - statistics.\ ^{***}:1\%,\ ^{**}:5\%,\ ^{*}:10\%\ siginificance.$$

I would like to comment briefly on each coefficient and its meaning.

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[4] The data was assembled and sold by the Nikkei Quick Information and Technology Co.

Coefficient of UKCAL (calories intake) is positive, but not significant. Consumers are not so much interested in the calorie intake from yogurt. It is often referred to people's concern about calories. But this result is not supportive to the prevailing view as far as yogurt concerns. People may consider yogurt as healthy food on one hand, but as dessert food on the other hand. In case of dessert, they may have less concern on calories intake.

UFG (fat) and UCAMG (calcium) have positive and significant coefficients. Unit price of yogurt would be increase according to the increase of these two factors. But UPTG (protein) is negative and significant.

High rate of non-fat solid contents (NFM) and use of fruit juice would (DFJ) decrease the prices. The latter must relate to the fruit yogurt category. In that category, high quality products tend to contain fruit pulp, not fruit juice. So the negative coefficient of DFJ must be a reflection of non-use of fruit pulp.

Describing the nutrient facts (DNEID) would increase the price, and use of picture (DEPT) or set (bundle) sales (DSETS) would decrease the prices. The positive and significant coefficient for the description of nutrient facts is very important. It suggests us the consumers' valuation on health information. Our estimate might be interpreted as the consumers' willingness to pay for this type of information.

As for the types of yogurt, comparing with plain type yogurt (DYT1), fruit yogurt (DYT2) and hard yogurt (DYT3) are getting higher evaluations. It is very natural that products processed further would be evaluated higher.

Private brand (DPB) shows positive and significant coefficient. This may be due to the limitation of store type where the data were obtained. If data had been collected from several stores in different super market chain, the results might be different.

Monday (DW1) shows slightly higher price that usual. We have estimated several functions using different day-of the-week dummies, and it seemed that there was a tendency that higher prices on Mondays, Tuesdays, Sundays, and lower prices on Thursdays and Wednesdays at 5% significance level.

As described above, the estimated hedonic function shows significant coefficients for most of the independent variables. Most parameters are consistent to our common sense and it is easy to interpret the estimation results.

5. Concluding Remarks

This short paper presents a hedonic price analysis of yogurt whose demand is increasing in

Japan recently.

The hedonic price function is estimated in linear models, semi-log models and double log models and the results are significant. The estimated coefficients offer useful information for marketers. The coefficients suggest us that producers should use more fat, calcium. Calories are not so significantly correlated to prices. And the coefficients also suggest they should use less non-fat solid, fruit juice (use of fruit pulp might be better), and should use package without pictures.

The results are almost satisfactory, but there remain several problems unsolved. One is more sample are needed to obtain better estimates. Another one is to get nutritional information of the yogurt. The former concerns the volume of my research fund because scanner data is expensive. The latter one would be solved by interdisciplinary cooperation between economists and nutrition scientists.

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Table-1 Linear Models (1)

	1	2	3	4
const.	54.840***	49.032***	−74.933***	38.985***
	(2.574)	(8.822)	(−3.278)	(6.891)
UKCAL			2.828***	1.127***
			(7.880)	(8.083)
UPTG	−27.199***	−26.956***	−33.603***	−30.206***
	(−15.265)	(−17.284)	(−23.792)	(−24.166)
UFG	14.555***	13.869***	−26.188***	1.842***
	(5.365)	(11.504)	(−4.423)	(0.794)
UCSG	2.873**	3.219***		
	(2.142)	(5.848)		
UCAMG	0.083***	0.075***	−0.091***	0.053***
	(2.803)	(6.186)	(−3.000)	(4.445)
NFM	−0.491		9.431***	
	(−0.282)		(5.143)	
DMLK	9.228**	10.376***	37.659***	14.198***
	(2.126)	(6.822)	(7.787)	(8.823)
DFJ	−0.349	−0.314	−2.212***	−1.344***
	(−1.240)	(−1.242)	(−6.696)	(−4.728)
DNEID	6.363***	6.597***	16.377***	9.507***
	(4.765)	(6.304)	(9.238)	(8.146)
DEPT	−42.857***	−43.990***	−71.924***	−48.638***
	(−9.445)	(−20.713)	(−14.282)	(−22.031)
DSETS	−11.796***	−11.901***	−17.425***	−13.487***
	(−21.717)	(−29.975)	(−19.330)	(−28.311)
DYT1				
DYT2	87.966***	86.549***	59.320***	82.452***
	(13.757)	(21.761)	(10.203)	(22.350)
DYT3	52.475***	50.092***	0.417	43.082***
	(5.472)	(10.993)	(0.045)	(10.082)
DPB	43.051***	44.072***	70.386***	48.610***
	(10.260)	(20.736)	(14.705)	(21.744)
DW1	0.434**	0.434**	0.440**	0.436**
	(1.990)	(1.990)	(2.023)	(2.001)
R**2	0.8426	0.8426	0.8435	0.8431
adj-R**2	0.8424	0.8424	0.8433	0.8429
Log of Max Likelihood	-37632.3	−37632.3	−37603.6	−37616.8
Sum of Squared Resid	683133	683138	679502	681173

Table 1 Linear Models (2)

	5	6	7	8
const.	99.645***	84.221***	101.285***	85.257***
	(31.607)	(40.605)	(31.400)	(40.503)
UKCAL			0.074	0.018
			(1.211)	(0.297)
UPTG	−29.793***	−34.992***	−30.216***	−35.200***
	(−22.933)	(−34.158)	(−22.424)	(−31.474)
UFG	20.066***	20.014***	19.005***	19.487***
	(25.040)	(24.928)	(16.146)	(16.555)
UCSG	0.072	−0.118		
	(0.284)	(−0.467)		
UCAMG	0.144***	0.139***	0.138***	0.134***
	(18.349)	(17.814)	(18.472)	(17.968)
NFM	−3.953***		−4.035***	
	(−6.487)		(−6.603)	
DMLK				
DFJ	−0.596**	−0.316	−0.679***	−0.341*
	(−2.324)	(−1.248)	(−2.554)	(−1.304)
DNEID	4.219***	2.097***	4.422***	2.184***
	(4.817)	(2.576)	(4.975)	(2.653)
DEPT	−33.692***	−33.188***	−34.291***	−33.677***
	(−23.764)	(−23.399)	(−24.167)	(−23.738)
DSETS	−10.978***	−11.167***	−11.152***	−11.269***
	(−28.635)	(−29.158)	(−27.492)	(−27.751)
DYT1				
DYT2	99.867***	104.264***	98.341***	102.903***
	(32.333)	(34.534)	(33.264)	(35.728)
DYT3	72.027***	75.284***	70.323***	73.753***
	(25.506)	(28.136)	(27.657)	(29.572)
DPB	34.981***	36.155***	35.854***	36.876***
	(19.541)	(20.262)	(19.848)	(20.449)
DW	10.433**	0.435**	0.434**	0.435**
	(1.987)	(1.991)	(1.989)	(1.993)
R**2	0.8426	0.8420	0.8426	0.8420
adj-R**2	0.8424	0.8418	0.8484	0.8418
Log of Max Likelihood	−37634.6	−37655.6	−37633.9	−37655.7
Sum of Squared Resid	683420	686094	683332	686102

Table 2 Semi-log Models (1)

	1	2	3	4
const.	381.358***	25.071***	2309.50***	30.638
	(11.058)	(2.377)	(12.536)	(0.512)
LUKCAL			−610.558***	−8.286***
			(−12.227)	(−0.428)
LUPTG	−112.214***	−120.624***	16.514***	−116.382***
	(−23.797)	(−25.794)	(1.451)	(−22.587)
LUFG	60.034***	36.746***	198.592***	36.020***
	(21.814)	(21.234)	(14.802)	(7.114)
LUCSG	−175.596***	−23.719**		
	(−10.074)	(−2.273)		
LUCAMG	74.520***	33.421***	140.369***	28.556***
	(15.638)	(11.507)	(15.102)	(7.805)
LNFM	−119.925***		−223.094***	
	(−10.845)		(−13.068)	
DMLK	−33.146***	5.090**	−78.609***	8.818***
	(−7.978)	(2.304)	(−11.043)	(3.598)
DFJ	−0.883***	−0.095	4.710***	−0.035
	(−3.380)	(−0.377)	(9.648)	(−0.106)
DNEID	−21.730***	1.581	−63.492***	5.244**
	(−6.840)	(0.672)	(−10.633)	(1.841)
DEPT	21.142***	−31.774***	94.535***	−38.567***
	(3.313)	(−7.686)	(8.435)	(−8.183)
DSETS	−8.324***	−11.292***	2.424**	−11.515***
	(−16.905)	(−27.438)	(2.012)	(−20.386)
DYT1				
DYT2	179.359***	121.474***	140.307***	111.730***
	(23.799)	(22.710)	(36.816)	(35.518)
DYT3	191.945***	92.100***	205.234***	77.956***
	(16.408)	(12.694)	(19.070)	(16.897)
DPB	−25.294***	31.527***	−97.152***	38.822***
	(−3.686)	(7.078)	(−8.469)	(7.978)
DW1	0.441**	0.436**	0.442**	0.435***
	(2.036)	(2.002)	(2.046)	(1.998)
R**2	0.8447	0.8430	0.8454	0.8429
adj-R**2	0.8445	0.8428	0.8452	0.8427
Log of Max Likelihood	−37561.5	−37620.1	−37537.8	−37622.6
Sum of Squred Resud	674216	681587	671246	681903

Table 2 Semi-log Models (2)

	5	6	7	8
const.	118.117***	47.426***	282.253***	239.561***
	(11.708)	(11.472)	(18.102)	(16.354)
LUKCAL			−63.194***	−74.644***
			(−10.412)	(−12.636)
LUPTG	−110.312***	−124.550***	−96.822***	−108.897***
	(−23.356)	(−28.595)	(−19.560)	(−23.088)
LUFG	41.262***	39.070***	52.494***	52.344***
	(28.821)	(27.774)	(23.402)	(23.271)
LUCSG	−39.554***	−46.343***		
	(−10.901)	(−13.134)		
LUCAMG	38.024***	39.369***	39.004***	40.630***
	(28.399)	(29.579)	(26.569)	(27.879)
LNFM	−45.047***		−45.910***	
	(−7.679)		(−7.828)	
DMLK				
DFJ	−0.422**	−0.078	0.206	0.673***
	(−1.652)	(−0.309)	(0.76)	(2.549)
DNEID	1.952**	−3.430***	1.193	−4.459***
	(1.720)	(−3.831)	(1.023)	(−4.853)
DEPT	−28.033***	−22.916***	−27.847***	−22.543***
	(−16.932)	(15.080)	(−16.564)	(−14.611)
DSETS	−10.827***	−10.935***	−10.121***	−10.097***
	(−28.451)	(−28.675)	(−25.068)	(−24.938)
DYT1				
DYT2	127.288***	130.218***	114.199***	15.009***
	(33.682)	(34.542)	(37.993)	(38.178)
DYT3	103.038***	106.683***	89.995***	91.560***
	(28.867)	(30.075)	(34.022)	(34.616)
DPB	26.758***	22.429***	27.344***	22.958***
	(12.559)	(10.886)	(12.841)	(11.144)
DW1	0.436**	0.437**	0.435**	0.437**
	(2.003)	(2.007)	(2.003)	(2.003)
R**2	0.8438	0.8429	0.8436	0.8427
adj-R**2	0.8436	0.8427	0.8434	0.8426
Log of Max Likelihood	−37593.3	−37622.8	−37598.5	−37629.1
Sum of Squared Resid	678206	681924	678856	682724

Table 3 Double-log Models (1)

	1	2	3	4
const.	10.677***	4.091***	48.787***	4.008***
	(20.714)	8 25.882)	(17.770)	(4.465)
LUKCAL			−11.890***	−0.055
			(−15.979)	(−0.191)
LUPTG	−2.617***	−2.773***	−0.114	−2.725***
	(−37.138)	(−39.559)	(−0.672)	(−35.290)
LUFG	1.232***	0.802***	3.974***	0.780***
	(29.953)	(30.903)	(19.877)	(10.273)
LUCSG	−3.110***	−0.302**		
	(−11.936)	(−1.933)		
LUCAMG	1.229***	0.470***	2.595***	0.398***
	(17.260)	(10.788)	(18.738)	(7.264)
LNFM	−2.217***		−4.384***	
	(−13.412)		(−17.231)	
DMLK	−0.587***	0.119***	−1.545***	0.173***
	(−9.461)	(3.603)	(−14.565)	(4.706)
DFJ	−0.023***	−0.009**	1.628***	−0.987***
	(5..934)	(−14.348)	(9.749)	(−13.973)
DNEID	−0.105**	0.326***	−0.971***	0.379***
	(−2.217)	(9.238)	(−10.917)	(8.880)
DEPT	0.089	−0.889***	1.628***	−0.987***
	(0.934)	(−14.348)	(9.749)	(−13.973)
DSETS	−0.084***	−0.138***	0.131***	−0.142***
	(−11.360)	(−22.447)	(7.323)	(−16.822)
DYT1				
DYT2	3.680***	2.610***	3.043***	2.482***
	(32.667)	(32.550)	(53.586)	(52.637)
DYT3	3.721***	1.875***	4.185***	1.684***
	(21.280)	(17.234)	(26.094)	(24.351)
DPB	−0.187***	0.863***	−1.704***	0.968***
	(−1.827)	(12.926)	(−9.970)	(13.266)
DW1	0.007**	0.007**	0.007**	0.007**
	(2.290))	(2.243)	(2.313)	(2.240)
R**2	0.8794	0.8774	0.8807	0.8774
adj-R**2	0.8793	0.8773	0.8805	0.8772
Log of Max Likelihood	7712.43	7623.12	7767.91	7621.26
Sum of Squared Resid	150.605	153.124	149.062	153.176

Table 3 Double-log Models (2)

	5	6	7	8
const.	6.013***	4.615***	8.942***	8.104***
	(38.909)	(74.460)	(38.326)	(36.897)
LUKCAL			−1.132***	−1.356***
			(−12.460)	(−15.315)
LUPTG	−2.584***	−2.865***	−2.342***	−2.579***
	(−36.557)	(−43.867)	(−31.614)	(−36.462)
LUFG	0.899***	0.856***	1.103***	1.100***
	(41.979)	(40.586)	(32.848)	(32.603)
LUCSG	−0.699***	−0.833***		
	(−12.866)	(−15.738)		
LUCAMG	0.582***	0.609***	0.603***	0.635***
	(29.072)	(30.517)	(27.454)	(29.060)
LNFM	−0.890***		−0.901***	
	(−10.135)		(−10.270)	
DMLK				
DFJ	−0.015***	−0.008**	−0.004	0.005*
	(−3.974)	(−2.221)	(−0.961)	(1.337)
DNEID	0.314***	0.208***	0.300***	0.189***
	(18.513)	(15.507)	(17.180)	(13.714)
DEPT	−0.782***	−0.681***	−0.777***	−0.673***
	(−31.583)	(−29.904)	(−30.890)	(−29.089)
DSETS	−0.128***	−0.130***	−0.115***	−0.115***
	(−22.472)	(−22.753)	(−19.049)	(−18.879)
DYT1				
DYT2	2.757***	2.815***	2.530***	2.546***
	(48.749)	(49.793)	(56.252)	(56.366)
DYT3	2.145***	2.217***	1.920***	1.951***
	(40.159)	(41.682)	(48.503)	(49.183)
DPB	0.735***	0.650***	0.743***	0.657***
	(23.058)	(21.030)	(23.308)	(21.256)
DW1	0.007**	0.007**	0.007**	0.007**
	(2.253)	(2.250)	(2.249)	(2.245)
R**2	0.8784	0.8773	0.8783	0.8771
adj-R**2	0.8783	0.8771	0.8782	0.8770
Log of Max Likelihood	7667.80	7616.62	7662.73	7610.19
Sum of Squared Resid	151.859	153.309	152.002	153.492

XII A Generalized Rank-3 Demand System Nesting the AIDS and Translog Models

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1 Introduction

In this paper, we present and estimate a new flexible consumer demand system that incorporates the rank-3 property into Lewbel's (1989) model. One of the recent developments in the literature of empirical demand systems may be the introduction and estimation of some rank-3 systems. The rank of a demand system, originally defined by Gorman (1981) and widely extended by Lewbel (1991), means the rank of its Engel curve coefficient matrix, from which it follows that the number of columns of the matrix equals the maximum possible rank of the demand system. The well-known flexible systems such as the almost ideal demand system (AI) of Deaton and Muellbauer (1980) and the exactly aggregable version of translog model (TL) of Jorgenson et al. (1982) are rank-2 systems, whose Engel curves are linear in logarithm of total expenditure. Banks et al. (1997) introduced the quadratic rank-3 extension of the AI (QUAI), and showed that, maintaining the desirable properties of the popular AI, it had the advantage of allowing the case where the change in income level would move commodities from luxuries to necessities.[1] Applications of the QUAI were made by Lewbel (1995), Banks et al. (1996), Jones and Mazzi (1996), Denton et al. (1999), and Michelini (1999), among others.

Another remarkable development in the literature may be Lewbel's (1989) contribution to demand system specification. Lewbel (1989) developed the generalized model that nests two widely used and competing demand systems—the AI and the TL. Like the nested

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[1]The most recently proposed rank-3 demand systems are the three generalized quadratic expenditure systems of Ryan and Wales (1999).

AI and TL, this composite model, which we call the AITL, is a rank-2 demand system that satisfies the requirement of exact nonlinear aggregation across consumers and the property of second-order flexibility (Diewert, 1974, p.113). In the empirical literature, Yen and Chern (1992), Chern et al. (1995), and Ramezani et al. (1995) applied the AITL to U.S. food consumption data, and their test results rejected both the AI and the TL in favor of this generalized model.

Given the advantage of rank-3 demand systems such as the QUAI, a close theoretical relationship between the AITL and the AI, and the empirical evidences that support the possible statistical superiority of the AITL to the AI, the rank-3 extension of the AITL, termed the quadratic AITL, or the QUAITL for short, can be constructed and may be a better alternative to the QUAI. Since the QUAITL includes the AITL, the QUAI, and several other systems as special cases, it carries over their theoretical properties while, in the empirical context, it can also serve for the purpose of specifying functional forms.

The remainder of this paper is organized as follows. The theoretical specification of the QUAITL is described in the following section. In section 3 this generalized system is applied, for an empirical illustration, to a Japanese survey data set. The nested models are tested, and the performance of the QUAITL is compared with those of the nested models. Summary and concluding remarks are reserved for section 4.

2 Specification of the model

Let $p = (p_1, \ldots, p_n)$ denote the nominal price vector of n goods, y denote total expenditure on the goods (expenditure, for short), and w_i denote the expenditure share of good i. The indirect utility function of the AITL can be written as

$$\ln V(p, y) = \frac{c(p) \ln y - \ln a(p)}{b(p)}, \tag{1}$$

where

$$\ln a(p) = \alpha_0 + \sum_{j=1}^{n} \alpha_j \ln p_j + \frac{1}{2} \sum_{j=1}^{n} \sum_{k=1}^{n} \gamma_{jk} \ln p_j \ln p_k, \tag{2}$$

$$b(p) = \prod_{j=1}^{n} p_j^{\beta_j}, \tag{3}$$

$$c(p) = \sum_{j=1}^{n} \alpha_j + \sum_{j=1}^{n}\sum_{k=1}^{n} \gamma_{jk} \ln p_k. \tag{4}$$

Equation (1) generates a PIGLOG demand system, which is linear in $\ln y$. Following the extension method of PIGLOG preferences proposed by Banks et al. (1997), we can extend equation (1) to specify the indirect utility function of the QUAITL as

$$\ln V(p,y) = \left\{ \left[\frac{c(p)\ln y - \ln a(p)}{b(p)} \right]^{-1} + m(p) \right\}^{-1}, \tag{5}$$

where,

$$m(p) = \sum_{j=1}^{n} \mu_j \ln p_j. \tag{6}$$

Applying Roy's identity to equation (5), the corresponding system of demand functions are derived in expenditure share form as

$$w_i = \frac{\alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln(p_j/y) + \beta_i [c(p)\ln y - \ln a(p)]}{c(p)} + \frac{\mu_i [c(p)\ln y - \ln a(p)]^2}{b(p)c(p)}, \quad i = 1, \ldots, n. \tag{7}$$

The following parameter constraints can be imposed to ensure the QUAITL is consistent with the neoclassical consumer demand theory:

$$\text{Adding-up:} \quad \sum_{i=1}^{n} \alpha_i = 1, \quad \sum_{i=1}^{n} \beta_i = 0, \quad \sum_{i=1}^{n} \mu_i = 0. \tag{8}$$

$$\text{Homogeneity:} \quad \sum_{i=1}^{n}\sum_{j=1}^{n} \gamma_{ij} = 0. \tag{9}$$

$$\text{Slutsky symmetry:} \quad \gamma_{ij} = \gamma_{ji}, \text{ for all } i \text{ and } j. \tag{10}$$

Equation (7) is a rank-3 demand system that permits exact nonlinear aggregation across consumers and second-order flexibility. Expenditure shares are quadratic in $\ln y$ and, when the restrictions (8) through (10) are imposed and the value of α_0 is predetermined,[2] the total number of free parameters is $(n+8)(n-1)/2$, which is $2(n-1)$ more than the number

[2]The estimation and test results are found virtually unchanged whether α_0 is estimated or fixed at any particular value.

required for parsimonious flexible functional forms (Pollak and Wales, 1992, p.63) such as the AI and the TL. $n-1$ of the additional parameters are for combining the AI and the TL, while $n-1$ independent μ_i for quadratic logarithmic expenditure terms.

The expenditure elasticities and uncompensated price elasticities can be obtained from

$$\eta_i = 1 + \frac{\beta_i}{w_i} - \frac{\sum_{j=1}^{n} \gamma_{ij}}{w_i c(p)} + \frac{2\mu_i [c(p) \ln y - \ln a(p)]}{w_i b(p)}, \tag{11}$$

and

$$\begin{aligned} \epsilon_{ij} = & -\delta_{ij} + \frac{\gamma_{ij} - \beta_i [\alpha_j + \sum_{k=1}^{n} \gamma_{jk} \ln(p_k/y)]}{w_i c(p)} - \frac{\sum_{k=1}^{n} \gamma_{jk}}{c(p)} \\ & - \frac{\mu_i [c(p) \ln y - \ln a(p)] \{2 [\alpha_j + \sum_{k=1}^{n} \gamma_{jk} \ln(p_k/y)] + \beta_j [c(p) \ln y - \ln a(p)]\}}{w_i b(p) c(p)}, \end{aligned} \tag{12}$$

respectively, where δ_{ij} denotes the Kronecker delta, which is equal to unity if $i = j$ and zero otherwise. Since η_i are linear functions of $\ln y$ and ϵ_{ij} are quadratic in $\ln y$, these demand elasticities, depending on the parameter estimates, may allow more flexibility in expenditure levels than in the rank-2 case, where $\mu_i = 0$. The compensated price elasticities are given by the Slutsky equation, $\epsilon_{ij}^c = \epsilon_{ij} + w_j \eta_i$.

An interesting and distinguishing feature of the QUAITL is that it has nested within it, as more restrictive cases, the five exactly aggregable, flexible demand systems. When additional parameter constraints are imposed for all i, the QUAITL reduces to the following models:

(i). The AI: $\sum_{j=1}^{n} \gamma_{ij} = 0$, $\mu_i = 0$:

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln[y/a(p)]. \tag{13}$$

(ii). The TL: $\beta_i = 0$, $\mu_i = 0$:

$$w_i = \frac{\alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln(p_j/y)}{c(p)}. \tag{14}$$

(iii). The AITL: $\mu_i = 0$:

$$w_i = \frac{\alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln(p_j/y) + \beta_i [c(p) \ln y - \ln a(p)]}{c(p)}. \tag{15}$$

(iv). The QUAI: $\sum_{j=1}^{n} \gamma_{ij} = 0$:

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln[y/a(p)] + \frac{\mu_i \{\ln[y/a(p)]\}^2}{b(p)}. \tag{16}$$

(v). The quadratic extension of the TL (QUTL):[3] $\beta_i = 0$:

$$w_i = \frac{\alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln(p_j/y) + \mu_i [c(p) \ln y - \ln a(p)]^2}{c(p)}. \tag{17}$$

In order to impose on the QUAITL the curvature conditions required by microeconomic theory,[4] which implies that the Slutsky matrix is negative semidefinite, we employ the procedure recently proposed by Ryan and Wales (1998) and extended by Moschini (1999). This method, although the imposition is local, can maintain the curvature property at many or, at the best, all sample points without losing flexibility. Letting curvature be imposed at the approximation point $p = y = 1$ without loss of generality, the ij th element of the $n \times n$ Slutsky matrix (S) of the QUAITL is given by

$$\begin{aligned} S_{ij} = {} & \gamma_{ij} - (\alpha_i - \alpha_0\beta_i + \alpha_0{}^2\mu_i)\delta_{ij} + (\alpha_i - \alpha_0\beta_i + \alpha_0{}^2\mu_i)(\alpha_j - \alpha_0\beta_j + \alpha_0{}^2\mu_j) \\ & - (\alpha_i - \alpha_0\beta_i + \alpha_0{}^2\mu_i) \sum_{k=1}^{n} \gamma_{jk} - (\alpha_j - \alpha_0\beta_j + \alpha_0{}^2\mu_j) \sum_{k=1}^{n} \gamma_{ik} \\ & - \alpha_0\beta_i\beta_j + \alpha_0{}^2(\beta_i\mu_j + \beta_j\mu_i) - 2\alpha_0{}^3\mu_i\mu_j, \qquad i,j = 1,\ldots,n. \end{aligned} \tag{18}$$

Moschini (1999) showed that, if homogeneity and symmetry are satisfied, a necessary and sufficient condition for S to be negative semidefinite is negative semidefiniteness of an $(n-1) \times (n-1)$ matrix obtained from S by deleting any one row and the corresponding column. Following the procedure presented by Moschini (1999), equation (7) can be rewritten as

$$\begin{aligned} w_i = {} & \frac{\alpha_i + \sum_{j=1}^{n-1} \gamma_{ij} \ln(p_j/p_n) + \theta_i \ln(p_n/y) + \beta_i [\tilde{c}(p) \ln y - \ln \tilde{a}(p)]}{\tilde{c}(p)} \\ & + \frac{\mu_i [\tilde{c}(p) \ln y - \ln \tilde{a}(p)]^2}{b(p)\tilde{c}(p)}, \qquad i = 1,\ldots,n-1. \end{aligned} \tag{19}$$

[3] Banks et al. (1997) mention this model in a footnote as a potential alternative to the QUAI.

[4] Diewert and Wales (1988) gives alternative expressions of these curvature conditions in expenditure and some utility functions.

where

$$\theta_i = \sum_{j=1}^{n} \gamma_{ij}, \tag{20}$$

$$\ln \tilde{a}(p) = \alpha_0 + \sum_{j=1}^{n} \alpha_j \ln p_j + \frac{1}{2} \sum_{j=1}^{n-1} \sum_{k=1}^{n-1} \gamma_{jk} \ln p_j \ln p_k + \theta_n \ln p_n, \tag{21}$$

$$\tilde{c}(p) = \sum_{j=1}^{n} \alpha_j + \sum_{j=1}^{n} \theta_j \ln p_j. \tag{22}$$

Homogeneity requires that $\sum_{j=1}^{n} \theta_j = 0$. The restrictions which yield the nested AI and QUAI are now $\theta_i = 0$ and $\mu_i = 0$, and $\theta_i = 0$, respectively. Substituting equation (20) into equation (18) and replacing S with $-AA^\top$,

$$\begin{aligned} \gamma_{ij} = & -(AA^\top)_{ij} + (\alpha_i - \alpha_0\beta_i + {\alpha_0}^2\mu_i)\delta_{ij} - (\alpha_i - \alpha_0\beta_i + {\alpha_0}^2\mu_i)(\alpha_j - \alpha_0\beta_j + {\alpha_0}^2\mu_j) \\ & + (\alpha_i - \alpha_0\beta_i + {\alpha_0}^2\mu_i)\theta_j + (\alpha_j - \alpha_0\beta_j + {\alpha_0}^2\mu_j)\theta_i \\ & + \alpha_0\beta_i\beta_j - {\alpha_0}^2(\beta_i\mu_j + \beta_j\mu_i) + 2{\alpha_0}^3\mu_i\mu_j, \qquad i,j = 1,\ldots,n-1, \end{aligned} \tag{23}$$

where A is an $(n-1) \times (n-1)$ lower triangular matrix and $(AA^\top)_{ij}$ denotes the ij th element of $AA^\top$. Local curvature, or negative semidefiniteness of the Slutsky matrix at the point of approximation, can be guaranteed by substituting equation (23) into equation (19) and (21). Since A consists of the same number of elements as S with symmetry taken into account, this reparameterized QUAITL has as many free parameters as the basic system (7), and maintains the property of flexible functional form.

3 Empirical results

The data on expenditures are obtained from Annual Report on the Family Income and Expenditure Survey and the corresponding price indices are from Annual Report on the Consumer Price Index, both of which are published by the Statistics Bureau of the Management and Coordination Agency of Japan. Individual observation values of expenditure data are not available, and the published data are average values of a sample survey which covers about 8,000 randomly selected consumer households in Japan except those engaged in agriculture, forestry and fishery, and one-person households. The data set consists

of highly aggregated annual data per household on three categories of commodities—1) services, 2) nondurables (including semi-durables), and 3) durables—for the period 1980–1998 inclusive. It is assembled for the quintile income groups—the five equally divided groups in terms of the number of households, after arranging them in order of annual income—and therefore the total number of observations is 95. Since household size is the only demographic variable available for our expenditure data, we have demographic characteristics represented by household size and incorporated into equations (7) and (13)–(24) through α_i, which are assumed to be nonlinearly dependent of the number of persons per household z and linearly dependent of a time trend t:[5]

$$\alpha_i = \alpha_{i0} + \sum_{h=1}^{m} \alpha_{ih} z^h + \alpha_{i,m+1} t. \tag{24}$$

The maximum order of z can be determined by the statistical significance of estimates of α_{ih}, and we choose that $m = 3$.

The Stone index approximation to equation (2), often employed in the estimation of the AI, is not used to avoid the bias pointed out by Pashardes (1993) and Moschini (1995). All the regressors are assumed exogenous, and the system is estimated using the nonlinear iterative seemingly unrelated regression procedure of SHAZAM 8.0, with the value of α_0 set to zero. The equation of durables is dropped in estimation because of singularity of the covariance matrix of errors across equations, which is a consequence of the adding-up restrictions. The Davidon–Fletcher–Powell method is employed as nonlinear algorithm. The equations fit the data generally well, having the single-equation R^2 statistics in the range 0.984 to 0.989.[6] The curvature condition, which is not imposed but is checked by the eigenvalues of the Slutsky matrix evaluated at the sample mean, was found to hold (locally).

Estimates of the QUAITL and the nested systems are presented in Table 1. Since the matrix of price parameters γ_{ij} is symmetric, only its upper triangle is shown. All the systems yield generally significant estimates, and estimated parameters of the AI, the TL, and the AITL are fairly similar to those of their rank-3 counterparts, that is, the QUAI, the QUTL, and the QUAITL, respectively. The statistical significance of parameters on quadratic logarithmic expenditure terms μ_i suggests nonlinearity in $\ln y$ for nondurables.

[5] Therefore the household size elasticities can be obtained from $\sigma_i = (\sum_{h=1}^{m} h\alpha_{ih} z^h)/[w_i c(p)]$.

[6] These R^2 are obtained from regressions of w_i on $\hat{w}_i$.

The hypothesis that the Engel curve for services is linear in $\ln y$ is not rejected, whereas linearity of the Engel curve for durables is indecisive since t-ratio for μ_3 is quite different in each model.

Table 2 contains the results of the Wald tests of the nested models. The AITL decisively rejects the nested AI and TL, like in the previous empirical studies that applied the AITL. The QUAITL rejects all the nested systems but the AITL, while the QUAI and the QUTL do not reject the AI and TL, respectively, at the 0.01 significance level, although the three rank-3 systems do reject their rank-2 counterparts at the 0.1 level. These results suggest that combining the AI and the TL is a preferable specification in both rank-2 and rank-3 contexts. The statistical superiority of the rank-3 systems over their rank-2 counterparts are not strong, which is somewhat different from results of the previous studies, presumably and partly because our data set is a quasi panel that is highly aggregated over commodities and has only five different observations in each year.

Reported in Table 3 are estimated uncompensated elasticities evaluated at the mean of the data. The estimates of all the systems are generally reasonable and quite similar, except those for durables. The absolute values of both own- and cross-price elasticities for durables are unusually high. This may be in part due to violent fluctuations of the real estate market in the period of our data, which we failed to control effectively in the estimation stage.

4 Conclusion

This paper developed the QUAITL, a new rank-3 specification of empirical demand system in flexible functional form, and illustrated it with an application to Japanese household survey data. The test results were in favor of the AITL and the QUAITL in the rank-2 and rank-3 contexts, respectively. The statistical superiority of the QUAITL suggests that it can serve as a better, or at least reasonable, alternative to the QUAI, a popular rank-3 system in the recent empirical literature. Its property of nesting the five flexible systems with exact aggregability, including the familiar AI and TL, is likely to play a useful role in empirical model specifications. Since quadratic (logarithmic) expenditure terms can provide additional information about variation in expenditure levels, data with substantial expenditure variation may offer greater opportunities for applying rank-3 demand systems. The flexible rank-3 systems such as the QUAITL may be of interest especially when we

want to use a panel, which is likely to show wider variation in prices than a cross section and in expenditures than a time series.

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Table 1

Parameter estimates [a]

	AI	TL	AITL	QUAI	QUTL	QUAITL
α_{10}	-0.944	-0.716	-0.469	-0.629	-0.448	-0.521
	(-3.349)	(-2.501)	(-2.256)	(-2.179)	(-1.924)	(-2.011)
α_{11}	1.019	0.861	0.576	0.737	0.662	0.621
	(4.034)	(3.396)	(3.186)	(2.846)	(3.324)	(3.120)
α_{12}	-0.287	-0.240	-0.152	-0.203	-0.183	-0.166
	(-3.837)	(-3.198)	(-2.820)	(-2.642)	(-3.122)	(-2.849)
α_{13}	0.026	0.022	0.013	0.018	0.016	0.014
	(3.566)	(2.928)	(2.340)	(2.326)	(2.733)	(2.417)
α_{14}	0.009	0.008	0.007	0.009	0.008	0.008
	(5.083)	(5.125)	(4.624)	(5.274)	(4.235)	(4.992)
α_{20}	1.908	2.076	1.872	1.767	1.859	1.899
	(5.974)	(6.477)	(6.155)	(5.940)	(5.823)	(6.546)
α_{21}	-1.041	-1.232	-0.865	-0.917	-1.100	-0.932
	(-3.694)	(-4.339)	(-3.120)	(-3.446)	(-3.900)	(-3.714)
α_{22}	0.291	0.349	0.228	0.251	0.312	0.252
	(3.488)	(4.142)	(2.716)	(3.152)	(3.678)	(3.316)
α_{23}	-0.027	-0.033	-0.019	-0.022	-0.029	-0.022
	(-3.274)	(-3.941)	(-2.293)	(-2.760)	(-3.359)	(-2.848)
α_{24}	-0.006	-0.006	-0.002	-0.005	-0.005	-0.002
	(-4.671)	(-7.293)	(-1.176)	(-3.741)	(-5.202)	(-1.488)
α_{30}	0.036 [b]	-0.360 [b]	-0.403 [b]	-0.137 [b]	-0.412 [b]	-0.377 [b]
	(0.133)	(-1.192)	(0.218)	(-0.553)	(-2.177)	(-1.482)
α_{31}	0.022 [b]	0.370 [b]	0.289 [b]	0.179 [b]	0.438 [b]	0.311 [b]
	(0.091)	(1.386)	(1.516)	(0.792)	(2.550)	(1.458)
α_{32}	-0.004 [b]	-0.108 [b]	-0.076 [b]	-0.048 [b]	-0.129 [b]	-0.085 [b]
	(-0.057)	(-1.364)	(-1.327)	(-0.683)	(-2.479)	(-1.326)
α_{33}	0.001 [b]	0.011 [b]	0.007 [b]	0.004 [b]	0.013 [b]	0.008 [b]
	(0.088)	(1.405)	(1.201)	(0.576)	(2.441)	(1.212)
α_{34}	-0.003 [b]	-0.002 [b]	-0.005 [b]	-0.005 [b]	-0.002 [b]	-0.006 [b]
	(-2.145)	(-1.535)	(-3.655)	(-2.910)	(-1.531)	(-3.824)
β_1	0.070		0.124	0.083		0.133
	(9.886)		(2.143)	(3.302)		(1.566)
β_2	-0.084		-0.363	-0.157		-0.351
	(-10.962)		(-5.150)	(-4.580)		(-3.928)
β_3	0.014 [b]		0.239 [b]	0.074 [b]		0.218 [b]
	(2.035)		(6.292)	(3.438)		(4.693)
γ_{11}	-0.168	-0.113	-0.111	-0.162	-0.125	-0.141
	(-2.725)	(-2.039)	(-1.912)	(-2.611)	(-2.054)	(-1.951)
γ_{12}	-0.005	-0.112	-0.010	-0.002	-0.153	0.021
	(-0.126)	(-3.985)	(-0.093)	(-0.049)	(-3.165)	(0.135)
γ_{13}	0.173 [b]	0.153	0.164	0.164 [b]	0.153	0.162
	(3.726)	(3.659)	(3.452)	(3.623)	(3.153)	(3.469)
γ_{22}	0.106	0.304	-0.502	0.076	0.463	-0.396
	(2.639)	(10.186)	(-2.531)	(1.753)	(6.409)	(-1.460)
γ_{23}	-0.102 [b]	-0.113	0.246	-0.075 [b]	-0.149	0.171
	(-3.736)	(-4.474)	(3.029)	(-2.575)	(-3.937)	(1.759)
γ_{33}	-0.071 [b]	-0.047 [b]	-0.189 [b]	-0.090 [b]	-0.039 [b]	-0.170 [b]
	(-1.742)	(-1.216)	(-3.445)	(-2.261)	(-0.887)	(-3.323)
μ_1				-0.005	-0.026	-0.006
				(-0.452)	(-1.624)	(-0.545)
μ_2				0.035	0.042	0.028
				(1.974)	(2.366)	(1.977)
μ_3				-0.030 [b]	-0.016 [b]	-0.021 [b]
				(-2.505)	(-1.180)	(-1.838)
Log likelihood	791.638	790.801	802.587	798.297	794.300	804.599

[a] t-ratios are in parentheses.

[b] Parameters derived from adding-up or homogeneity constraints.

Table 2

Statistics for Wald tests of nested models [a]

Null	Alternative							
	AITL		QUAI		QUTL		QUAITL	
	df [b]	*Wald* [c]	*df*	*Wald*	*df*	*Wald*	*df*	*Wald*
AI	2	41.226	2	6.276			4	25.807
TL	2	43.167			2	5.600	4	33.175
AITL							2	4.613
QUAI							2	12.332
QUTL							2	27.965

[a] The 0.01 critical values of the chi-squared distribution of two and four degrees of freedom are 9.210 and 13.277, respectively.

[b] Degrees of freedom.

[c] Test statistic.

Table 3
Estimated uncompensated elasticities at the sample mean

	Services	Nondurables	Durables	Total expenditure	Household size
			AI		
Services	-1.281	-0.377	0.467	1.191	-0.226
Nondurables	-0.147	-0.534	-0.172	0.853	0.042
Durables	2.938	-2.030	-2.132	1.225	0.921
			TL		
Services	-1.238	-0.387	0.427	1.197	-0.231
Nondurables	-0.125	-0.547	-0.190	0.862	0.023
Durables	2.488	-1.856	-1.740	1.108	1.119
			AITL		
Services	-1.188	-0.397	0.365	1.219	-0.282
Nondurables	-0.358	-0.426	-0.046	0.830	0.111
Durables	4.307	-2.895	-2.681	1.269	0.618
			QUAI		
Services	-1.311	-0.381	0.480	1.212	-0.270
Nondurables	-0.132	-0.507	-0.160	0.799	0.207
Durables	2.975	-2.251	-2.318	1.594	-0.314
			QUTL		
Services	-1.256	-0.418	0.418	1.256	-0.396
Nondurables	-0.103	-0.516	-0.189	0.808	0.185
Durables	2.396	-1.958	-1.702	1.265	0.608
			QUAITL		
Services	-1.248	-0.392	0.412	1.228	-0.312
Nondurables	-0.297	-0.428	-0.077	0.802	0.199
Durables	4.100	-2.899	-2.675	1.473	-0.004
Mean shares	0.365	0.572	0.063		

XIII Bayesian Inference of the Rotterdam Model Under the Different Conditions.

Yosiharu Saegusa

1. Introduction

Theil and Latinen (1979) described maximum likelihood(ML) procedures for the Rotterdam model under two different conditions. For numerical examples, in his book, Theil(1976) used Dutch and Us data which are shown in Table 5.2 (the Dutch data) and in Table 7.3(the Us data). To illustrate ML procedures, They used the same data. The Dutch data consists of consumption data for 4 commodities(Food , Beverages, Durables, and Remainder) in the Netherland from 1922 to 1963 except for the period of world war. The Us data consists of annual observations on meat(Beef , Pork, Chicken, and Lamb) in United States 1950-1972. We used these data for the numerical examples. The first theme in this paper is to estimate the rotterdam models under the defferent conditions by bayesian way via Markov-Chain Monte Carlo(MCMC)method. For bayesian inference, we adopt vague priors on the model parameters, so that the estimation results comparable with the ML estimates by Theil and Latinen (1979)are obtained.

For commodity i(=1,..., m, the number of commodities) and period t(=1,..T, the sample size after lagging), the absolute price version ofthe Rotterdam model is

$$\bar{w}_{it}\, Dq_{it} = \mu_i DQ_t + \sum_j^m \pi_{ij}\, Dp_{jt} + e_{it}, \quad i=1,..m.\ t=1,..T$$

For the Dutch data, m=4, T=31, and for the us data, n=4, T=22.

Restrictions on slutsky coefficients are

Homogeneity constraints. $\sum_j \pi_{ij} = 0. \qquad i=1,..m. \qquad (1)$

Symmetry constraints $\pi_{ij} = \pi_{ji} \quad i, j=1,...m \qquad (2)$

The relative price version is

$$\bar{w}_{it}\, Dq_{it} = \mu_i DQ_t + \sum_j \upsilon_{ij}\, (Dp_{jt} - \sum_{k=1}^m \mu_k Dp_{kt}) + e_{it} \quad i=1,..m.\ t=1,..T.$$

where

$$\pi_{ij} = \upsilon_{ij} - \phi \mu_i \mu_j \text{ and } \sum_j \upsilon_{ij} = \phi \mu_i$$

$1/\phi$: the income elasticity of the marginal utility of income.

Under conditions of block-independence, off-diagonal elements of $[v_{ij}]$ vanish. For the dutch data, assumption of preference independence is relaxed to that of block- independence with three blocks; Food, Beverages and Durables/Remainder. Then, $[v_{ij}]$ is restricted as

$$[v_{ij}]=\begin{bmatrix} v_{11} & 0 & 0 & 0 \\ 0 & v_{22} & 0 & 0 \\ 0 & 0 & v_{33} & v_{34} \\ 0 & 0 & v_{43} & v_{44} \end{bmatrix} \qquad v_{34} = v_{43} \qquad (3)$$

We assume the error term $E_t=[e_{it}]$ follows multinormal distribution with 0 mean and variance matrix Ω and E_t's are independent over time. For the Us data, Theil and Latinen(1978) specified Ω to be proportinal to slutsky matrix $[\pi_{ij}]$ under the theory of rational random behavior. In this paper, we adopt an alternative specification as follows:

$$\Omega = \lambda A \qquad (4)$$

where

λ : unknowne parameter, $\lambda > 0$

$A = [a_{ij}]$

$$a_{ij}\begin{cases} = \bar{w}_i \quad (1-\bar{w}_i) & \text{for } i=j \\ = -\bar{w}_i \quad \bar{w}_j & \text{for } i \neq j \end{cases} \qquad (5)$$

$\bar{w}_i$: avarage budget share of i-th commodity.

Hereafter, we work with the precision matrix Φ rather than the covariance Ω so that $\Phi^{-1} = \lambda\Omega$

Final task in this paper is to compare the Rotterdam models under the different constraints. For convenience, we distigwish the models as follows;
the absolute price version with no restriction by model(0),
model(0)under homogenety constraints (1) by model(1),
model(1) under symmetry constraints (2) by model(2),
the relative price version under block-independenc (3) by model(3)
and
model(2) under the constraints (4) by model(4).

In his book, Theil(1976) has evaluated the overall goodness of fit by the average information inaccuracy and for the dutch data, he compared model(3) with

model(2) in term of the average information inaccuracy(the one corrected for degrees of freedom). In this paper, for model comparison, we use the fractional bayes factor (FBF) proposed by O´Hagen(1995). For caluclation of the FBF, MCMC tecniques are the indispensable tools.

Appendix summarizes mathematical supplements for the bayesian computation used in this paper.

2. Bayesian Inference and the Results

In this paper, all of the models are written in matrix form as

$$Y_t = X_t\beta + E_t \text{ , or } Y_t = Z_t\theta + E_t,$$

where Y_t and E_t are 4×1 vector such that

$$Y_t = [\bar{w}_{i:t}\ Dq_{i:t}]' \text{ or } Y_t = [\bar{w}_{i:t}\ Dq_{i:t}\ /\bar{w}_{at}]' \text{ and } E_t = [e_{i:t}] \quad \text{for } t=1,\ldots,T$$

To estimate the model parameters β or θ, one of the equations should be deleted from the equation system, otherwise variance matrix of E becomes singular. Thus, We delted 4th commodity(Reminder for the Dutch data, Lamb for the Us data), so that Y_t is reduced to 3×1 vector . After deleting 4th commodity, the regression formats for model(0)～model(4) was setup(see, Appendix B). Consequently, to estimate the model parameters including eliminated parameters, the additional conputation vie (B. 5. 1) and (B. 5. 2) are required.

Adopting a vague prior density on the parameter vector and variance matrix of error terms, marginal posterior density $p(\theta \mid \text{Data})$ are obtained from the likelihood function. In the bayesian framewok, the point estimate of θ is given by mean value of $p(\theta \mid \text{Data})$ (posterior mean of θ).

2. 1. Estimation for model(0) and model(1)

Deta matrix X_t of model(0) is abbreviated as $X_t = I_3 \otimes (\sum_t x_t x_t')$ that is the special feature of model(0). Model(1) has same feature. In this case, $p(\beta \mid \text{Data})$ can be evaluated exactly and posterior inferences about specific regression coefficient β_{ij} are made from univariate Student´s t-distribution (see, Appendix. D) Then, bayesian estimate of β_{ij} is given by the posterior mean of β_{ij} in (D. 5) that is the same as OLS estimate and the standard eror of the posterior mean is given in (D 5). The important point is that the denominator(degrees of freedom) in (D. 5) is T-(n+k+1), not T.

Estimation results of model(1) are summarized in the upperpart of Table 1. 1(for the Dutch data) and table 2. 1(for the Us data) . The figures in parenthes are the standard errors of posterior means. Comparing with table 5. 6 and table 7. 5 in Theil(1976), the point estimates are pairwise same exept the standard erros. The discrepancies in the standard erros are owed to the differences

in "deg. of freedom".

Homogeneity test. There are two ways for testing the hypotheses of demand homogeneity. As shown in Appendix D, the conventional bayesian tests are based on the HPD region in (D.9) that are numericaly equvalent to the Laitinen's exact test for homogeneity, i.e. Let denote the test statistic in (D.11) by Ψ_H and α = 0.05. If $\Psi_H < F_{3,\nu,\alpha}$, then homogeneity for all commodities are accepted. The alternative way for homogeneity test is to compare model(0) with model(1) by use of the FBF.

Testing the homogeneity of i-commodidy is made from the univariate student t-distribution in (D.7). The basic statistic is $b_i = \sum_j^a \pi_{ij}$. Let $b=(b_1, b_2, b_3)$. Using test statictic η_i in (D.10), If $\eta_i < t_{\nu, 0.025}$, homogeneity of i th commodity is accepted. The values of Ψ_H and η_i are

For the Dutch data($t_{24,0.025}$ =2.064, $F_{3,24,0.05}$ =3.01)

	b_i	η_i
Food	0.042	1.702
Beverages	0.012	1.101
Durables	-0.046	-1.857

$\Psi_H = 0.972$ (6)

For the Us data($t_{15,0.025}$ =2.131, $F_{3,15,0.05}$ =3.29)

	b_i	η_i
Beef	-0.016	-1.802
Pork	-0.002	-0.181
Chickin	0.025	3.173

$\Psi_H = 1.024$ (7)

Thus, for both data, the homogeneity of the entire model are supported by the data, althogh the homogeneity of "Chickin" is doutful.

Symmetry test under the homogeneity

Since the symmetry constraints ($R\beta$ =0) are the linear restrictions between different commodites, the marginal postrior density of $\theta = R\beta$ is not available for our use in the exactly form. If We use the asymtotic density, as shown in (D.12), resultant test is numericaly equivalent to asymtotic Chi-square test. The alternative way to the conventional test is to compare model(1) with model (2) by use of the FBF.

2．2 Estimation of model(2) by Gibbs sampler

Although we can't evaluate the posterior means of θ exactly, by using the MC-MC techniques, it's possible to estimate these posterior means with the required precision. Joint posterior density p (θ, Φ|Y) of model(2)is given in (E.1). The Gibbs sampler algorithm for drawing θ from p (θ,Φ | Y)is described in Appendix E1. We generated 11,000 draws from p (θ,Φ|Y). The first 1,000 draws are discarded and the next 10,000 draws are used for the estimation of the posterior means. Let { θ_{ji} ; i=1,..N} denote the realized sequence of the j-th element of θ . Posterior mean of θ_j are estimated by sample mean $\bar{\theta}_j = \sum_{i=1}^{N} \theta_{ji} / N$. Using these 10,000 draws, we caluculated the posteror means. Besides means, related statistics are derived from the sequence, e.g. NSE, CD, 95%credibility interval etc. For assesing the accuracy of the estimates, NSE are caluculated by using (E.5) and (E.6). We caluculated CD for detecting the convergence of the sequences where N_A=1,000 and N_B=5000. The 95% intervals are given by using 2.5th and 97.5th percentiles of 10,000 draws. All of the statistcs are summarized in Table 1.2(for the Datch data) and Table 2.2(for the Us data). For all regression coefficients, the Values of NSE are quite small and according to CD values, realized sequences are supposed to be stationary . As compared with Table 5.6 and Table 7.5 in Theil(1976), the point estimates of model parameters are pairwise very close, but the discrepancies arise for the interval estimates as follows;

	95% interval reduced from Table 7.5 in Theil(1976)	95% credibility interval in Table 2.2 (the Us data)	
	Parameter:marginal share		
Beef	[.596, .788]	[.579, .810]	
Pook	[.113, .285]	[.094, .299]	
Chikin	[.018, .100]	[.011, .108]	(8)
Lamb	[.026, .074]	[.020, .077]	

The intervals at left side are shorter in width than the ones at right side for each commodity. The same discrepancies are seen between Table 1.3 and Table 1 in Theil and Laitinen(1979). The source of these dicrepancies is, e.g. the standard erros in Table 7.5 are the approximate erros based the symtotic teory.

The negative semi-definiteness of slutsky matrix (Concavity constraints).

The negative semi-definiteness is the 3rd restrictions for slutsky matrix $[\pi_{ij}]$.

A common way testing this concavity constraints is to compute the eigenvalues of $[\pi_{ij}]$. All of the non-zero eigenvalues must be negative for the concavity conditions to hold. So, any positive eigenvalues means that the concavity conditions is rejected. MCMC method will be the only feasible way to caluculate the probability that the concavity restrictions hold. Using the Gibbs sampler, we generated 20,000 draws from model(2). For each draw, the eigenvalues of $[\pi_{ij}]$ are caluculated. After deleting any draw with positive eigenvales, we conputed the proportion satisfying the eigenvalue test. Besides of it, the estimates of $[\pi_{ij}]$ restricted by the concavity conditions are obtained by averaging the draw which satisfied the eigenvalue test.

The proportion that the concavity condition hold is 0.9995 (for the Us data). and 0.6401 (for the Dutch data). The restricted estimates of $[\pi_{ij}]$ under the concavity conditiovns as follows:

Restricted estimates (for the Dutch data)

	margina share	slutsky coefficient		
Food	0.179	-0.110	0.021	0.045
Beverages	0.085		-0.34	0.004
Durables	0.480			-0.051

(9)

2. 3 Estimation of model(3) by the MCMC method

The special feature of model(3) is the structure of data matrix Z_t which has elements depend upon the marginal shares. Then, the sampling method comes to be complecated, but by using the MCMC tecniques described in Appendix F1, we can estimate the posterior mean of the model parameters. The estimation results are summarized in Table 1.3. The means and the related statistics are caluculated by the same way as the procedures used in model(2).

Comparing with the ML estimates in Theil and Laitinen (1979), the posterior means in Table 1.3 are pairwise very close. Figure 1 show the estimated posterior densities of the marginal shares. For density estimator, a density estimator with normal kernel was used with window width suggested by Silverman(1986).

2. 4 Estimation of model(4)

The merits of model(4) are to be able to derive the marginal densities of the model parameters exactly. The posterior means and standard errors are calculated by using (G.1) and (G.2). Estimation results are summarized in the lower part of Table 1.1 (for the Dutch data) and Table 2.1, respectively.

2．5 Estimation of Variance Matrix

Using the samples generated for the estimation of regression parameters, we esmated the variance matrix of the demand disturbances. (see, Appendix H). The estimation results are summarized in Table 3, which is comparable to Table 5.8 and the matrix (3.22) in Theil (1976). For model(3), we caluculated the ML estimates of variance matrix Ω (see. Appendix F2, for detail). As compared to the ML estimates, the variances in Table 3 are large for each commodities. For model(2), we can see the same discrepancies.

2．6 Model comparison by Fractional Bayes Factor(FBF)

In sction 2.1, we have tested the hypotheses of demand homogeneity by the bayesian way. Alternative way for the conventional test, is to compare the models by use of Bayes factor. In this paper, we used a new variant of the Bayes factor, the fractional bayes factor(FBF) for model comparison. (see. Appendix c).

Let consider testing the homogeneity. Instead of the test statistic Ψ_H in (D.11), we calculate the fractional bayes factor $B_{0.5}(Y)$ of model(0) against model(1) by use of (C.1). For Dutch data, $B_{0.5}(Y)=0.54$:Since $B_{0.5}(Y)<1$, then we prefer model(1) to model(0)(in other word, homogeneity is acceptable).

FBF is defined in term of the fractional marginal likelihood $q_i(b, Y)$. For model(0), model(1) and model(4), we can get the exact value of $q_i(b, Y)$ by use of (D.11) and (G.3) respectively. Then, the exact values of the FBF against model (1) are obtained for model(0) and model(4) as follows;

	FBF against model(1)	
model(i)	Dutch data	Us data
i=0	0.54	0.43
1	1.00,	1.00
4	1.17	4.44
2	2.45	3.04
3	2.72	.?...

(10)

The FBF of model(2) was esimated by the iterative sampling scheme defined in Appendix E 1, as follows;for the random draw generated from the joint posterior density in (E.1), we caluculate the variables defined by (E.8) and after N iterations, the estimate of the FBF results from averaging the N variables. The FBF of model(3) was estimated by the same way. According (E.5) and(E.6), the related statistics are caluculated for assesing numerical accuracy and conver-

related statistics are caluculated for assesing numerical accuracy and convergence. The results are

	FBF againt model(1)		
	mean	NSE	CD
model(2)			(11)
Dutch data	2.45	0.06	0.44
Us data	3.04	0.13	-0.48
model(3)	2.72	0.04	-0.89

We suppose that the estmated FBF have enogh accuracy for the model comparison. Figure 1 shows the estimated density of the log(FBF) for the Dutch data, respectively. As contrasted with the marginal shares, density of the FBF has long tail.

3. Concluding Remarks

For model(2) and model(3), we could find the effective sampling schemes, so we can conclude that for the Dutch data, model(3) is best, althogh both modeles have same value for the average information inaccuracy corrected of degree of freedom(see, theil(1976, Section 5.5)).

In this paper we did not touch the bayesian infrences of model(2) under rational random behavior. But, using the asymtotic formula (c.5), we can approximate the FBF(against model(1)). as follows: For the Us data, log(max. likelihood)= 282.33. (see, Theil(1976, section 7.5)), so that FBF(agaist model(1))=3.1. Then, the merit of this model is doubtful.

The alternative specification of Ω defined by(4) is

$$\Omega = [e_{ij}] \qquad (12)$$

where

d_i are unkown constants and $k=\sum_{i=1}^{n} d_i$

$e_{ii} = d_i(1-d_i/k)$, $i=1,\ldots n$

$e_{ij} = -d_i d_j/k$, $i \neq j$

The specification (12) was introduced by de Boer and Harkema(1986) and is a generalization of (4). The next task of our study is to estimate of model(2) with the covariance matrix specified by (12).

Table 1.1 The Absolute Price Version :the Dutch data

Homogeneity-constrained estimates FBF=1.00

	Marginal share	Slutsky coefficients			
Food	.153(.038)	-.104(.029)	-.039(.057)	.044(.027)	.100(.053)
Beverages	.086(.015)	.023(.011)	-.031(.022)	.002(.010)	.052(.027)
Durables	.490(.040)	.053(.030)	.015(.061)	-.047(.028)	-.022(.056)
Remainder	.271(.036)	.029(.028)	.055(.055)	.001(.026)	-.084(.051)

Homogeneity-and Symmetry-constrained estimates under the constraints (4) FBF=1.17

	Marginal share	Slutsky coefficients			
Food	.179(.027)	-.106(.025)	.020(.013)	.043(.018)	.042(.020)
Beverages	.083(.017)		-.038(.026)	.003(.012)	.014(.023)
Durables	.483(.027)			-.043(.022)	-.003(.018)
Remainder	.256(.029)				-.071(.051)

NOTE:The figures in parentheses are standard errors.

TABLE 1.2 Bayes Estimates of Absolute Price Version under Homogeneity and Slutsky Symmetry:the Dutch Data

FBF=2.45

Parameter		Mean	NSE*100	95% interval	CD
Food	μ_1	.179	.027	[.116, .241]	.77
	π_{11}	-.107	.023	[-.162, -.054]	.38
	π_{12}	.022	.010	[.001, .042]	-.74
	π_{13}	.043	.022	[.000, .086]	-.87
	π_{14}	.042	.021	[-.002, .087]	1.04
Beverages					
	μ_2	.088	.015	[.060, .117]	-.73
	π_{22}	-.026	.020	[-.066, .013]	-.72
	π_{23}	.002	.009	[-.018, .022]	.67
	π_{24}	.002	.019	[-.035, .039]	1.08
Durables					
	μ_3	.482	.028	[.420, .545]	.16
	π_{33}	-.044	.025	[-.096, .009]	.87
	π_{34}	-.001	.019	[-.029, .037]	-.57
Remainder					
	μ_4	.251	.029	[.189, .311]	-.50
	π_{44}	-.043	.031	[-,103, .017]	-1.01

TABLE 1.3 Bayes Estmates of Relative Price Versin
under Block-independence :the Dutch Data

FBF=2.724

Parameter	Mean	NSE*100	95% interval	CD
Food				
	.196	.030	[.140, .256]	.47
	-.088	.023	[-.126,-.005]	.25
	.009	.002	[.005, .014]	- .01
	.051	.014	[.028, .076]	- .57
	.027	.008	[.014, .042]	.40
Beverages				
	.083	.011	[.060, .106]	.25
	-.042	.010	[-.060,-.024]	.32
	.022	.005	[.012, .031]	-.67
	.012	.003	[.006, .018]	.24
Durables				
	.471	.033	[.409, .532]	-1.31
	-.069	.024	[-.069, .024]	.46
	-.004	.017	[-.038, .030]	.18
Remainder				
	.250	.036	[.192, .307]	.93
	-.035	.021	[-.073, .001]	-.37

TABLBE 2.1 The Absolute Price Version:the US Data

Homogeneity-constrained estimates FBF=1.00

	Marginal share	Slutsky coefficients			
Beef	.712(.069)	-.196(.060)	.176(.025)	.026(.029)	-.005(.079)
Pork	.192(.062)	.157(.054)	-.219(.023)	.050(.025)	.012(.053)
Chicken	.046(.027)	.009(.024)	.030(.010)	-.087(.001)	.048(.030)
Lamb	.050(.015)	.030(.013)	.013(.005)	.012(.006)	-.055(.017)

Homogeneity-and Symmety-constrained estimates under the constraints (4) FBF=4.44

	Marginal share	Slutsky coefficients			
Beef	.694(.043)	-.225(.019)	.165(.013)	.031(.011)	.029(.013)
Pork	.198(.040)		-.216(.013)	.039(.009)	.012(.006)
Chicken	.059(.028)			-.083(.012)	.013(.006)
Lamb	.050(.015)				-.106(.023)

NOTE:The figures in parentheses are standard errors.

TABLE 2,2 Bayes Estimates of Absolute Price Version under Homogeneity and Sultsky Symmetry:the Us Data

FBF = 3.04

Parameter		Mean	NSE*100	95%interval	CD
Beef					
	μ_1	.694	.054	[.579, .810]	-.24
	π_{11}	-.226	.020	[-.272,-.182]	-1.02
	π_{12}	.164	.017	[.131, .197]	.33
	π_{13}	.033	.010	[.013, .058]	.56
	π_{14}	.029	.015	[.005, .054]	.83
Pork					
	μ_2	.198	.050	[.094, .299]	-.32
	π_{22}	-.214	.016	[-.245,-.182]	-.24
	π_{23}	.038	.008	[.023, .054]	-1.01
	π_{24}	.012	.006	[.002, .023]	1.00
Chikin					
	μ_3	.059	.022	[.011, .108]	.44
	π_{33}	-.024	.010	[-.105,-.064]	.58
	π_{34}	.013	.006	[.002, .025]	-.63
Lamb	μ_4	.049	.015	[.020, .077]	1.20
	π_{44}	-.055	.021	[-.087,-.023]	-.71

Table 3 Estimates of the Variances and Covariances of the Disturbances

(the Dutch data)

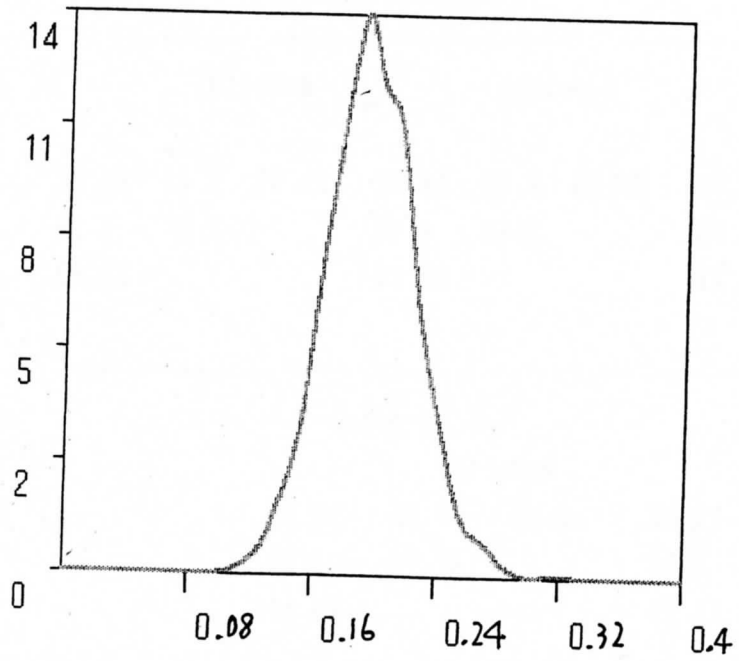
	Mode(1)			Model(2)			Model(3)		
Food	27.49	3.29	-16.58	25.50	2.98	-14.97	25.79	2.77	-15.27
Beverages		4.15	- 5.08		3.80	- 4.49		4.06	- 4.74
Durables			30.71			27.14			27.42

(the Us data)

	Model(1)			Model(2)		
Beef	72.22	-58.44	-12.47	59.65	-47.55	-10.95
Pork		58.24	1.73		47.70	1.21
Chickin			11.16			10.11

All entries are to be multiplied by 10^{-6}.

Food



Beverages

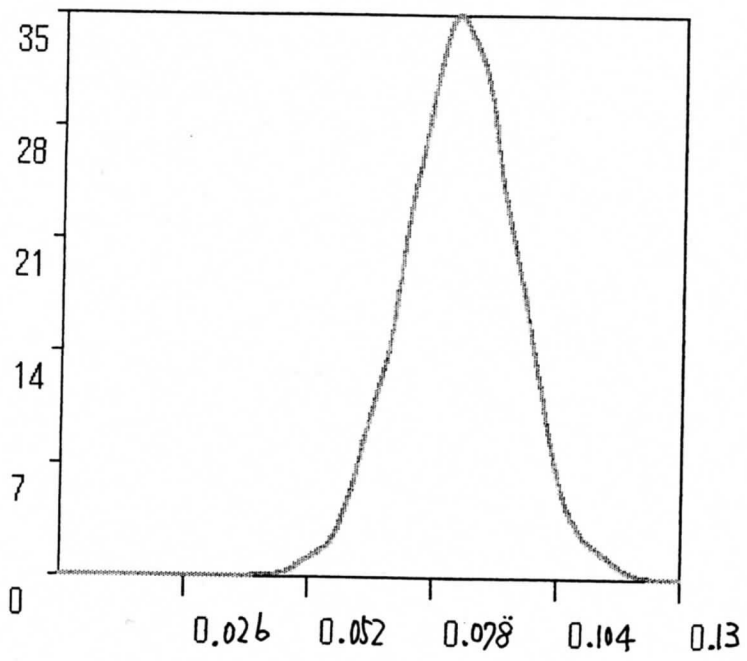
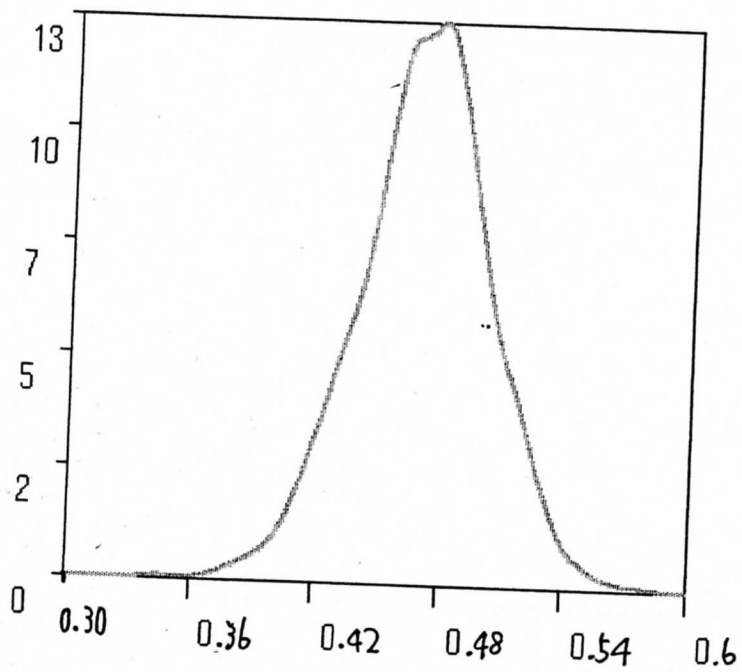


Figure 1-1. Estimated Densities of the Marginal Shares Under Model(3) in the Dutch data

Durables



Remainder

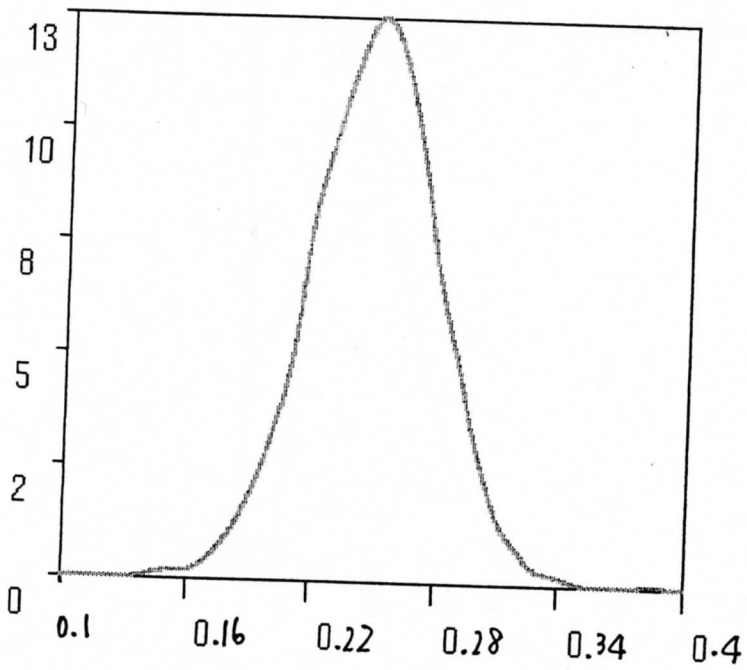
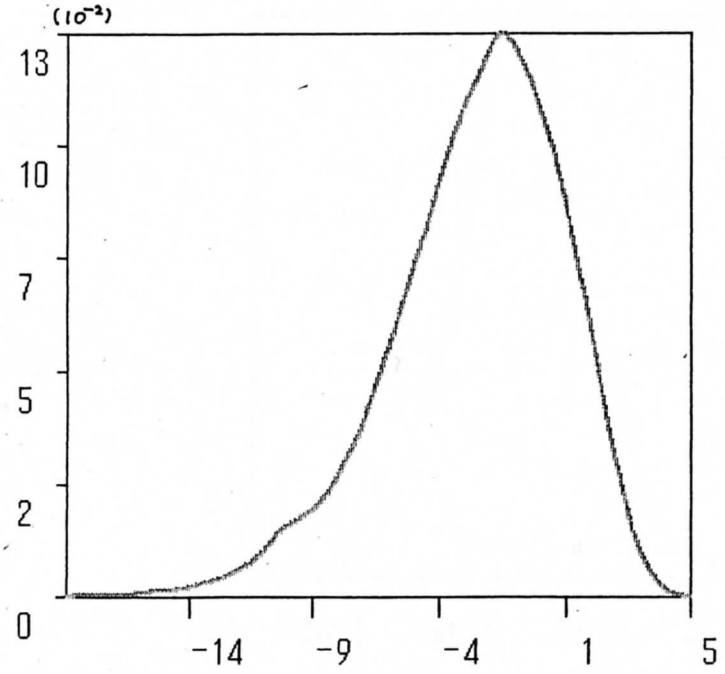


Figure 1-2. Estimated Densities of the Marginal Shares Under Model(3) in the Dutch data

Model(2)



Model(3)

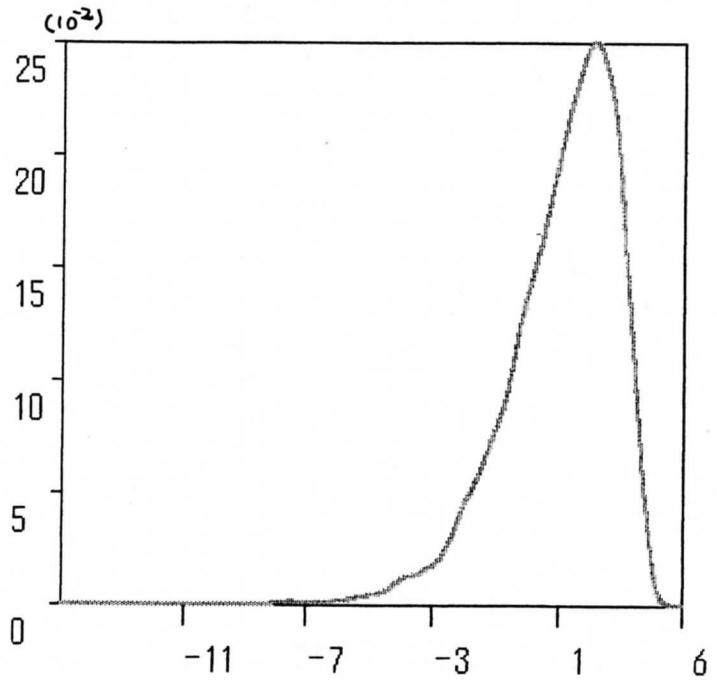


Figure 2. Estimated densities of log(FBF) Under the Different Models in the Dutch data.

APPENDIX

A. Notation for density function

Distribution	Notation	Parameters
Multivariate normal	$N(\mu, \Sigma)$	location $\mu = [\mu_1, \ldots, \mu_d]'$ symmetric, pos. def. $d \times d$ scale matrix Σ
Student-t	$t_\nu(\mu, \sigma^2)$	deg. of freedom $\nu > 0$ location μ scale $\sigma > 0$
	• t_ν is short for $t_\nu(0,1)$	
	• $t_\nu, 0.05$: 5%point	
Multivariate Student-t	$t_\nu(\mu, \Sigma)$	deg. of freedom $\nu > 0$ location $\mu = [\mu_1, \ldots, \mu_d]'$ symmetric, pos. def. $d \times d$ scale matrix Σ
Fisher's F	$F(\nu, \rho)$	deg. of freedom $\nu > 0$, $\rho > 0$
	$F_{\nu,\rho}, 0.05$: 5%point	
Wishart	$W_\nu(S)$	deg. of freedom ν symmetric, pos. def. $k \times k$ scale matrix S

B. Reduction to regression format

Let denote $y_{it} = [\tilde{w}_{it}\ Dq_{it}]$ for the Dutch data or $y_{it} = [\tilde{w}_{it}\ Dq_{it}\ /DW_{Gt}]$ for the Us data and, after deleting 4th commodity, we define

$$Y_t = [y_{1t}, \ldots, y_{3t}]', \quad x_t = [Dq_t, Dp_{1t}, \ldots Dp_{4t}], \quad E_t = [e_{1t}, \ldots, e_{3t}]' \text{ for } t = 1, \ldots T.$$

and

$$X = \begin{bmatrix} x_t & 0 & 0 \\ 0 & x_t & 0 \\ 0 & 0 & x_t \end{bmatrix} \qquad \beta = \begin{bmatrix} \beta_1 \\ \beta_2 \\ \beta_3 \end{bmatrix} \qquad \beta_i = \begin{bmatrix} \mu_i \\ \pi_{i1} \\ \vdots \\ \pi_{i4} \end{bmatrix} \quad \text{for } i = 1, \ldots 3$$

Then, model(0) becomes

$$Y_t = X_t \beta + E_t, \quad E_t \sim N(0, \Phi^{-1}) \qquad (B.1)$$

where $E_1, \ldots, E_T$ are independent random vectors. For convenience, we work with the precision matrix Φ rather than the covariance matrix Ω

By writing $\pi_{i4} = -(\pi_{i1} + \pi_{i2} + \pi_{i3})$, model(1) has same form as (B.1) with minor changes. i.e. $x_t = [Dq_t, Dp_{it} - Dp_{4t}, \ldots, Dp_{3t} - Dp_{4t}]$ and $\beta_i = [\mu_i, \pi_{i1}, \ldots \pi_{ij}]'$

★ Reparametrization of model(2)

Slutsky symmetry is expressed as a linear restriction $Q'\beta = 0$, where Q is $k \times q$ of known constants and rank(Q)=q=3 . Define a $K \times (K-q)$ marix such that matrix (Q, R) is nonsingular and $R'Q=0$. such a matrix can be always be found. Then, defining $Z_t = X_t R[R'R]^{-1}$, We can rewrite model(2) as the form with free parameter θ.

$$Y_t = Z_t\theta + E_t \qquad \text{(B.2)}$$

where $\theta = R'\beta$. So that, the problem of estimating K parameters subject to q constraints are rduced to the problem of estimating K-q free parameters. In this case, the original parameters β are estimated via the following constraints

$$\beta = R[R'R]^{-1}\theta \qquad \text{(B.2.1)}$$

★ The regressin form of model(4) is

$$Y_t = Z_t\theta + E_t \qquad \text{(B.3)}$$

where $\theta = R'\beta$ and $E_t \sim N(0, \Phi^{-1})$. Φ^{-1} is the matrix specified by (4).

★ We write model(3) for i=1, 2, and 3, in matrix form as foloows;

$$Y_t = Z_t\theta + E_t \qquad \text{(B.4)}$$

where

$$Z_t\theta = \begin{bmatrix} Dq_t & 0 & 0 & 0 & a_{1t} \\ 0 & Dq_t & 0 & 0 & a_{2t} \\ 0 & 0 & Dq_t & DP_{4t} - Dp_{3t} & a_{3t} \end{bmatrix} \begin{bmatrix} \mu_1 \\ \mu_2 \\ \mu_3 \\ \upsilon_{34} \\ \phi \end{bmatrix}$$

and

$$a_{it} = \mu_i (Dp_{it} - Dp_{4t} - \sum_{k=1}^{3} \mu_k (Dp_{kt} - Dp_{4t}))$$

★ Estimation of the eliminated parametres

Let β^* denotes the vector of the eliminated parameters in model(2) under homogeneity. Estimates of the elements of β^* are obtaind from the constraint;

$$\beta^* = L\beta \qquad \text{(B.5)}$$

where L is the 8×12 matrix shown in Table 5.9 in Theil(1976).

Estimates of the eliminated parameters in model(3) are obtained from the constrains;

$$\begin{aligned} \mu_4 &= 1 - \sum_{i=1}^{3} \mu_i \\ \upsilon_{ii} &= \phi\mu_i - \sum_{j \neq i} \upsilon_{ij} \quad \text{for i} = 1, \ldots 4 \\ \pi_{ij} &= \upsilon_{ij} - \phi \cdot \mu_j \mu_i \quad \text{for i, j} = 1, \ldots 4 \end{aligned} \qquad \text{(B.6)}$$

C. Fractinal Bayes Factor (F B F)

For simplicity, we consider the two models M_1 and M_2 for the data Y. Under M_i, Y has likelihood function $f_i(Y|\theta_i)$ and prior density is $p_i(\theta_i)$, i=1, 2. Bayes factor B(Y)(of M_1, with respect to M_2) is defiend as

$$B(Y)=q_1(Y)/q_2(Y)$$

where

$$q_i(Y)=\int p_i(\theta_i) f_i(Y|\theta_i) d\theta_i \quad , i=1, 2$$

The bayes factor provides, in the bayesian framework, the sample weight of evidence for M_1 over M_2. If B(Y)>1, then we suppose that M_1 fits the data better than M_2 in the sense that $q_1(Y) > q_2(Y)$.

O'Hagen(1995) proposed a new variant of bayes factor, fractional bayes factor (F B F) ;

$$B_b(Y)=q_1(b, Y)/q_2(b, Y) \qquad (C.1)$$

where

$$q_i(b, Y)=\frac{\int p_i(\theta_i) f_i(Y|\theta_i) d\theta_i}{\int p_i(\theta_i) f_i^b(Y|\theta_i) d\theta_i} \qquad (C.2)$$

b: a given constant, 0<b<1

For model comparison, we use this F B F and Gilks(1995) refered $q_i(b, Y)$ as fractional marginal likelihood (F M L).

$q_i(b, Y)$ defined by(C. 2) can be rewritten as .

$$q_i(b, Y)=\int p_i(\theta|Y, b) f_i^{1-b}(Y|\theta_i) = E_{\theta_i}^{(b)}(f^{1-b}) \qquad (C.3)$$

where

$E_{\theta_i}^{(b)}$ denotes expectation over the following distribution for θ_i

$$p(\theta_i|Y, b)=\frac{p_i(\theta_i) f_i^b(Y|\theta_i)}{\int p_i(\theta_i) f_i^b(Y|\theta_i) d\theta_i} \qquad (C.4)$$

Using formula (C. 3), we estimated the F M L of model(2) and model(3).

The problem in use of F B F is the choice of b. (see. O'HAGEN(1995))

Refering to his informal advice, we set b=0. 5. Also, in his paper, O'HAGEN showed

asymtotically, the F M L of model i becoming

$$q_i(b, Y) \approx L_i^{*b}\, b^{k_i/2} \qquad \text{(c. 5)}$$

where

$L_i = f_i(Y \mid \hat{\theta})$

$\hat{\theta}_i$ =maximum likelihood estimate of θ_i

k_i :number of elements in θ_i

D. Bayesian inference for model(0) and model(1)

D 1. Posterior densities

Ignoring a proportinality constant, the likelihood function of model(0) becomes

$$f(Y \mid \beta, \Phi) \propto |\Phi|^{T/2} \exp\{-\sum_t (Y_t - X_t\beta)' \Phi (Y_t - X_t\beta)/2\}$$

where

$$X_t = I_n \otimes x_t$$

Adopting a vague prior density on (β, Φ) gives

$$p(\beta, \Phi) = p(\beta)p(\Phi)$$

$$p(\beta) \propto \text{const.}$$

$$p(\Phi) \propto |\Phi|^{-(n+1)/2}$$

Then, joint posterior density is

$$p(\beta, \Phi \mid \text{data}) \propto |\Phi|^{(T-n-1)/2} \exp\{-\sum_t (Y_t - X_t\beta)' \Phi (Y_t - X_t\beta)/2\}$$

From this joint density, various marginal densities are produced(see, Box and Tiao(1973))

Notation(for n=3)

let denote $\beta_i = (\mu_i, \pi_{i1}, \ldots \pi_{i4})'$ or $\beta_i = (\mu_i, \pi_{i1}, \ldots, \pi_{i3})$, and define

$\beta = (\beta_1, \beta_2, \beta_3)$

$\hat{\beta}_i = (\sum_t x_t' x_t)(\sum_t x_t' y_{it}) = (\beta_{ij})$ for i=1, 2, 3

$S = [\sum (y_{it} - x_t\hat{\beta}_i)(y_{jt} - x_t\hat{\beta}_j)] = [s_{ij}]$ where S is 3×3 matrix

$c = (\sum_t x_t' x_t)^{-1}$, $C = I_n \otimes c$ where c is $k \times k$ matrix

$\nu = T-(n+k)+1$; k=5 for model(0) and k=4 for model(1)

We summarize the inportant distributions used in this study as follows:

(1) Marginaly, Φ follows wishart distribution;

$$\Phi \sim W_\nu(S^{-1}) \qquad \text{(D. 1)}$$

(2) Conditionaly on Φ, marginal posterior density of β is normal;

$$\beta|_{\phi} \sim N(\beta, \Omega) \qquad (D.2)$$

where

β : column vector expantion of B. $\Omega = \Phi^{-1} \otimes C$:

(3) Marginaly, B follows matric-variate t distribution. Therfore its columns (and raws) marginally follow multivariare Student's t-distributions, so that

$$\beta_i \sim t_v (\hat{\beta}_i, v^{-1} s_{ii}\, c) \text{ for } i=1, 2, 3 \qquad (D.3)$$

and specific coefficients β_{ij} follow univariate t-distributions:

$$\beta_{ij} \sim t_v (\hat{\beta}_{ij}, \sigma_{ij}^2) \qquad (D.4)$$

where

$$\sigma_{ij}^2 = v^{-1} s_{ii}\, c_{jj}$$

Then, $E(\beta_{ij} \mid \text{data}) = \hat{\beta}_{ij}$ and $Var(\beta_{ij} \mid \text{data}) = s_{ii}\, c_{jj} / (v-2)$ (D.5)

The 95% "credibility interval" for β_{ij} is

$$\hat{\beta}_{ij} - t_{v, 0.025}\, \sigma_{ij} \leq \beta_{ij} \leq \hat{\beta}_{ij} + t_{v, 0.025}\, \sigma_{ij} \qquad (D.6)$$

Credebility interval (D.6) is the version of 95% cofidence interval.

H. P. D. region

Let $b = L B = (b_1, b_2, b_3)$ where L is $1 \times k$ vector. Then

$$b \sim t_v (\hat{b}, d S / \nu)$$

where

$$\hat{B} = (\hat{\beta}_1, \hat{\beta}_2, \hat{\beta}_3)$$

$$\hat{b} = L \hat{B} = (\hat{b}_1, \hat{b}_2, \hat{b}_3)$$

$$d = L C L$$

$$b_i \sim t_v (\hat{b}_i, d\, s_{ii} / v) \quad \text{for } i=1, 2, 3 \qquad (D.7)$$

and

$$(b - \hat{b})' (d S / \nu)^{-1} (b - \hat{b}) \sim n F(n, \nu) \qquad (D.8)$$

Based on (D.8), We can define a region R_α such that

$$R_\alpha = \{ b \mid (b-b)' (d S / \nu)(b-b) \leq n F_{n, \nu, \alpha} \} \qquad (D.9)$$

R_α is the smallest region containing a proportion $(1-\alpha)$ of the posterior distribution $p(b \mid \text{data})$. so, R_α is called by the H. P. D. region of content $(1-\alpha)$ of $p(b \mid \text{data})$. In this paper, we set $\alpha = 0.05$.

D 2. Bayesian test

Consider a linear hypothesis $L B = b_0$ where L is $1 \times k$ vector and b_0 is

a given vector. For bayesian "test", there are two ways. The first is to use the H. P. D. region .

Let

$$Q(b_o) = (b_o - \hat{b})' (d \cdot S / \nu)^{-1} (b_o - \hat{b})$$

If $Q(b_o)/nd > F_{n,\nu,\alpha}$ we regard the hypothesis as implausible. Thus Bayesian test is numericaly equivalent to the F-test with critical value $F_{n,\nu,\alpha}$.

Homogeneity test(n=3, k=5)

Let $L = (0, 1, 1, 1, 1)$. Then, homogeneity-restriction of the i-th equation ($\sum_{j=1}^{4} \pi_{ij} = 0$) can be written as $L \beta_i = b_i = 0$. For i=1, 2, and 3, jointly homogeneity-restrictions are expressed as $L B = 0$.

As showed above, b_i follows univariate Stdent's t-distributib(see. (D. 6)) . Then, test statistic for homogenety of the i-th equation is

$$\eta_i = \hat{b}_i / (ds / \nu)^{1/2} \quad \text{for } i=1, 2, 3 \qquad (D.10)$$

and the critical value is $t_{\nu, 0.025}$.

The test statistic for $L B = 0$ is

$$\Psi_H = \hat{b}' (S^{-1} \nu / dn) \hat{b} \qquad (D.11)$$

and critical value is $F_{n,\nu,0.05}$

So, under the vague prior density, the bayesian homogeneity test for all equations is numerically equivalent to the Latinen's exact test(Latinen(1978)).

Symmetry test

Slutsky symmetry takes the form $R\beta = 0$ where R is $n \times K$ matrix and β is the vector expansion of B. Unfortunatry, marginaly posterior density of $\theta = R\beta$ is not available in exact form . But, we know that asymptotica-ly, θ follows multivariate normal distribution.

Let

$$Q(\theta) = (\theta - \hat{\theta})' H^{-1} (\theta - \hat{\theta}) \qquad (D.12)$$

where

$$H = R \Gamma R'$$
$$\theta = R\beta$$

then, $Q(\theta)$ Follows Chi-square distribution asymptoticaly. Thus, Bayesian

test based on (D.12) is numerically equivalent to classical Chi-square test.

D 2. Sampling (β, Φ) from joint posterior density $p(\beta, \Phi \mid \text{data})$

Using of (D.1), (D.2), (β, Φ) are generated from $p(\beta, \Phi \mid \text{data})$ as follows; at first, Φ is drawed from $W(S)$, next, $\beta_{|\Phi}$ is drawed from $N(\beta, \Phi^{-1} \otimes C)$.

D 3. Computation of the fractional marginal likelihood (F M L).

Integration in (C.1) is carried out readily by recognizing that posterior density $p(\beta, \Phi \mid b, \text{data})$ is product of conditional normal by wishart density. The result is

$$q_o(b, Y) = \text{const.} \times a(n,k) |S|^{-T(1-b)/2} \qquad (D.13)$$

where

$$\text{const} = (\pi)^{-Tn(1-b)/2} \, b^{Tnb/2}$$

$$a(n,k) = \frac{\prod_{i=1}^{n} \Gamma((T-k+1-i)/2)}{\prod_{i=1}^{n} \Gamma((Tb-k+1-i)/2)}$$

n=3. k=5(model(0)) or k=4(model(1))

Model(1) has same form as (D.11). Then, the F B F of model(0) against model(1) is

$$B_b(Y) = q_o(b, Y)/q_1(b, Y) = \left| S / S^H \right|^{-T(1-b)/2} [\, a(n,k)/a(n,k-1)] \qquad (D.14)$$

where

$$S^H = \sum_t (y_t - X_t \hat{\beta}^H)(y - X_t \hat{\beta}^H)$$

$\hat{\beta}^H$: OLS estimates of β undre model(1)

Example.

$B_{0.5}(Y) = 0.54$ for Dutch data

Thus, model(1) is better than model(0) in the sense that $q_1(0.5, Y) > q_0(0.5, y)$.

E. Bayesian inference for model(2)

The matrix form of model(2) is

$$Y_t = Z_t\theta + E_t \qquad \text{for} \quad t=1,\ldots,T$$

where

$$Z_t = X R\,(R' R)^{-1},\quad \theta = R'\beta \text{ and } E_t \sim N(0, \Phi^{-1})$$

As contrasted with the homogeneity, symmetry-constraints are the conditios across the commodity groupes . In this case, we have no way to evaluate the posterior mean of θ exactry. Although we know that θ follows multinormal distribution asymptoticaly, we adopt the alternative approach based on the sampling method similar to D2.

E 1. Sampling method for model(2)

Joint posterior density $p(\theta, \Phi \mid Y)$ of model(2) is

$$p(\theta, \Phi \mid Y) \propto |\Phi|^{(T-n-1)/2} \exp\{-\textstyle\sum_t (Y_t - Z_t\theta)' \Phi (Y_t - Z_t\theta)/2\} \qquad (E.1)$$

From this density, the set of conditional distributions is derived;

$$\Phi|_\theta \sim W_T(S) \qquad (E.2)$$

where

$$S^{-1} = (\textstyle\sum_t (Y_t - Z_t\theta)(Y_t - Z_t\theta)')$$

$$\theta|_\Phi \sim N(\hat{\theta}, \Omega) \qquad (E.3)$$

Where

$$\hat{\theta} = (\textstyle\sum Z_t' \Phi Z_t)^{-1} (\sum Z_t \Phi Y_t)$$

$$\Omega = (\textstyle\sum Z_t' \Phi Z_t)^{-1}$$

Defferent from D2 where random draws (β, Φ) are repli cated independently, model parameters (Φ, θ) are generated by the cyclical process("GIBBS SAMPLER") . The gibbs sampler algorithm proceeds as follows;

1 . Specify starting values $\theta^{(0)}$ and set i=0

2 . Given $\theta^{(i)}$, draw $\Phi^{(i)}$ from $W_T(S)$ defined by (E.2)

3 . Then, given $\Phi^{(i)}$, draw $\theta^{(i+1)}$ from $N(\theta^{(i)}, \Omega)$ defined by(E.3)

4 . Set i=i+1, and go to step 2.

After N iterations, we get sequence of realized parameters $\{\theta^{(i)}; i=1,..N\}$. Let $\{\theta_{ji}\}_{i=1}^{N}$ denotes the sequence of the specific parameter θ_j . As $N \to \infty$ we suppose the random sequence converges to the limiting distribution(=mar-

nal posterior distribution of θ_j). Thus, by averaging $\{\theta_{ji}\}_{i=1}^{N}$, we get the estimate of the posterior men of θ_j .

For the estimation of θ_j , we generated 11000 draws. The first 1000 draws were deleted and the next 10000 draws were used for the estimation.

E 2. Assessing Numericl Accuracy and convergence

For simlicity, let $\{G_i\}_{i=1}^{N}$ denotes the sequenceof the specific element of θ . and $\bar{G} = (\sum_{1}^{N} G_i) / N$.

As the sequence $\{G_i\}_{i=1}^{N}$ generated by gibbs sampler is autocorrelated , the evaluation of standard error of $\bar{G}$ is complicated. In his paper, Geweke(1992) proposed the next approach. If the $\{G_i\}_{i=1}^{N}$ is stationary series, the Var(G)can be approximated as follows.

$$\mathrm{Var}(\bar{G}) \sim \tau^2 / N \qquad \text{(E. 4)}$$

where

$$\tau^2 = S(0)$$

S(f):spectral density of $\{G_i\}$

Using spectral density estimate of S(0), the next statistic(NSE)is formed.

$$\mathrm{NSE} = \hat{\tau}^2 / \sqrt{N} \qquad \text{(E. 5)}$$

where

$$\hat{\tau}^2 = \hat{S}(0)$$

$\hat{S}(0)$:spectral density estimate of S(0)

In this paper, $\hat{\tau}^2$ is formed from the periodogram of $\{G_i\}_{i=1}^{N}$ using a Parzen window. For assessing convergence of $\{G_i\}_{i=1}^{N}$, we used the convergence diagnostic statistic (CD) given by Geweke(1992);

$$\mathrm{CD} = (\bar{G}_A - \bar{G}_B) / \mathrm{sd}(\bar{G}_A - \bar{G}_B) \qquad \text{(E. 6)}$$

where

$\bar{G}_A$:sample mean of first N_A draws in the $\{G_i\}_{i=1}^{N}$

$\bar{G}_B$:sample mean of last N_B draws in the $\{G_i\}_{i=1}^{N}$

$$\mathrm{sd}(\bar{G}_A - \bar{G}_B) = (\hat{\tau}_A^2 / N_A + \hat{\tau}_B^2 / N_B)^{1/2}$$

$\hat{\tau}_A^2$ and $\hat{\tau}_B^2$ are the estimates of τ^2 based on both subsamples, respectively. If the $\{G_i\}_{i=1}^{N}$ is stationry series , we expect that CD$\sim$N(0, 1). Thus, accordind to the CD value, we test the convergence of $\{G_i\}_{i=1}^{N}$.

NOTES

For the estimation of β and the elimtnated prameters β^*, it is required to genarate $\{\beta_{ij}\}_{j=1}^{N}$、 $\{\beta_{ij}^*\}_{j=1}^{N}$ from $\{\theta_{ij}\}_{j=1}^{N}$ by use of (B. 2. 1)and (B. 5) .

E 3. Estimation of the FBF (against model(1))

The fractional likelihood function of model(2) is

$$f(Y \mid \theta, \Phi) = (2\pi)^{-Tm/2} |\Phi|^{T/2} \exp\{-\sum_t (Y_t - Z_t\theta)' \Phi (Y_t - Z\theta_t)/2\}$$

Then, joint posterior density becomes

$$p(\theta, \Phi \mid Y, b) \propto |\Phi|^{(Tb-m-1)/2} \exp\{-b\sum_t (Y_t - Z_t\theta)' \Phi (Y_t - Z_t\theta)/2\} \qquad (E.7)$$

For estimating the FML, it is required to draw (θ, Φ) from this joint density. The set of conditional distribution for gibbs sampler are as follows:

$$\Phi|_\theta \sim W_{Tb}(S)$$

Where

$$S^{-1} = b\sum_t (Y_t - Z_t\theta)' \Phi (Y_t - Z_t\theta)$$

$$\theta|_\phi \sim N(\hat{\theta}, \Omega)$$

where

$$\hat{\theta} = (\sum_t Z_t' \Phi Z_t)^{-1} (\sum_t Z_t' \Phi Y_t)$$

$$\Omega = (b\sum_t Z_t' \Phi Z_t)^{-1}$$

Depedent on the draws $\{\Phi^{(i)}, \theta^{(i)}, i=1,..N\}$, the sequence of $f^{1-b}(Y|\Phi^{(i)}, \theta^{(i)})$ is determined.

Let define

$$G_i = f^{1-b}(Y|\Phi^{(i)}, \theta^{(i)}) / q_1(b, Y) \qquad (E.8)$$

where the denominator is the known constant given by(D.13)

By averaging G_i's, we can get the estimate of the FBF(against model(1)). For assesing accracy and convergence, we caluculted NSE and CD according to (E.5) and (E.6).

In this study, we set N=22,000. The first 2000 draws are deleted and the next 20,000 are saved for our uses.

F. Bayesian inference for model(3)

F 1. Sampling method

Joint posterior density $P(\theta, \Phi|Y)$ has the same form as (E.1) where $Z_t\theta$ is defined by (B.4).

The set of conditional distribution for the itertive sampling are

$$\Phi|_{\theta} \sim W_T(S) \qquad (F.1)$$

where

$$S = \left(\sum_t (Y_t - Z_t\theta)'(Y_t - Z_t\theta)\right)^{-1}$$

$$\theta|_{\Phi} \sim |\Phi|^{(T-n-1)/2} \exp\{-F(\theta)/2\} \qquad (F.2)$$

where

$$F(\theta) = \sum_t (Y_t - Z_t\theta)' \Phi (Y_t - Z_t\theta)$$

Samplig from $P(\theta|\Phi)$

Since the conditional density in (F.2)has not normal density kernel, it is very hard to draw θ dirctly from the conditional distribution $P(\theta|\Phi)$. But, in lager sample, this can be closely approximated by a normal distribution with $\hat{\theta}$, maximum likelihood estimate Of θ, and variance Ω, the inverse of the Fisher information. We use this distribution as the instrumental distribution for to draw θ from the target distribution $P(\theta|\Phi)$. A sample from the target distribution can be obtained by using additional algorithm. (See Robert and Casella (1998) for details). For simplicity, let denote instrumental distribution $g(\theta)$ and target ditibution by $f(\theta)$. A constant M, is chosen such that, hopefully, $f(\theta) \leq Mg(\theta)$ over the range of θ. In this paper, we chose M such that $M=f(\hat{\theta})/g(\hat{\theta})$.

Step(1)(Accept-Reject Algorithm)

(1) Generate θ from $g(\theta)$

(2) Generate a uniform (0, 1) variate U

(3) If $U \leq f(\theta)/Mg(\theta)$, then $\theta^* = \theta$, otherwise return 1

If the bound M on f/g is a uniform bound, then, we obtain sample θ from $f(\theta)$, else we make an error. For correcting this error, we go to the next step.

Step(2)(version of Independent Metropolis-Hasting Algorithm)

let $\theta^{(i)}$ be sample draw at th iteration of the Gibbs sampler

Given θ^* and $\theta^{(i)}$, take

$$\theta^{(i+1)} = \begin{cases} \theta^* & \text{with probability } \rho(\theta^{(i+1)} = \theta^* | \theta^{(i)}) \\ \theta^{(i)} & \text{otherwise} \end{cases}$$

where

$$\rho(\theta^{(i+1)} = \theta^* \mid \theta^{(i)}) = \begin{cases} \min\left\{1, \dfrac{f(\theta^*)g(\theta^{(i)})}{g(\theta^*)f(\theta^{(i)})}\right\} & \text{if } f(\theta^*) > Mg(\theta^*) \\ \min\{1, Mg(\theta^{(i)})/f(\theta^{(i)})\} & \text{otherwise} \end{cases}$$

Using the algolithms mentioned above, we produced a sample θ from $P(\theta \mid \Phi)$.

F 2. Maximum likelihood(ML) estimates for model(3)

For reference, we calculated the ML estimates:

	estimste	standard error	
μ_1	0.195	0.027	Food
μ_2	0.083	0.010	Beverages
μ_3	0.472	0.028	Durables
υ_{34}	-0.563	0.126	
ϕ	-0.070	0.027	

The estimates of variance matrix Ω are

$$10^{-4}\begin{bmatrix} 0.2468 & 0.0275 & -0.01463 \\ . & 0.0391 & -0.0465 \\ & & 0.2602 \end{bmatrix}$$

Food
Beverages
Durables

F 3. Estimation of the deleted parameters

Estimation of β and the FBF are carried out by the same way as the method for model(2) exept for the estimation of the deleted parametres. Estimates of the deleted parametres in model(3) are formed from the constraints (b.6).

G. Bayesian inference for model(4)

G 1. Marginal postrior density of θ .

Ignoring a proportionality constant, the likelihood function becomes

$$f\ (Y|\theta,\ \tau) \propto |W|^{\frac{T}{2}}\ \tau^{\frac{Tn}{2}}\ \exp\{-\tau \sum_t (Y_t - Z_t\ \theta)'\ W\ (Y_t - Z_t\theta)/2\}$$

We adopt the vague prior density

$$p\ (\theta,\ \tau) = p\ (\theta)\ p\ (\tau)$$

$$p\ (\theta) \quad \text{constant}$$

$$p\ (\tau) \propto \tau^{-1}$$

Then, the joint posterior density is

$$p\ (\theta,\ \tau) \propto |W|^{\frac{T}{2}}\ \tau^{\frac{Tn}{2}-1} \exp\{-\tau \sum_t (Y_t - Z_t\theta)'\ W\ (Y_t - Z_t\theta)/2\}$$

Integrating with respect to τ gives the marginal posterior density $p\ (\theta|Y)$

$$p\ (\theta|\ Y) \propto [A + (\theta - \hat{\theta})'\ (\sum_t Z_t'\ W Z_t)\ (\theta - \hat{\theta})]$$

where

$$A = \sum_t (Y_t - Z_t\hat{\theta})'\ W\ (Y_t - Z_\tau\theta)$$

$$\hat{\theta} = (\sum_t Z_t'\ W Z_t)^{-1}\ (\sum_t Z_t'\ W y_t)$$

Therefore, marginarly θ follows multivariate student-t distribution;

$$\theta \sim t_\nu\ (\hat{\theta},\ \Omega) \qquad (G.1)$$

where

$$\nu = Tn - K$$

K: number of elements of

$$s^2 = A/\nu$$

$$\Omega = s^2\ (\sum_t Z_t'\ W Z_t)^{-1}$$

Suppose $\phi = (\phi_1, \ldots \phi_m)'$, $m \leqq K$, is a set of parameters defined by $\phi = D\theta$ where D is an $m \times K$ matrix of rank m. Then, posterior density of ϕ is

$$t_\nu (D\hat{\theta},\ D\Omega D') \qquad (G.2)$$

Postrior inferences for β and deleted parameters β^* are made from (G.2).

G 2. Computation of the fractional marginal likelihood(FML)

Joint posterior density p (θ, τ | Y, b) is

$$p(\theta, \tau \mid Y, b) \propto \tau^{Tbn/2} \exp(-b\,\tau \sum_{t} (Y_t - Z_t\theta)' W (Y_t - Z_t\theta)/2\}$$

Integration in (C.1) is carried out readily by recognizing that the joint psosterior density is the product of conditional normal density by gamma density . The result is

$$FML = \pi^{-Tn(1-b)/2}\, b^{T(1-b)/2} |W|^{T(1-b)/2} [\Gamma(\alpha')/\Gamma(\alpha)]\ (S^2) \qquad (G.3)$$

where

Γ () :gamma function

$\alpha = (Tbn-K)/2$: K=9, n=3

$\alpha' = (TN-K)/2$

As such, we can evaluate the FML of model(4) exactly.

H. Estimation of the variance matrix

In this paper, we work with precison matrx Φ instead of variance matrix Ω , so that the estimates of Ω are obtained by inversion of Φ.

* Posterior means of Φ in model(1) are obtained from the wishaet distribution defined by (D.1), i.e.

$$E(\Phi) = \upsilon_1 S^{-1}$$

where υ and S are given in (D.1).

* marginal posterior ditribution of Φ becomes Gamma distribution, so that posterior means of Φ are

$$E(\Phi) = s^2 W^{-1}$$

where s^2 is defined in (G.1).

* Posterior means of Φ in model(2) and model(3) are estimated by using of the samples generated for the estimation of θ . e.g. Φ in model(3) are estimated as follows;

	mean	NSE	CD
Φ_{11}	57846.8	142.6	-0.20
Φ_{21}	-2323.8	278.0	2.25
Φ_{22}	308849.7	864.8	0.41
Φ_{31}	31807.5	110.3	0.03
Φ_{32}	52088.0	309.9	0.79
Φ_{33}	63187.2	I62.3	-0.20

AS compared to marginal shares, estimates of Φ have large NSE, respectively.

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XIV Effects of Image Formation of Rural Scenery on Consciousness and Willingness to Protect Rural Farming Villages

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1.Introduction

Recently, many learned experts say that the value of agriculture consists of reduction of natural disasters, landscape of farming villages, and cultural or historical materials around the villages, in addition to agricultural products. In fact, there have been many papers which evaluate these values by means of various econometric methods, e.g. Hedonic method, TCM(Travel Cost Method), CVM(Contingent Value Method), Conjoint method. These methods are based in common on the model of market economy. This seems that the total value of agriculture could be measured by the hypothetical market price which might be determined by behaviors or actions of rational citizens. Is this true?

I see that considerable parts of the value of agriculture should be evaluated as symbolic one, not instrumental one, which is related to labors and lives of citizens in the village. But there is no research that focuses on measuring the symbolic value directly. This would arise from the fact that we all have considered that the symbolic value can not or should not be measured, even if the value has an important role to evaluate agricultural environments. Although we admit the difficulty of measuring the symbolic value, it would be wrong to evaluate farming villages without including it. But I think the evaluation including the symbolic value would not make the policy of protecting rural faming villages more powerful even if some elite researchers argue a view of farming villages plausibly(Rural farming villages would be referred as RFV in short hereafter). Though it is wrong to measure the symbolic value by econometric methods and add the value to the other economic values, it would be important to measure or grasp the meaning of symbolic values "objectively" with some reasonable methods.

In fact, it is very difficult for persons who don't live or have not lived in RFV to judge or represent their preference on agricultural policies meaningfully. The possible way that we can do is to find a number of factors underlying expressions and attitudes for or against a protection policy of rural villages. Of course, researchers sometimes make a survey to ask persons' view on the protection, and investigate the relations between their views and attributes using econometric methods. But this approach is based on economic models and aims to evaluate the policy in the framework of

econometrics. (That is, an aggregation or an average of subjects' views is the most important amount to evaluate the policy) If we try to evaluate the policy in addition to econometric methods, I think we have to pay attention to every individual's view and its variation. Moreover, it would be an interesting viewpoint to analyze changes of subject's views after presenting some real matters (e.g.pictures,movies) in relation to landscape, life, culture of a certain faming village. Citizens have various images on rural scenery, and those formations had been made in their growth environments. If we present many pictures of farming village repeatedly to them, they would change their attitudes on the protection policy of farming villages according to the formation of their image on rural scenery.

The paper aims to clarify the relationship between the attitude toward defending landscape of rural faming villages and the image on rural scenery. The relationship might give us a new evaluation framework of RFV, which would stand up for *ethics* of agriculture. The investigation has conducted using PC(personal computer) automatic questionnaire system, where subjects are supposed to be young persons who are students and around 20 years old. We can assume that they all be estranged from rural faming village at present.

2. Image Formation on Rural Scenery and Attitude for Protection of Farming Villages

2.1. Model for image formation on rural scenery

The attitude for the protection of RFV must be influenced by the image on rural scenery, and the difference on experiences in RFV in childhood would bring about the different images. Moreover, the experiences in RFV are probably acquired in physical and social environments that involve the physical access to faming village and whether parent's home practices agriculture or not. I show the causal relationship stated above by Fig.1.

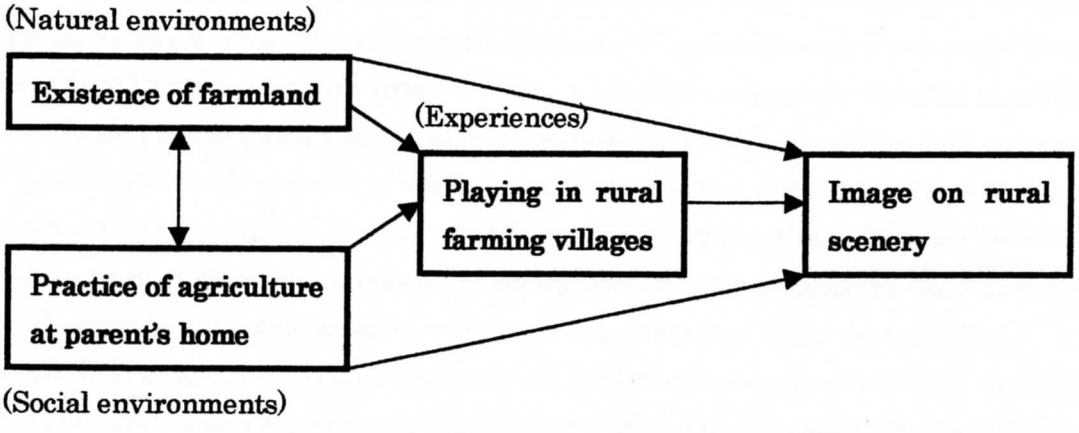

Fig.1 The model for image formation on rural scenery

We assume that the image on rural scenery consists of the following three components:

(1) **The image on natural scenery:** greenish woods, scarlet-tinged (autumn) leaves, small streams, landscape with the hill in the background

(2) **The image on life scenery:** cultivating farmland, children playing in the field, enjoying a relaxing break

(3) **The image on cultural and historical scenery:** woods in former residences, historical buildings, temples, festivals, long-established traditions

Most environmental economists have seemed that the image on natural and historical scenery could partially be reflected by economic values as if we consume the scenery as if we do private goods. In fact, there are so many papers where authors try to clarify economic values of rural natural landscapes or historical and cultural structures on assumption that we can buy them under some contingent markets.

In this paper, an image of life scenery is much taken notice of than the other two components of the image, because I think that an image of life scenery has more closely related to individual's past accessibility to farming village. According to Fig.1, past accessibility can be defined by natural/social environments and experiences when a subject was a child. Here, I formulate the first proposition.

[1] The image on life scenery would be enhanced by natural and social environments of rural faming villages via experiences in the faming fields.

2.2. Attitude for protection of RFV

To capture individuals' attitudes, we shall pay attention to their consciousness and willingness to protect RFV. The attitude may differ from their types of image on rural scenery. To clarify this point, we shall discuss on the next two viewpoints. First, we shall investigate their consciousness to protect faming village by asking yes or no on two different policies: protection policy for a specific faming village and that for all over the country. It is easier to make their decisions for the former policy (local policy) than for the latter (global policy), because the former policy is the one that subjects can have concrete ideas of what's going on farming villages. Second, I shall pay an attention to a set of changes of subjects' attitude after giving some visual information on rural scenery.

On the process of PC automatic questionnaire, subjects make paired comparisons of pictures related to rural scenery, which are structured ones according to AHP (Analytic Hierarchical Process) algorism. (The set of pictures consists of three groups, which have

five pictures corresponding to three kinds of the image as above. As paired comparisons are made in each group, the required number of times of comparisons is 30.)

What can I expected in this experiment in relation to the change of their attitude? First of all, I will find enlightening effects. That is to say, each subject's attitude for protection of farming village would become affirmative after making paired comparisons of pictures, because the pictures seem to give them good impressions on rural faming villages. But the interests of us are not in this point. According to the viewpoints stated above, we shall investigate the consistency of consciousness to protect RFV in the two different policies and the differences in directions of change of each subject's attitude, which might be related to their attributes of physical/social environments and experiences in RFV in childhood. On these points, I can formulate the next two propositions.

[2] The consciousness on protection of rural faming villages for all over the country changes more largely than that of a specific faming village after paired comparison of pictures.

[3] The magnitude of the change in the attitudes on protection of rural faming villages after paired comparison of pictures has significant relations to the experiences in RFV and the image on life scenery.

The second proposition can be stated on the assumption that after paired comparison, they would revise their expressions on the consciousness of the policy for protection of faming villages for all over the country, and would give them more compatibly with that on the policy for a specific faming village. I think this phenomenon could be considered as a leaning process. The third proposition means that the attitude of subjects who have substantial experiences and the image on life scenery are vulnerable and changeable. To remark, the magnitude of the change does not mean an aggregation of positive changes of subject's attitudes. I here add negative changes of the attitudes of subjects (from affirmative attitude to negative one) to the magnitude as absolute changes.

3. Carrying the Survey and Measuring a Value of a Rural Faming Village

3.1.The flow of the survey

A set of data I will use in the paper is one which my research group had surveyed to measure a value of the landscape of the rural farming village that had got a grand prize for the good panorama by Japanese Government. The survey had been carried in two

years (1998-1999) by PC automatic questionnaire system, which has composed of two parts. One of the parts is a CVM questionnaire to measure a value of the landscape where each subject make a dichotomous choice (DC-CVM) on whether he pays a given sum of money or not to protect the landscape of the farming village. (This is oriented to a purchasing behavior in a micro-economics framework.) The other part is an AHP questionnaire to figure out the subjects' image of the faming villages.

Fig.2 shows the whole flow of the survey. In1999, Japan Government has put the protection policy of direct payments to hilly and mountainous areas into force.

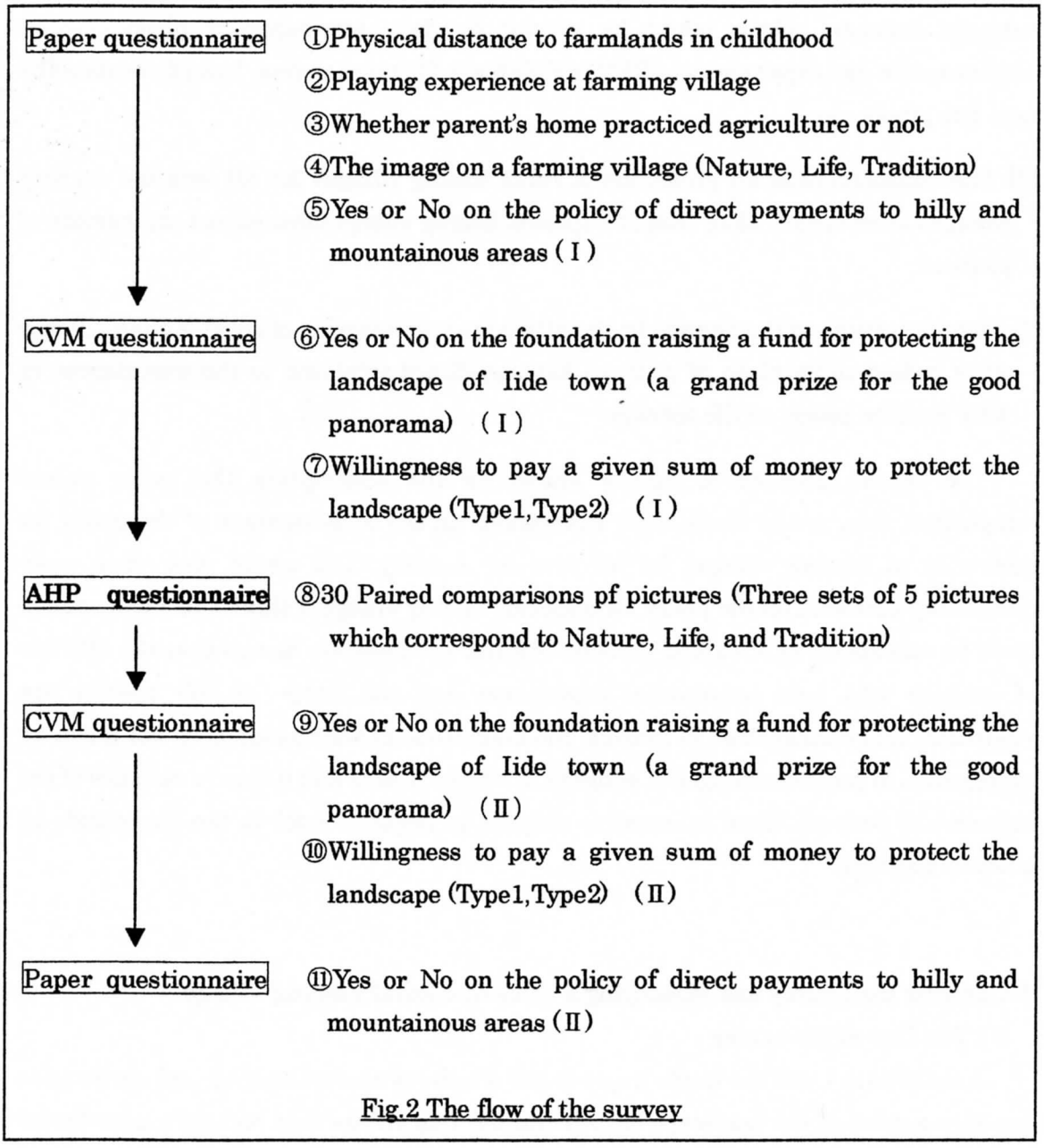

Fig.2 The flow of the survey

This policy has an implication to save farmhouses which are located at remote villages and disadvantageous in productivity. Iide town is a typical Japanese village where rice fields spread all over the town. In 1994, Iide town won the highest award (the award of Ministry of Agriculture) in the first contest of beautiful landscape village in Japan.

In the paper questionnaire, subjects' attributes related to rural faming village ①②③, the strength of subject's images of nature, life and tradition on faming villages ④, and yes or no on the policy of direct payments to hilly and mountainous areas ⑤ are surveyed. Questions ⑤(⑪) and ⑥(⑨) correspond to the consciousness on the protection policy for all over the country and a specific faming village respectively. Questions ⑦(⑩) and ⑧ are for CVM, and AHP respectively. Because subjects are young persons who all would be estranged in rural faming villages, some opinions of both sides are shown for consultation, and a choice of reservation is also accepted in ⑤(⑪). Only subjects who answer 'yes' in ⑥(⑦) are required to answer ⑦(⑩). Here, I would like to take up one question. In DC-CVM, willingness to pay a given sum of money is usually asked on the hypothetical foundation to contribute⑦(⑩). It is very strange for me because CVM must be designed to represent a person's decision to buy a private goods and able to get the goods after making a decision 'yes'. In this case, it is not sure for any citizen that the landscape of Iide town would be protected, for the protection decisively depends on the other citizens' decision (This refers to the problem on public goods supply or Social Dilemma in the game theory). So our group set two types of asking:

(Type.1) Paying money as a contribution (usual asking)
(Type.2) Paying money as deficiency in putting the protection into practice

In spite of impracticalness of Type.2, we ask willingness to pay as if the protection fund had already been raised up to necessary sum of money except the subject concerned, in order to find a difference on effectiveness between the types. That is, we can formulate the following hypothesis:

[4] Willingness to pay in type 1 would be smaller than that in type 2 because of its ineffectiveness to put the policy into force.

Still, if a subject opposes the aims of the foundation, I shall regard that he refuse to pay to it (Resistance answers).

The investigation has been carried in PC lecture rooms of Universities, where we selected subjects who are mainly the first or second grade students of undergraduates. Because it is necessary for us to show each subject a different sum of money(DC-CVM),

a different type(Type.1,2), and to give him pictures for paired comparison in random order(AHP), we can't get many samples at a time as usual assembled surveys. As stated, the grounds for selecting such subjects is that they wouldn't generally have a vital interest in RFV and would become in pivotal classes in the future, any of whom would participate in framing a plan for agriculture in Japan. Moreover, fortunately they could easily operate personal computers. To consider the difference of nature on subjects' environments in childhood, we also carried the investigation at Hokkaido and Okinawa, each of which is located at the northern end, the southern end of Japanese islands respectively, and they have largely different nature of agriculture from Honshu(the central island in Japan). The number of samples is 631(269 in Honshu, 137 in Hokkaido, and 225 in Okinawa).

3.2.Measurement of willingness to pay for protecting a specific rural farming village

Fig.3 shows ratios of willingness to pay according to type and pre and post-AHP. Willingness to pay on T2 seems higher than that on T1. In fact, we can calculate the median WTP using logistic regression estimation curves showed in Fig.3, and we get ¥305.58, ¥427.92 on T1 and ¥491.54, ¥762.25 on T2, where the former value is at pre-AHP and the latter is at post-AHP respectively. In almost all of 10 surveys (2 times and 5 presentations of sum of money) except at post-AHP presented ¥5,000, willingness to pay on T2 is higher than that on T1. Therefore, I can say there is the difference

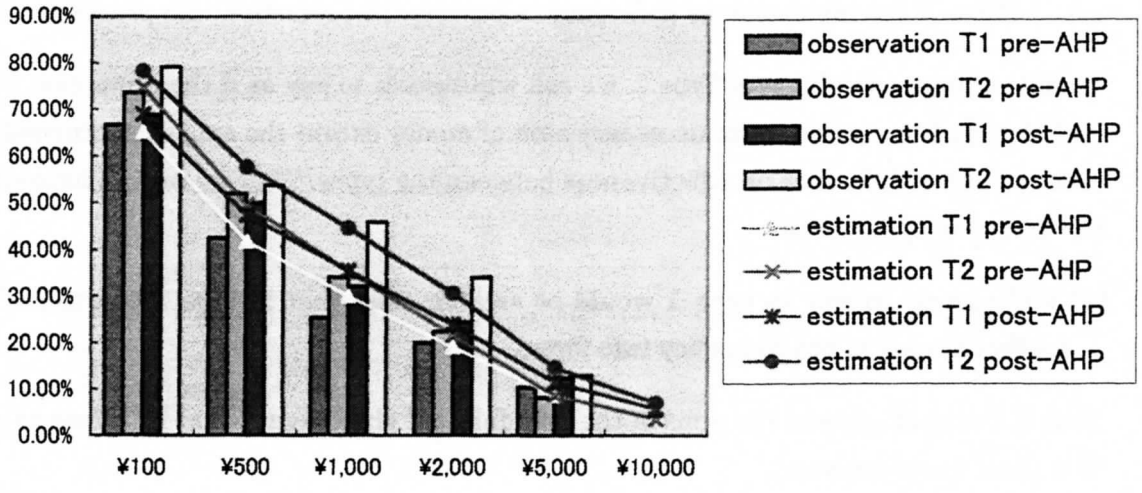

Fig.3 Ratio of willingness to pay according to type and pre and post-AHP

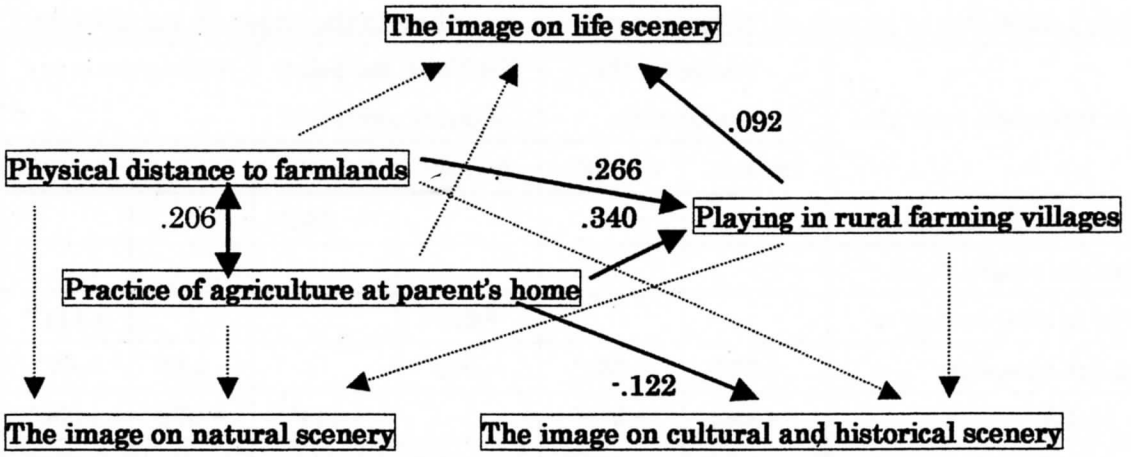

Fig.4 Image formation on rural scenery

between two types statistically (nonparametric test in 5% significant level). As a result, I can support the forth hypothesis : There would be a possibility that many calculated values of CVM based on contributions to hypothetical foundation have been underestimating.

4 . Factors of Consciousness and Willingness to Protect RFV

4.1. Verification of the model for image formation

The result of path analysis to verify the model for image formation is shown in Fig.4 (Residual terms are omitted). Significant causal relationships are shown by bold lines with correlation coefficients. According to this diagram, the amount of experiences of playing in RFV are strongly determined by physical distance to farmlands in childhood and whether parent's home practices agriculture or not, and leads to form the image on life scenery. Practice of agriculture at parent's home gives a direct negative effect on the image on cultural and historical scenery. This means that citizens who are not familiar to agriculture tend to form the image on cultural and historical scenery. Furthermore, the image on natural scenery has not relation to attributes of physical/social environments and experiences in RFV in childhood (In fact, the correlation coefficient between the image on natural scenery and amount of experiences of playing in RFV is negative although it is not significant). As a result, the image on life scenery is different from the other two images, and this image is only related to attributes of physical/social environments and experiences in RFV in childhood.

Tab.1 Attitudes to protect rural faming villages according to the image on rural scenery

Independent variables	Yes/No on the foundation		Yes/No on the policy of direct payments		Willingness to pay	
	Pre-AHP	Post-AHP	Pre-AHP	Post-AHP	Pre-AHP	Post-AHP
Physical dist. to farmlands				−.082*		
Practice of agriculture						
Play in rural farming vil.			+.073			+.111**
Image on nature	+.076*	+.081*	−.086*		+.079*	+.077
on life	+.064	+.075*		+.114**	+.072	+.080*
on cultural/historical	+.112**	+.086*	+.117**			+.078*
Disposable income	—	—	—	—	+.088*	+.076*
R^2	.036**	.033**	.027*	.024*	.031*	.043**

Partial regression coefficients (displayed only when p <0.2) (*p<0.1,**p<0.05)

4.2. The image on rural scenery and attitudes to protect rural faming villages

Tab.1 shows the result of regression analysis where dependent variables are in the model for image formation and independent variables are attitudes to protect rural faming village, to be concrete, yes or no on the foundation raising a fund for protecting the landscape of Iide town, yes or no on the policy of direct payments to hilly, and mountainous areas, and Willingness to pay a given sum of money to protect the landscape. According to the results, consciousness to support the foundation is positively explained by the total image on rural scenery, especially on nature and cultural/historical one. On the other hand, consciousness to support the policy of direct payments is positively explained by images on life and cultural/historical one, and negatively by the image on nature. Willingness to pay is also explained by the total image on rural scenery, and it is very interesting to appear a positive and significant correlation between willingness to pay and playing experience in rural faming villages after AHP investigation.

To sum up, Consciousness on protecting RFV is largely influenced by the image on rural scenery, and the image on nature has a positive relation only to consciousness on a specific rural faming village. Images on life and cultural/historical scenery has relation to the general and global protection of rural faming villages. Experience in rural faming villages and the image on life scenery mainly formed by the experience would enhance the strength of relationship to consciousness and willingness to protect RFV after AHP investigation.

It would be possible to interpret that only citizens that had experienced in rural

Tab.2 Change in relationship of yes/no between on the foundation of protecting landscape and on the policy of direct payments

<Pre-AHP investigation>

Protecting Landscape \ Direct Payments	Approval	Approval a little	Opposition a little	Opposition	Can't tell	Total
Approval	104	235	58	9	100	506
	86.7%	88.3%	60.4%	50.0%	83.3%	81.6%
Oppsition	16	31	38	9	20	114
	13.3%	11.7%	39.6%	50.0%	16.7%	18.4%
Total	120	266	96	18	120	620

Gamma coefficient G =−0.461

<Post-AHP investigation>

Protecting Landscape \ Direct Payments	Approval	Approval a little	Opposition a little	Opposition	Can't tell	Total
Approval	141	290	23	3	59	516
	95.9%	93.9%	31.9%	13.0%	77.6%	82.3%
Opposition	6	19	49	20	17	111
	4.1%	6.1%	68.1%	87.0%	22.4%	17.7%
Total	147	309	72	23	76	627

Gamma coefficient G=−0.857

(G=−0.831: excluding subjects who "can't tell" at pre-AHP)

faming villages and formed the image on life could feel para-experience in rural villages in AHP investigation. I shall discuss this point later.

5. Changes in Attitudes on Protecting RFV

5.1 Changes in Consciousness and Willingness to pay after AHP investigation

The ratio of approval for the foundation of protecting landscape increases slightly after AHP investigation (81.1% to 82.4%), but I can't find the difference between them significantly. Moreover, the ratio of subjects who changed their decisions after AHP investigation (from approval to opposition, from opposition to approval) is 6.0%. Therefore, I could say that the decision is robust through paired comparisons of pictures. On the contrary, the ratio of approval for the policy of direct payments increases largely after AHP investigation (77.0% to 82.8% in the group not involving "can't tell" at both pre- and post-AHP investigation). The ratio of "can't tell" decreases to 11.9% from 19.5% and more than half (55%) of subjects who were "can't tell" at pre-AHP express

their attitude at pre-AHP, most of them answer approval (83.3%). As a result, the ratio of approval at post-AHP is 82.9% (Refer to Tab.4).

On the other hand, the ratio of subjects who changed their decisions on the policy of direct payments after AHP investigation (from approval to opposition, from opposition to approval) is 14.5% except "can't tell" subjects. Although this ratio is quite larger than that in protecting landscape, this fact would not contribute to raising the ratio of approval. In fact, there are considerable subjects who changed their decisions from approval to opposition (one-third of subjects who changed their decisions negatively (23 cases)). Uniformly increasing on the ratio of approval could be considered to be a kind of enlightening effects, but what on earth the change of decision on both sides means ?
In the end of this section, I shall try to explain the change in two contexts: learning process (acquiring consistency) and capability (an ethical point of view).

As shown in tab.2, the correlation between the attitude for protecting landscape and that for direct payments is significant and high. To pay close attention to the coefficients, the correlation after AHP is much higher than that before AHP (from 0.471 to 0.857 in terms of γ-coefficients). This means that the attitude for protecting landscape changes to be consistent with that for direct payments, which is robust through AHP investigation. In other words, the consciousness on protecting a specific rural farming village extends to that on preserving hilly and mountainous villages all over the country.

The ratio of subjects who are willing to pay also increases from 36.2% to 42.8% significantly. The number of resistances (that is, the number of subjects who oppose against the foundation) is almost the same between pre- and post-AHP, and more than 80% of resistances remain opposite. The fact indicates that the increase of willingness to pay is simply caused by subjects who change their willingness to paying from not paying.

When we researchers have an intention to make subjects heighten their consciousness to protecting RFV or guide them to approval for it, it is possible to consider above-stated facts as enlightening or commitment on their actions.
Although we cannot avoid these situations on carrying this kind of surveys, our aims to study here are not to these points, but to understanding of some structures of decision making for protecting RFV and investigation on the relationships of them to subjects' attributes.

5.2 Changes of decision in relation to the image and experience on rural villages

There would be a difference on the situation of decision making between the

groups which would be classified by the image and experience on RFV (which would give each subject a different meaning of farming villages). To investigate an influence of paired comparisons of pictures on an attitude of a specific group for protecting RFV, it is insufficient only to see an aggregate change in the group. First, there is a considerable number of subjects who couldn't tell their attitudes, especially those to the policy of direct payments, and many of them would show their attitudes after AHP investigation. Second, as stated above, we can't see an aspect of the change without seeing it on both sides individually. We shall give some indicators based on these points.

In order to consider an influence of subjects who can't tell about the policy of direct payments or resist against the foundation of protecting landscape, we shall compute the ratio of approval after AHP investigation excluding subjects who can't tell or resist at pre-AHP. Here, we shall four indicators as follows;

δ : a ratio of subjects who change their decision from opposition (not willing to pay) to approval (willing to pay) or its reverse, except subjects who can't tell or resist.

γ : a gamma coefficient between decisions of pre- and post-AHP, in view of consistency of decision.

ρ : a ratio of subjects who change their decision to approval (willing to pay) in those who oppose (is not willing to pay) at pre-AHP.

ζ : a ratio of subjects who change their decision to opposition (not willing to pay) in those who approve (is willing to pay) at pre-AHP.

Both δ and γ indicate the amount of change, but to our remark, the smaller value of γ shows, the larger the amount would be.

In Tab.3, and Tab.4, changes of willingness to pay and consciousness are shown according to attributes which are related to RFV (Natural/Social environments, experiences in childhood, and the image on RFV) . The symbol * means a significant difference between categories of each items by the statistical test of difference (significant level is 10%).

The amount of change in the ratio of willingness to pay is closely related to three items : distance from farming fields in childhood, experience of playing in farming fields in childhood, and the image on life scenery. Moreover, we can find an experience of playing and the image on life scenery make 'not willing' change to 'willing'. Unnatural results of amount of increasing in practicing agriculture at parents' home, the image on natural scenery, and the image on cultural and historical scenery seems to be caused by a restoration on accidental results at pre-AHP.

The amount of change in the ratio of approval for the policy of direct payments to hilly farming villages is closely related to four items : distance from farming fields in childhood, experience of playing in farming fields in childhood, the image on life scenery and the image on cultural and historical scenery. In the group of having been near farming fields in childhood, we can see a considerable amount of subjects who change their decision from approval to opposition, which makes the ratio of approval lower than any other categories. We can also confirm the similar tendency in the group of having experience of playing in farming fields in childhood, the image on life scenery and the image on cultural and historical scenery.

5.3 Discussions

Here, we shall discuss on three points: What we can say about the change of attitudes for protecting rural farming village in relation to the model of image formation, how to interpret the change of decision, especially the negative change of decision, and how to deal with enlightening effects or commitments on subjects' decisions by the PC questionnaire system.

Firstly, under the model of image formation, we can suppose that an image of life scenery would be more deepened by having pseudo-experience through paired comparisons of many pictures on RFV. To contrast with an image of nature scenery and a part of cultural and historical scenery which would be influenced largely by physical environments, an image of life scenery would be formed mainly by social relationship or kinship in each life-style. So we can suppose the image not to be the one of a specific rural village, but of general rural villages in the country. Thus we could accept the increase of approval on the policy of direct payments which is largely brought by the change of decisions from opposition to approval.

Secondly, in the group of having been near the farming fields in childhood, some subjects change their decision from positive to negative decision as stated above. Moreover, there would be the same phenomenon in the group of having experience of playing in RFV. These groups also have many subjects who change from negative to positive decision. That is, decision of subjects in these groups might be vulnerable and inconsistent throughout AHP investigation.

Thirdly, although visual and narrative information by the PC questionnaire system clearly gives strong effects on the attitude for protecting RFV, there would be some effects that we can't regard entirely as enlightening ones or commitments on subjects' decisions. An enlightening effect, we think, is the one which gives all subjects the same influence that would be supposed in the system (e.g. the same direction of change of

their decisions), and commitments means that our system restricts all subjects' decisions in the same manner. Indeed, our PC questionnaire system has an enlightening effect (commitment on subjects' decisions) as a whole, but it would be appropriate for us that the change of subjects' attitudes to be considered from some different viewpoints, especially consciousness on the policy of direct payments, because we have already seen a conformity of two attitudes (approval/opposition for/against protecting a specific farming village and farming villages all over the country), and because we can't see the change of decisions in the same direction.

The first point of view on the alternation of subjects' decisions is a learning process, where they would try to conform their decisions of two types : ón protecting a specific landscape of a rural farming village and on protection RFV all over the country. Of course, the decisions might not be made on the same standard, but it would be reasonable for us to understand that two policies would become common to many subjects after AHP-investigation. The second point is more difficult to understand. We shall make a proposal for a framework that makes sense of subjects' behaviors before and after AHP investigation.

In theories on modern distributive justice, we can see some excellent conceptions about what should be distributed to citizens in order to avoid the welfarism which had envolved the notorious conception, utilitarianism. For examples as equalisandum, social primary goods by J.Rawls, capability by A.Sen, resources by R.Dworkin. Here, we shall focus on capability. A.Sen says that various economical goods to be distributed should be captured in their functionings, and societies should equalize the set of functionings (which is called capability) on each citizen. A functioning doesn't necessarily mean a utility which is assumed to be brought by consuming economical goods. The essential thing is what the goods gives a citizen comprehensively. So, some say that in some cases capability means the number of choices that citizens would make. But we think the choices should not be counted on capability if things that would be brought by them are little meaningful for citizens. To remark, being different from economic goods, the evaluation on things brought by the choices are not always positive for citizens

To apply this discussion to our survey, subjects who had been estranged from RFV and opposed against protecting RFV would change their minds and regard them as favorable goods after the AHP investigation. On the other hand, subjects who had been familiar to RFV would have psudo-experiences there and change their minds according to their past experiences. Changes would occur on both sides and the amount of them here would be larger than that of RFV-estranged subjects. In conclusion, RFV-familiar citizens would have more capability than RFV-estranged ones in the sense that the

former have more various contextual effects[1] than the latter.

6. Conclusions

We have proved four propositions stated in the chapter 2 and 3 using statistical methods. (1)An Image of life would be largely formed by experiences in RFV and natural/social access to RFV in childhood. (2)AHP investigation gives a conformity of subjects' attitudes on protecting local and global RFV. (3)Subjects who had much experienced in RFV and had formed an image of life on them tend to change their decisions on protecting RFV positive after AHP investigation, but the decisions might not necessarily be positive. (4)Willingness to pay in DC-CVM by the usual asking (whether you will contribute the foundation of recovering environments as they used to be or not) might be smaller value than the theoretical compensating surplus.

We shall focus on the third statement and interpret it in the framework of capability. Recently, many researchers of agricultural economics have emphasis on multi-dimensional functionings of RFV and they has been measuring the values based on micro economic models. But the values that would not directly based on physical things of RFV, such as societies, lives, and existence itself of RFV are easily able to enhanced in citizens who had estranged to RFV, because they would regard RFV as favorable economic goods. The thing that we would like to say is that we should recognize another kind of values of RFV. In the paper, we proposed one of frameworks of measuring the value from an ethical viewpoint 'capability'.

Tab.3. Willingness to pay for the foundation protecting landscape of Iide village

Attributes in relation to farming	Ratio of willingness to pay				Ratio of change of decision			
	Pre-AHP	Post-AHP a	b	Amount of increase b−Pre-AHP	ρ	ζ	δ	γ
Total	36.2	42.8	42.1	5.9*	.110	.032	.067	.991
Distance from farming fields in childhood								
near	35.8	43.9	43.6	7.8*	.115	.000	.057	1.000
apart from	32.4	39.5	38.8	6.4	.109	.045	.075	.987
nothing	38.7	42.6	41.9	3.2	.084	.040	.055	.992
Practicing agriculture at parents' home								
both	38.0	40.8	40.0	2.0	.097	.053	.083	.987
one of them	32.7	44.4	44.3	11.6*	.152	.000	.082	1.000
none	37.9	42.9	42.1	4.4	.099	.048	.065	.988
Experience of playing in farming fields in childhood								
every day	39.8	51.2	50.0	10.2	.200	.030	.104	.984
somtimes	37.5	44.0	44.4	6.9*	.108	.038	.069	.990
none	33.3	38.3	37.0	3.7	.083	.028	.052	.994
The image on RFV								
The image on natural scenery								
essential	40.4	45.2	44.8	4.4	.089	.036	.056	.992
a little	25.9	37.1	36.7	10.8*	.147	.000	.069	1.000
unrelated	42.9	45.0	39.1	-3.8	.083	.111	.056	.975
The image on life scenery								
essential	41.0	49.4	48.7	7.7*	.150	.033	086	.987
a little	29.4	35.2	34.3	4.9	.078	.021	.050	.996
unrelated	30.0	28.3	30.0	0.0	.000	.067	.014	1.000
The image on cultural and historical scenery								
essential	45.1	51.1	50.7	5.6	.115	.047	.056	.986
Aalittle	34.2	41.9	41.8	7.6*	.113	.014	.068	.996
unrelated	31.9	36.9	35.5	3.6	.098	.039	.059	.990
Disposal income (Pocket money)								
−¥20,000	34.7	41.1	40.8	6.1	.087	.015	.052	.997
−¥40,000	33.2	39.7	39.1	5.9	.126	.063	.085	.980
¥40,001−	44.5	49.6	48.3	3.8	.091	.019	.046	.998

Post-AHP(a) : excluding all subjects who resist against the foundation at pre- or post-AHP.

Post-AHP(b) : excluding only subjects who resist against the foundation at post-AHP.

Tab.4 Consciousness for the policy of direct payments to hilly farming villages

Attributes in relation to farming	Ratio of approval				Ratio of change of decision			
	Pre-AHP	Post-AHP a	Post-AHP b	Amount of increase b−Pre-AHP	ρ	ζ	δ	γ
Total	77.0	82.8	82.9	5.9*	.404	.061	.112	.902
Distance from farming fields in childhood								
near	79.8	81.7	80.6	0.8	.400	.094	.130	.836
apart from	72.2	81.0	81.1	8.9*	.429	.055	.127	.904
nothing	77.8	85.2	85.9	8.1*	.425	.036	.095	.941
Practicing agriculture at parents' home								
both	81.8	88.1	84.6	2.8	.375	.000	.053	1.000
one of them	76.7	82.8	83.1	6.4*	.432	.074	.130	.856
none	77.9	83.8	84.2	6.3*	.441	.063	.117	.886
Experience of playing in farming fields in childhood								
every day	78.2	84.7	80.9	2.7	.526	.088	.154	.757*
somtimes	77.3	83.6	84.0	6.7*	.457	.053	.123	.891*
none	77.0	82.1	83.3	6.3*	.319	.051	.087	.941*
The image on RFV								
The image on natural scenery								
essential	76.5	81.6	81.8	5.3*	.390	.060	.110	.912
A little	78.3	86.0	86.0	7.7*	.387	.045	.097	.922
unrelated	82.8	82.1	80.6	-2.2	.600	.125	.167	.633
The image on life scenery								
essential	77.9	85.6	84.8	6.9*	.517	.047	.119	.893*
A little	82.1	84.6	84.9	2.8	.400	.080	.114	.860*
unrelated	62.7	66.0	68.4	5.7	.091	.054	.056	.985*
The image on cultural and historical scenery								
essential	82.2	86.4	84.4	2.2	.478	.047	.097	.910
A little	81.8	84.2	85.1	3.3	.382	.065	.098	.907
unrelated	69.4	79.1	79.7	10.3*	.375	.063	.132	.901

Post-AHP(a) : excluding all subjects who can't tell about the policy at pre- or post-AHP.

Post-AHP(b) : excluding only subjects who can't tell about the policy at post-AHP.

XV Ethics of Diet

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1. Introduction

Diet is not limited to human beings' acquisition of nutrition for the maintenance of the body, but is instead associated with a host of other expressions and meanings. For example, the term 'food' can denote 'diet' in the home and the term 'meals' can denote the eating of that food. Similarly, 'cooking' can refer to the making of meals from foodstuffs, including foodstuffs which have been processed outside the home. The 'culture' of diet can be considered as a combination of arranging cooked/prepared foods on dishes, placement and sequencing of foods/dishes on the table, and the manner of consumption-related behavior exhibited at the table. There are also other issues of diet, such as the division of supportive roles associated with the production or purchase of foodstuffs, the preparation and cooking, the arrangement and serving of foodstuffs, and the clearing/cleaning of tables and dishes. Moreover, the communication between people throughout this activity, and during the consumption of meals, can also be an issue of diet. In this sense, diet is a matter that is intimately and integratedly related to human relations, culture, and the idealization of society.

However, in recent years diet has increasingly become a personal, individual concern. This is obvious in the spread of the phenomena of individualization such as 'eating alone' and the occurrence of a 'private' or unique menu for each family member even when consuming foods at home. Nonetheless, in this paper, the position taken is that human beings are essentially social and that the eating of meals for the purpose of sustaining life is itself a social event.

The purpose of this paper is to clarify a number of relationships involved in

diet: (1) the relationship of the body (the consumer) to itself, (2) the relationship of the consumer to that which is consumed, (3) the relationship between the consumer and other consumers. The result of such clarification will lead to a discussion of justice and ethics as regards diet. That discussion will expose the inadequacy of conventional economics as system capable of addressing issues of the ethics of diet. Now, as an initial step in that direction, it is necessary to consider the issue of diet from the viewpoint of the body and its ownership.

2. Viewpoints for an Analysis

The analytical perspective employed in this paper is illustrated by figure 1. One's body is surrounded by the environmental world, including nature, society, and other human beings. The problem at hand is how to consider the relation between oneself and one's body. If the self is considered to be "mind" then there is the so-called mind-body problem to be grappled with. It is convenient, nowadays, to approach this problem by regarding the human being as analogous to a computer that consists of hardware and software. There are many possible patterns in the relations between hardware and software, as is shown in figure 2. In this paper, and in figure 2, the 'body' as a thing is to be thought of as the physical body.

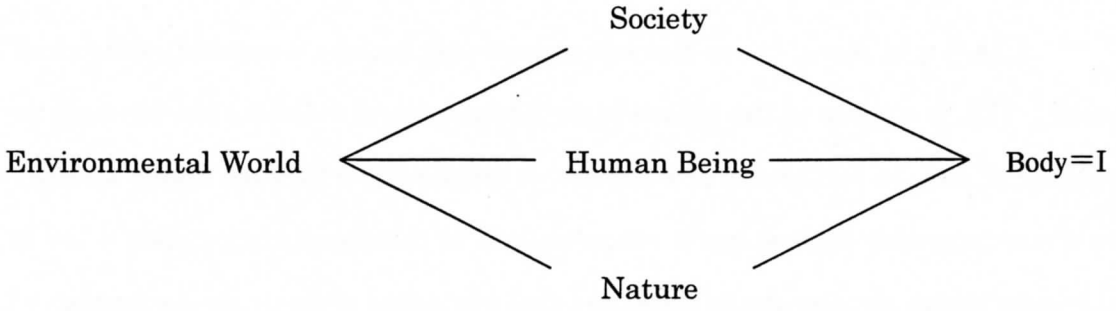

Fig. 1 Analytical Viewpoint

There are logically extreme types of classification that present a computer as constructed exclusively of either hardware or software, respectively type 1 or type 2. In figure 2, if 'hardware' is specified as equivalent to the physical body, type 1 can be identified as materialism. If 'software' is specified as equivalent to mind, then type 2 can be identified as spiritualism.

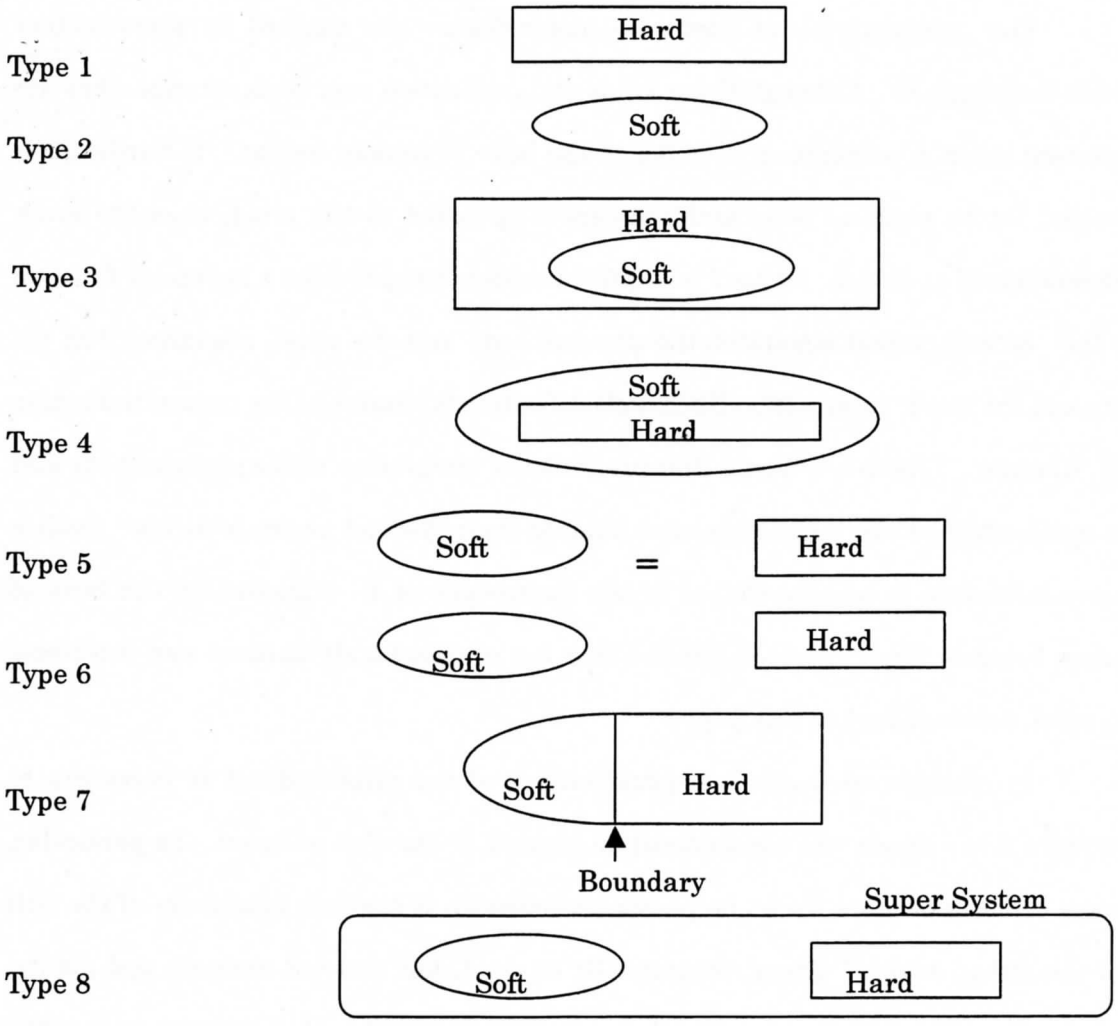

Fig. 2 The Relation Between Mind and Body

There are kinds of classification that implies the inclusion relation from type 3 through type 5. There is a modified type of type 3 that implies software controls hardware. There is a small man in the body (or brain). In the case of type 4, it is said that body is software (Hardware is a set of software). Type 5 implies that hardware and software are both same. If hardware is specified to the physical body, type 5 is called as a model of materialism. If software is specified to mind, type 5 is called as a model of spiritualism

The independence of hardware and software are implied by classificatory models 6 through 8. Although these kinds of classification may seem strange, they are important when consideration is given to the body of human beings. If hardware is specified tot he physical body and software is specified to the mind, then there are different kinds of model. Type 7 is a type of model that provides a sphere of function for the boundary that separates the physical body and the mind, assuming that the body and the mind "intersect". Such a classification is similar to the conceptualization of S. Kimura. Type 8 is a model that presents the integration of the physical body and the mind while at the same time maintaining their discreet characteristics. Such a conceptualization is accommodated in the discussions of H. Ichikawa on the body of human beings. Type 7, which implies that the physical body borders and intersects the mind, is introduced in this paper.

In addition to these conceptualizations of the mind/body, it is necessary to introduce other issues when consideration is given to the diet at home. In particular, society consists of more than one person; specifically, it consists minimally of the Self and the Other, both of whom, theoretically at least, kill and eat animals and plants. Society, as a cooperative and mutually-sustaining system, "works" however only if the decisive rules for people's behavior are established and recognized. For the purposes of this discussion, the essential concern is the analysis of the meaning of the Other for the Self, and the relation between the Other and the Self.

3. Agriculture as Life-Death Exchange

The function of agriculture is to grow plants and animals and to supply them as foods and processing stuffs. At the subsistence level of self-sufficiency, a human being can live by killing and eating plants and animals that are hunted and gathered or are raised and and grown through the process of animal husbandry and horticultural production. At that level of development, people could personally participate in or observe the acts of killing and preparing for consumption plants and animals which may have been raised or grown in their presence. Thus in olden days, people could regard agriculture as a form of life-death exchange.

With the production of surplus and the accompanying division of labor, the economy changed from self-sufficiency to exchange. Expansion of exchange increased the distance between the places of production and consumption. As a result, people lost their intimate and personal awareness of food-consumption as life-death exchange. People could not so readily observe the direct relationship of killing and eating plants and animals: the meat purchased at the retail shop became simply a piece of meat of an anonymous chicken which would be taken home, cooked, and eaten. The relationship to that which was consumed differed according to the societal/developmental level of the consumers.

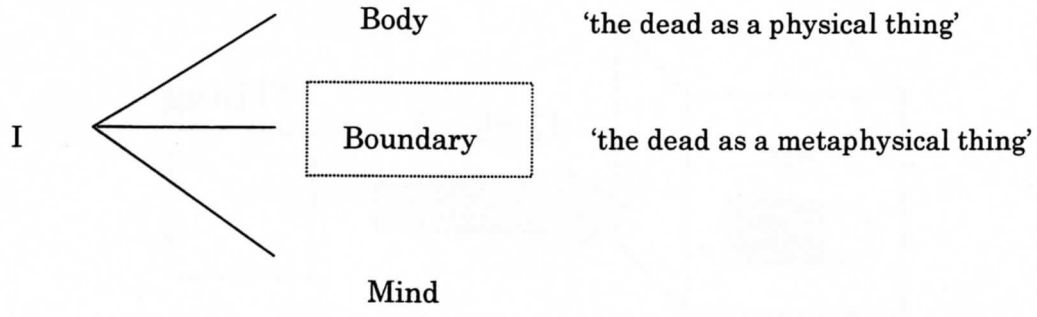

Fig. 3 Two Kinds of Dead

4. My body and Myself

1) Private ownership of the body

Awareness of the reciprocal exchange of life has become difficult in the modern world. Washida has asserted that there are two reasons for this, one being the development of supra-personal industries such as those that provide hospitals and restaurants, and the second being that the body has come to be viewed as a physical thing which can be owned, along with associated property rights.

Currently people appear to have the sense of the body as a form of private property. Along with this concept comes the view that one has rights of usage and disposibility. An example of this is the development of the trade and sale of internal organs. Ultimately, this concept seems to promote the commercialization of life.

Because it is difficult to discuss on the private ownership of body, it is better to begin the discussion from the point of "I" as the body (See fig.4). The works of S. Kumano (1999) and Y. Saito (1999) would be examined below. They are researches on works of Levinas.

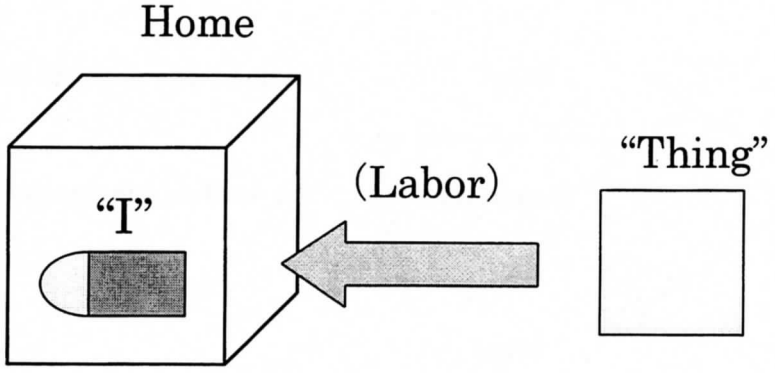

Fig. 4 I as a Body

E. Levinas was a French philosopher of Jewish extraction. He was born in Lithuania in 1906 and studied under E. Husserl and M. Heidegger, but he was opposed to Heidegger's thoughts concerning the theory of existence. Levinas insisted that the ethical relation with the Other is the basic problem of philosophy. He published numerous books, such as Totalite et Infini (Totality and Infinity) 1961 By the time he died in Paris in 1995, he was ranked as one of the twentieth century's outstanding philosophers.

2) Establishment of "I" (the Self) as the body

One can live with the gifts of nature such as air, light, water, the landscape, and so on, all of which can be labeled "elements" of nature. The body lives with and because of them and can be sustained by partaking of them as foods. Levinas characterized this as "enjoyment," meaning the acceptance of the gifts of nature.

After born as nude body in this world, I live by having, for example, the fruit from the tree. Thus, "I" as the body can live by breathing, drinking, eating, digesting, excreting and sleeping.

Although the body is sensible to the elements and can feel sunlight and the stream of wind, the elements are not perceived to be external to the body. Humans come to recognize the boundary between the body and the elements as a consequence of wearing clothing. However, inasmuch as clothing offers only limited protection from the uncertainties of the changes and instabilities of the world, the construction of a dwelling and other buildings is seen as necessary, which in turn increasingly separates the body from the surrounding and encompassing elements.

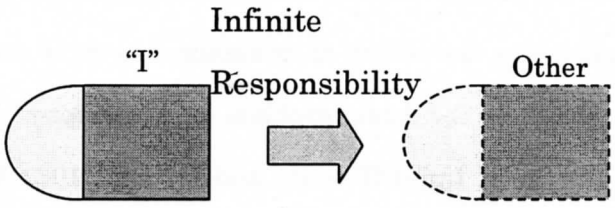

Fig. 5 Ethical Relation

5. Ethics and Justice

1) The Other and I

The identification of the Self necessitates awareness of and confrontation with the Other. At the simplest level, the body necessarily needs to obtain what it lacks, for which reason the body experiences hunger and thirst and humans aquire the desire to eat foods and drink water. At a primitive level, the desire can be satisfied by plucking fruit from a tree and consuming the fruit. By ingesting the fruit, the Self causes the fruit to become part of the body of the Self. However, not all desires are so readily satisfied. Humans develop desires not only for physical things but also for metaphysical things, which are not so readily obtained. Thus the "thirst" or "hunger" can be unceasing when that which is desired cannot possibly be converted to one's Self. The nearest approach to satisfaction, in such a situation, is the achievement of ownership of that which is desired. Ownership entails rights of disposability.

2) Establishment of society

Let consider how to establish the society. A third party is introduced here. A third party is also the Other for myself. Therefore, there is another relation between a third party and myself. The relation between a third party and myself is the same

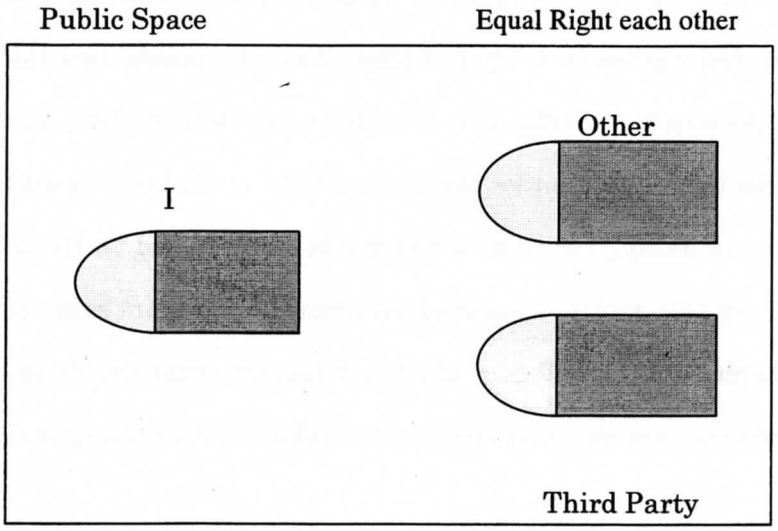

Fig. 6 Establishment of Society

relation between the Other and myself as that "I" should response to the continuous question from the Other. It is the ethical relation. Because each relation is not independent, the relation between the Other and a third party affects myself. If another hungry child as a third party would be introduced in addition to a hungry child, a new question how to distribute the bread among three peoples would be caused. I could give whole bread if there would only one hungry child. Because there are not independent relations, I should be responsible for both children. I should compare the incomparable things. The criterion is necessary to compare Therefore, not only the Other and a third party but also I have the same right and exit in the same space (See figure 6). I am a person who has the same right.

Here, homogeneous public space is created, and the foundation for discussion on the justice as a criterion to compare each other is established. This is the moment when the society is established. And "I" as a body am one of the members of it. It can be said that society is a set of bodies. Therefore, my body is social.

3) Intermediate summary

The continuity of my personality is needed for the establishment of modern thought of ownership represented by J. Locke. Washida points two things on the continuity of my personality. Firstly, it is a relation between my body and "I" in the space. It introduces the foundation for the disposability of my body. Secondly, it is the continuity of my personality over time. It has not been discussed on the second point. The continuity of my personality is satisfied over time. (I, now, am same myself before five minutes.) Therefore, Locke's theory of labor ownership that the thing that I have gotten by labor becomes my own property is established by continuing the same of my personality.

It reached to the place where the difference between the discussion of Levinas and conventional economics can be discussed. Contrary to the discussion of Levinas that insists infinite responsibility for the Other, economics stands at the foundation that the society is a set of persons who have equal right. The transformation from the "I" as the body to "I" as a person is hypothesized. If the ethical relation would be ignored, the discussion of Levinas and theory of conventional economics could not be identified in this context each other. It is the conclusion that the economics can discuss on justice, but cannot discuss on ethics.

6. Eating Meals as the Social Thing

Society is a set of bodies. Foods are necessary for my life. I take the thing outside of me and make it the same. I continue to live by excreting. Continuing the body by eating foods is the one of basic conditions for the establishing society.

Diet is not limited for supplying nutrition to the body. After stating that the body is social in its use, Washida adds following things. The relation between my body and myself depends on the Other. Interpretation of my expression, appearance and whole image of body becomes possible after looking at the eyes and the face of Other as

the mirror. Washida also states that imagination is necessary because enjoyment of foods is not clear from people's expression. There is reciprocity in diet.

As stated above, economics has the assumption of the transformation from the "I" as the body to "I" as a person and it has the idea that society is a set of persons who have the equal right. By the same logic before, it concludes that economics cannot discuss the ethics of diet.

7. Conclusion

In this paper, the following points are discudded by combining the Washida's theory of body with Saito's interpretation of Levinas' works. This is the first attempt of ourself to consider of the ethics of diet according to the work of Washida.

1) Society is a set of bodies and eating is a social event.
2) Although conventional economics can refer to justice of diet, it cannot refer to ethics of diet.

Let consider these results from another point of view.

(1) As it was explained in chapter 3, the world of microcosm was established in agricultural production in olden times. In the times when people worked on the earth with their own body and consumed products of their own production, it was appropriate to express that the cosmos is conceive of the cosmos as included in the body. There was a world where people could relax. As the division of labor expanded, the harmony of such world was destroyed. Moreover, the modern world has become a homogeneous space where there is no mythological narrative.

(2) Recently people live in the world where they can get anything that they want if they have money. However, this phenomenon has produced a new phase of society. Because people can get things easily, they have been lost reliability for the things.

The model of conventional economics that stresses competition rather than

cooperation would result in loss of the reciprocity under the high pressure market competition. "I" as a person becomes "I" as the body (People loses public consciousness). It is the problem that the reliability for the identity of things is lost because of the ease of satisfying the desire. The loss of the reliability for the identity of things would destroy the foundation of "I" as the body caused by the ownership of my own products.

Note

1) ' The face is the part of the body of other people which is readily (or most often) visible; it is also most expressive part of the body, and the notion of the face as expression plays an important part in Levinas's thinking ' (Davis 1996: 46)

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XVI　「いのち」の与えあいとしての食とその個別化

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1　はじめに

1）研究の背景と課題

食はそれなしに人間が生存できないという単純な事実であるのみならず、食文化という言葉があるように人間関係や文化、さらには社会の在り方に大きく関わる出来事でもある。しかし、近年親密な関係にある家族においても、食べることは個人的なことがらへと解消される傾向が強まり、食についての考え方そのものをとらえ直す必要に迫られている。例えば、現在の食事の情景を象徴する表現として、一人で食事をする「孤食」、家族が一緒に食卓を囲んでもそれぞれの食事のメニューが異なる「個食」がよく取り上げられる（本稿でこれらの現象を「食の個別化」と呼ぶ）。これらの現象は、「家族の団らん」といった近代家族のあり方の典型とみなされる表現を無効にするものである。

食の個別化と強く相関していると考えられることとして、身体について「自分のからだは自分のもの」という私的（自己）所有の意識がある。ここには、あたかも「もの」であるかのようにみなされることになった身体の現実がある。人間の身体や動植物の生体を「もの」ととらえる感覚では、本稿で課題とするわれわれが生きるために他の生き物を殺して食べているという「いのち」の与えあいとしての食という発想を持ちにくい。この課題に迫る一つの視点を探るために拙稿［2002］では、身体には社会性があり、生きるために食べるという出来事にも社会性があるということを議論した。

また、拙稿［2001］では、マルティン・ハイデガーの技術論に依拠して、人間にとっての効率的利用が目標である近代科学技術が農業生産に関わる人間を道具化し、かつ、人間を個別的に支配する構造(体制)になっていることを論じた。しかし、そこでは、人間が技術支配よって個々ばらばらになる契機の可能性を指摘できても、親密な関係にある家族構成員が食において個別化することを論証するまでに至らなかった。

そこで、本稿では、基本的にハイデガー技術論に依拠しつつ、現代社会の特徴である技術至上主義によって科学技術が生産現場だけでなく日常生活をも支配することが家族における食の個別化を招く一因である可能性について検討したい。

本稿の構成は次の通りである。以下で本稿の議論のポイントとなるいくつかの概念について説明し、２では、家事労働の技術革新という観点から食の外部化についてまとめる。３では、ハイデガー技術論に依拠して生活における技術の支配について論ずる。２、３の議論をふまえ、４では、家族における食の個別化を議論しうる新たな視

点を提示する。最後に、５で全体をまとめる。

なお、本稿は、食が原理的に「いのち」の与えあいであるという鷲田清一［1998］の考え方に触発され、それに上野千鶴子［1994］の近代家族論をつないで拡張をはかることを意図した。

２）分析上の概念

本節の議論に必要な概念について説明しておこう。

長谷部［2002］、長谷部［2001］では、近年研究が盛んな他者と私との（倫理的）関係を重視するエマニュエル・レヴィナス解釈に依拠して、社会は身体（である私）の集まりであることを明らかにした。これは、社会が(生物の一種として生きる)生命（である私）の集まりであることをも意味している（身体／生命の集合としての社会）。また、本稿では、身体や生命について「こと」と「もの」との両側面から考えたい。これは、身体や生命の持つ両義性へ着目する渡辺慧［1980］の発想を採用することを意味している。さらに、「こと」と「もの」を精神と物質と読み替えれば、本稿の身体／生命についての解釈は図１によって示される市野川容孝［2000］の理解に依拠しているということもできる。図１は、精神と物質の関係を縦軸にし、自己（私）と他者の関係を横軸にして、身体／生命を両軸の中間に位置づけている（この図は、レヴィナス解釈においても有効である）。なお、本稿では、次のような問題点を回避するため心とからだが接触しているという（界面型の）身体モデルを想定する。私的所有が議論される場合には、私と私の外にあるものとが区別されることが前提である。例えば、私が浜辺で見つけた貝殻をひろい私のものにする。ところが、私の身体についての私的所有には論理的な不整合がある。なぜなら、私の身体が私の外にあるとはいえないからである。

身体の持つ両義性へ着目するという視点から、本稿では、「こと」（図１の市野川［2000］であれば精神）としての生体と身体（私or他者）に対して、「もの」（同上、物質）としてのそれらをそれぞれ「ボディ」と「ボディ（私or他者）」と記すことにする。加えて、動植物の生体（＝ボディ）、人間の身体（私or他者）（＝ボディ（私or他者））に対応し、あたかも「もの」であるかのように現象している生命を本稿では《いのち》と表現する。

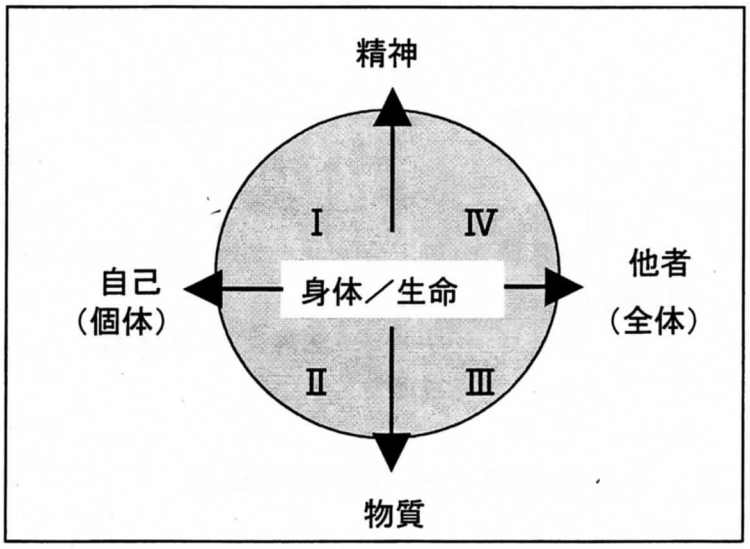

図1　身体／生命の位置づけ
1）市野川[2000]の図1より

さて、鷲田清一［1998］は、内田隆三の提起した「死体」と「屍体」との違いに着目した議論を展開しているが、これは本稿のような食の問題を考えるには有効な概念である。屍体は、「「だれ」という人称性を解除された純然たる物質的身体」（鷲田、1998：84）と定義されている。これに対して、死体は生体と屍体との象徴的中間項と位置づけられる。例えば、自分が慈しんで育て殺して食べたニワトリはきわめて身近な存在で、(やがてものとして屍体になるとしても)自分が首をしめて殺した時それは死体である。食肉工場見学で見る屠殺された豚は屍体である（畜産物の場合は、屍体を屠体と呼んでいる）。また、食材となる農産物の販売（商品化）は、市場を念頭におけば単なるものとしての屍体の販売であるといえる。（水産物には白魚やドジョウなどのように、生きているものを食べる場合もある。）

2　食の外部化

1）分業と外部化

食に関する分業は、大きく家計内分業と家計外分業とにわけることができる。家計内分業によって、家計内における調理と非調理の区別（「あなた作る人、わたし食べる人」）、家事部門と自営部門との分離等が生じてくる。

経済発展によって食料不足の状況から食料過剰の時代になると食における分業は急速に進展する。調理食品の購入の増大やファミリィ・レストランなど家庭外での食事

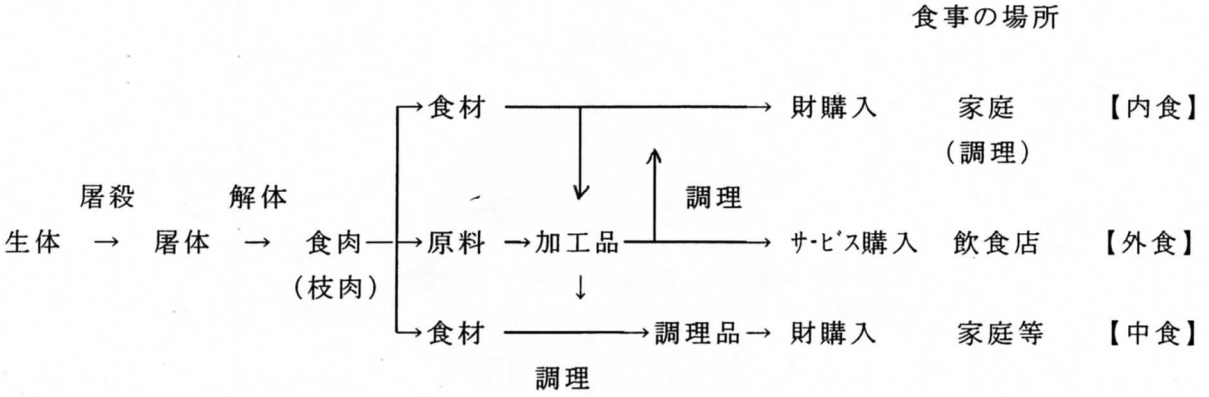

図２　畜産物消費にみる食の外部化

（外食）回数の増大にみられるように、調理過程の外部依存度が高くなる。また、近年では弁当等家庭に持ち帰って食べる食品の購入も増えている（中食）。これが、「食の外部化」といわれる現象である。図２は畜産物における食の外部化を概念的に示したものである。

第２次世界大戦後の日本における食の外部化の過程について、上野千鶴子［1994］の家事労働における技術革新に関する分析をもとに整理してみよう。

戦後の経済成長は、工業部門での労働力需要を増大させた。それに伴って、農村部から都市部へ労働力供給がおこなわれた（それは、一方での都市の発展であり、他方ではふるさとを捨てる若年労働力の流出による農村の衰退を引き起こした）。都市へ流出した人々は新たな家庭（マイホーム）を築いて定着した。そこにみられるのは、農村における大人数家族ではなく、「核家族」という言葉示されるような少人数家族（＝愛情共同体）の増大であった。さらに、単身世帯もふえ、家族の小規模化が進んだ。特に、1960年代に入ると都市人口が農村人口を上回る一方で、農村の過疎化という形でふるさとの崩壊が急速に進行した。

しかも、労働賃金が上昇してかつてのような（女中などの）家事使用人が存在するという状況ではなくなってきたため、家事労働の効率化が追求されるようになった。賃金上昇は調理等の家事労働の機会費用を上昇させ、家事における機械化を必然化させた。このような新たな需要の拡大により、電気釜や「三種の神器」（電気洗濯機、電気冷蔵庫、電気掃除機）の新製品が開発された。その結果、家事労働の余剰が生じ、主婦の労働力供給（兼業主婦化）の増大をもたらされた（これは農家の兼業化と類似している）。主婦労働の兼業化は、調理における機会費用を上昇させ、調理過程を外部依存する食の外部化を促す要因となった。

一方では、家事における機械化によって家庭に残った主婦はますます家事に専門特化するようになり、それが家事労働の専門化（熟練化）を促すという逆説的な状況が発生した（例えば洗濯回数の増加）。このため家事労働の専門化は、同時にその効率

化が一層求められるようになり、その結果、冷凍冷蔵庫、電子レンジ、電子ジャー等の「電子化」がもたらされた。電子化は調理活動の一部を簡便化させたため、家事労働が非熟練化するという効果をもたらした。このため単身世帯が容易に成立しやすい条件が整い、その増加を招いたのである。単身世帯に関しては、労働の機会費用の面からみても、規模の経済が働かないという理由からも、調理コストが高いため、その増大もまた食の外部化を促す要因であった。

2）広義・狭義の食の外部化

このように経済発展による需要増大と技術革新によって一般化した兼業主婦の増大、単身世帯の増大は、いずれも調理の機会費用を高め、食の外部化を促進させた。従来の「食の外部化」は、調理の外部委託の現象を示す概念であった。ここでは、最近のフード・システムの展開を食行動の視点を取り入れて分析した中嶋康博［1999］の「食行動外部化論」を参考に「食の外部化」を広義・狭義の二つに分類する。中嶋によると、家計を中心にみた食行動の外部化は次の四つに分けられるという。

（1）採餌活動の外部化：食材の多様化、広域的な調達、新規食材の探索、季節をこえた調達、安全性のチェック
（2）調理活動の外部化：可食化、高度加工、事前調理、味・香り・外見の強化、生鮮性の確保、献立決定の支援
（3）採取活動の外部化：咀嚼の補助、安全性の確保
（4）体内過程の外部化：消化・吸収の促進、栄養補給

中嶋は、採餌活動、調理活動、採取活動、体内過程におけるサービスの外部委託を食行動の外部化と捉えている。中嶋の議論の特徴は、食行動をいくつかのプロセスに分け、それぞれについて外部化を考慮している点である。食肉消費を例にとった場合、食に関する行動は図３のように示される。食行動を各プロセスに分けることにより、経済学的には「食のプロセス分析」を可能とし、「家計内生産」の内容を豊富にするというメリットがある。

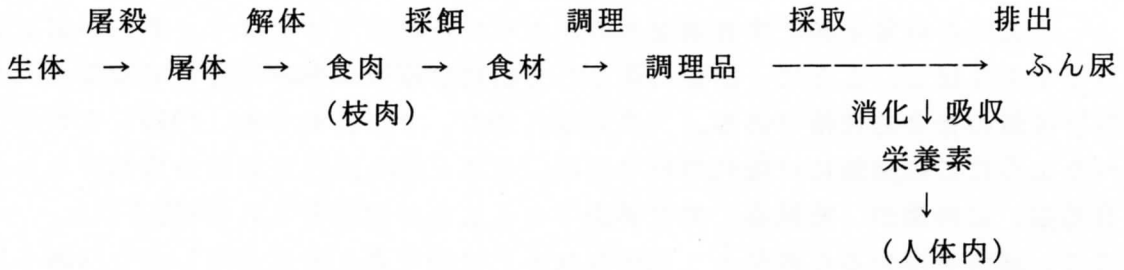

図３　食行動（畜産物）

本稿では、従来の意味での（２）調理活動の外部化を狭義の「食の外部化」と呼び、食行動サービスの外部委託全般を広義の「食の外部化」と定義したい。（１）採餌活動には半調理済みの食材を宅配するサービス等も含まれる。また、高齢化等にともなって（３）採取活動や（４）体内過程の外部化も重要性を増している。広義の「外部化」を視野に入れることにより、より幅広い近年の食についての議論が可能となる。

３　技術による生活の支配

１）科学技術のシステム化

２節と３節の結果をもとに、「食の個別化」について考察してみよう。図４では、(生活を念頭におき、)他者の成長の世話やその食事をつくることを想定している。私は、他者の顔を見て、その求めに応じて他者が健やかに育つように（骨身をけずり）世話をする(私は他者の顔をみたら応答せざるを得ない存在、他者に無限の責任を負う存在であり、他者の他者であること(他者性)によって私は私でありうる)。その甲斐あって他者は成長する。さらに、他者の問いかけに応じて、他者の食事をつくる。私は、他者が私のつくった食事を味わうことをみて、他者が味わうことを（自分も）味わい、そのことで（今の）私の生をも味わう。他者の享受を享受することが、私の（今の）生の享受ともなる。ここには、レヴィナスのいう「享受」が生の享受であるという性格が如実に出ている（注１）。まさに、生命の与えあいと表現することがふさわしい状況である。これを「レヴィナス的視点による生命の与えあい」と呼ぶことにしたい。図４には渡辺［1980］のいう（「こと」でもあり「もの」でもある）身体／生命の両義的性格がよく現れていることに注意したい。

続いて、ハイデガーの近代技術のとらえ方についてみてみよう。ハイデガーは、人間中心主義の近代において、技術が人間にとっての有用性（効率）という視点からのみ理解されるようになったと捉える（注２）。本稿では、秋富克哉［1999］に倣ってこのような近代技術の特徴を「技術のシステム化」と呼ぶことにしよう（ハイデガーはこれを「立て組み」と称している）（注３）。しかも、人間そのものをも巻き込んだシステムである。

このような背景のもとに、２０世紀は技術が世界のさまざまな問題を解決する主役とみなされる技術至上主義の時代となった。ハイデガーが論じようとしたのは、新技術によって人間の欲望を満たす有用なものが作りだされるだけでなく、それがまた新たな欲望を生み出し、さらに、欲望に促されて新たな技術が生み出されて来るという近代科学技術の社会的性格である。（長谷部［2001］では藤沢令夫［1993］を引用して述べたようにこの議論には現代の科学技術の起源となる近代における自然のとらえ方（自然観）の特徴が「機械論」的世界像であることが前提とされる(注４)）。

ここで、理解を深めるため私と１羽のニワトリの例で考えることにしよう（図５参照）。以下では、私がニワトリを世話することによってその成長（誕生）が可能とな

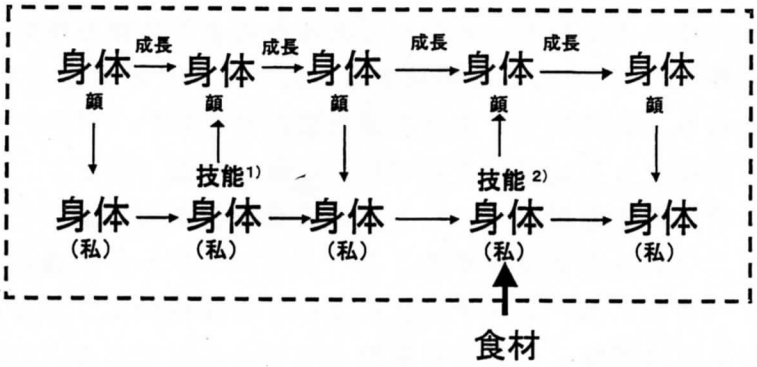

図4　他者の問いかけへの応答

1)私は他者の(顔による)問いに応答して世話をする
2)私は他者の(顔による)問いに応答して調理する
3)私は他者の享受を享受して私の(今の)生を生きる

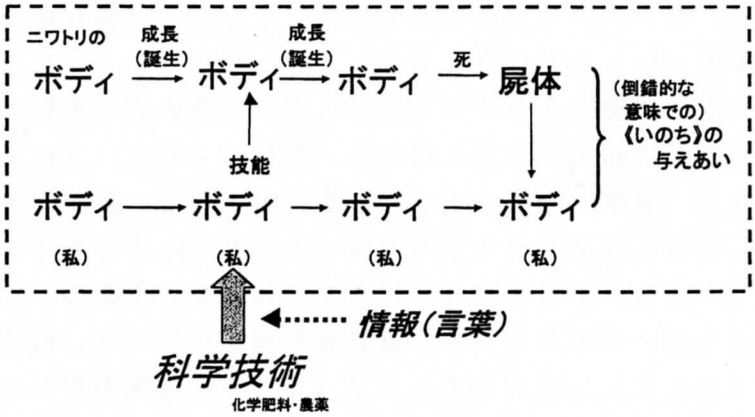

図5　科学技術による生産の支配

1)横の矢印は時間的推移を表す
2)私はニワトリの成長を世話する
3)ニワトリが何らかの理由で死ぬという想定
4)ニワトリの死を糧として私は生きる

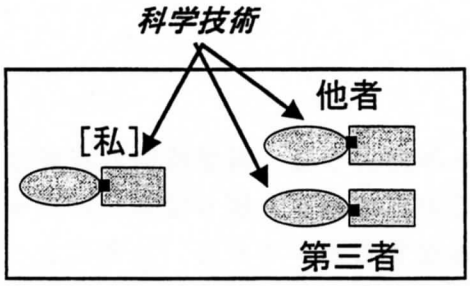

図6　立て組による人間の道具化

1)私と身体が分離するかのような状況の発生
2)「私の身体は私のもの」という意識が強まる

るという状況を想定しよう（注５）。近代の科学技術が依拠する「機械論」的世界像の下では、ニワトリも私もあたかも「もの」であるかのように取り扱われる(詳しくは長谷部［2001］を参照)。このことを明示するためニワトリの生体も私の身体も「ボディ」と表現される。試験研究によって新たに開発された（科学）技術は利用可能な形で言語による情報として定式化されて私に提供される（注５）。私は、それまでの経験を活かし、新技術を適用してニワトリの成長を引き出すように工夫する。かくして、私が眼前のニワトリの世話をすることにより、ニワトリの成長が促される。ここで確認しておくべきことは、システム化によって新技術がニワトリの成長をも引き出すように作用するだけでなく、私をも駆り立てている点である（ハイデガーの用語では「挑発」）。

さて、場面は変わって、ニワトリが成長の後なんらかの理由で死んで、かつ、私の目の前に屍体としてある。私はそれを食べものとして食べる。先に、ニワトリは私の世話によって成長（誕生）することができたが、今度は、私は死んだそのニワトリの屍体を食べることで生きることができる。ここに見られるのは、ものと化した身体である私＝ボディ（私）とニワトリの屍体とのやりとりである（長谷部［2001］ではこれを「倒錯した意味の《いのち》の与えあい」と呼んだ）。

図５に見られるのは、挑発によって「もの」と化した身体である私(＝ボディ(私))が言葉によって情報として定式化された技術を、同じく「もの」と化したニワトリの生体(＝ボディ)の成長（誕生）を引き出すことを目的として、経験をもとに磨き上げてきた技能を活かし現場に定着させる工夫を強いられている姿である。図６は、このような現象が社会全体を覆うようになった状況を示したものである。図では、私と他者と他者の他者である第三者の３名からなる社会を想定している。技術の挑発現象によって、身体は「もの」化し、楕円で表した私（こころ）と四角形として表した「もの」としての身体（＝ボディ）に分離するような状況が発生する（図では、私とボディがかろうじて一点でつながっているように表現した）。図１に即して言うなら、精神と物質の中間に位置する身体／生命が、精神と物質に分離することになる。この結果、「私のからだは私のもの」という身体の自己所有意識が顕在化する。ここでは、技術のシステム化（＝「立て組み」）によってハイデガーが「人間の道具化」と述ぶ現象が一般化している。

２）技術に支配される生活

２節の家事労働の例でもみたように、科学技術の成果は生産現場のみならず、日常生活にも浸透している。このため図５や図６で表した技術のシステム化は、日常生活をあまねく覆っているとみなすことができる。挑発によって「もの」と化した身体である私（＝ボディ（私））が言葉によって情報として定式化された技術を、同じく「もの」と化した他者の身体(＝ボディ)の成長を引き出すことを目的として、経験として培ってきた技能に新たなノウハウを付け加えて現場に活かす工夫を強いられてい

して培ってきた技能に新たなノウハウを付け加えて現場に活かす工夫を強いられている。このことを示したのが図７である。図は、生活技術に関する試験研究の成果が私のボディを通じて技能として成長の世話や調理の形で他者のボディに適用されることを想定して作成したものである。また、図では調理にあたって食材を外部に求めている(広義の外部化)。この結果、技術のシステム化現象は生産のみならず生活をも巻き込み、図６にみられる「人間の道具化」は日常生活でも一般化する。図７では、私も他者も「もの」化したボディ（私）やボディ（他者）であり、両者が対等平等な権利を持つもことが想定される。

４　食の個別化

２節と３節の結果をもとに、食の個別化について考察してみよう。この課題に接近する準備として、最初に、技術のシステム（＝「立て組み」）化によって生産及び生活が支配されると結論づけるハイデガーとは視点を変えて、むしろハイデガーに批判的なレヴィナスの視点に立って検討してみる。

近代の社会理論において、家族は社会の基本構成要素であり、両者は互いに同型である（注７）。また、近代社会は、平等で、自由な選択をおこなう独立した個人より構成されると想定されている。上野［1994］は、家族構成員が近代社会のように個々に独立した行動をおこなうことを家族の「個別化」と呼んでいる。本稿との関わりで問題なのは、食生活における技術のシステム化が家族の個別化に及ぼす効果である。

図８では、典型的な育児の例に見られるように私と他者の関係は、例えば母とその子どもといった親密な関係にあると想定しよう(厳密に考えれば、親子のような親密な関係で、他者としての顔による問いかけはないが、いずれ子供が成長して自立すれば他者化するので、そのような状態を示すことを意図して、子供の顔を［顔］であらわし、図４の他者の顔と区別して表した)。ところで、ハイデガーのいう技術のシステム化が一般化すると、意識の上では図８の関係であっても、図７の形態として現象する圧力が強まることが予想される。つまり、技術のシステム化は、私と他者の関係をレヴィナスのいう（他者に無限責任を負う）倫理的関係から対等平等な関係である図７で表されるような状態に変える。

試験研究開発の成果である技術革新によってレヴィナス的な倫理的関係にある私と他者の関係に育児や調理の新技術が浸透し、（理論的には）家族関係でも身体の「もの」化が進み、図６で示される技術のシステム化による生活の支配が一般化することになる。このように技術のシステム化は、身体の「もの」化を進めると同時に、図６で示したように技術が個々の構成員をとらえる。例えば、食の場合、上野［1994］が指摘するように冷凍冷蔵庫・電子レンジ・電子ジャーの普及は、ひとりで食事をとることやひとりひとりの食事の内容が異なることを可能とした。これが、本稿で 「食の個別化」と呼ぶ現象である。

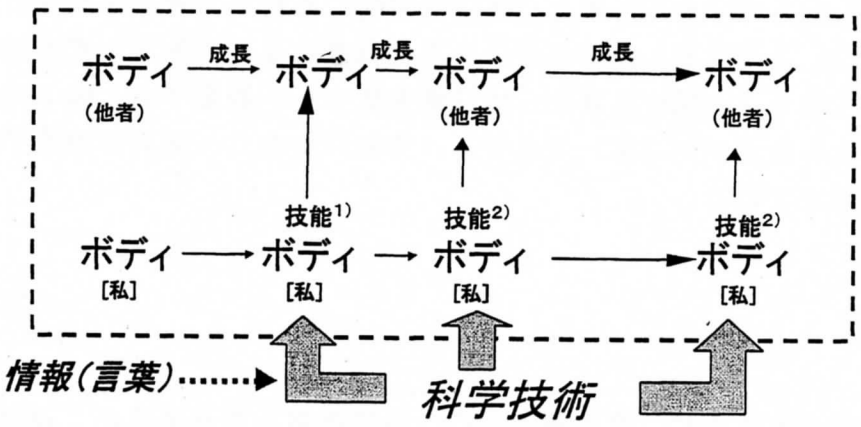

図7　科学技術による生活の支配

1）私は他者の成長を世話する
2）私は他者の食事を作る（調理）

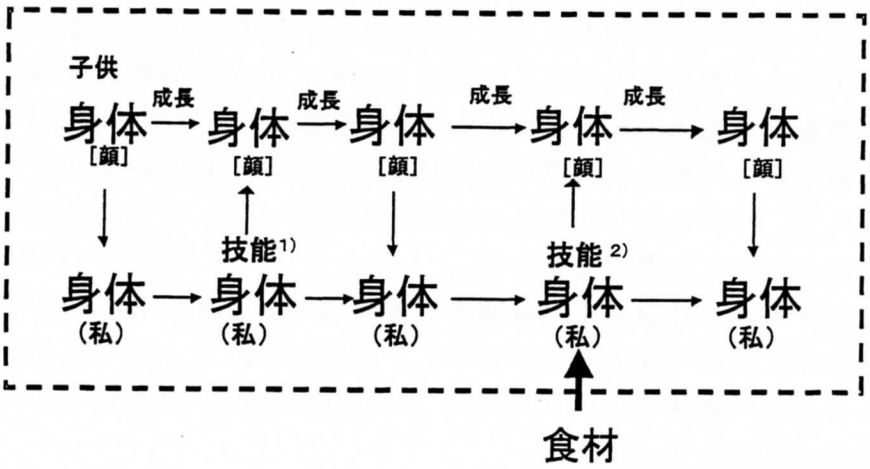

図8　他者化する子供の問いかけへの応答

1）私は他者化する子供の（顔による）問いに応答して世話をする
2）私は他者化する子供の（顔による）問いに応答して調理する
3）私は他者化する子供の享受を享受して私の（今の）生を生きる

また、既述のように経済発展にともなう分業の進展は、２節で述べた「食の外部化」にみられるような家族の基本的機能の外部化を進めることになる。しかも、近年は調理の外部化という狭義の「食の外部化」だけでなく、食行動サービスの外部委託全般を含む広義の「食の外部化」という状況が進行つつある。このような広範な家事サービスの商品化（外部化）の進展も、「食の個別化」を促進する要因であるといえる。そのことは、家族で一緒に出かけるファミリィ・レストランでの食事は、異なる時間帯で別々にとらざるをえない日常の食事に対するハレの行為として利用されている例などから指摘できる。

家族構成員の個別化で特記すべきは、（これも上野［1994］が指摘する）通信におけるコードレスフォン（の個室へ）の普及による家族内における通信の個別化である。加えて、近年の携帯電話の普及は、個々の家族構成員の外部との通信をより一層容易にしている。これらの家族を形作る装置の一つである通信機器に代表される物質基盤の変化は、家族の個別化をより一層徹底化させる。

5　まとめ

本稿では、現代社会の特徴である技術至上主義によって科学技術が生産現場だけでなく日常生活をも支配し、しかも、食や通信機器に関わる技術革新が家族構成員の食の個別化の推進力の一つとなったことを論じた。

食の外部化にともなって、食料消費の場と生産現場との空間的な距離が拡大するため、食が持っていた「いのち」の与えあい（＝生と死の交換）という意味合いは薄れざるをえない。この事態について、本稿をまとめるきっかけとなった鷲田清一の本では、次のように述べている。

> ひとは調理の過程で、じぶんが生きるために他のいのちを破壊せざるをえないということ、そのときその生き物は渾身の力をふりしぼって抗うということを、身をもって学んだ。そしてじぶんもまたそういう生き物の一つでしかないということも。そういう体験の場所がいまじわりじわり消えかけている。見えない場所に隠されつつある。このことがわたしたちの現実感覚にあたえる影響はけっして少なくないと思う。（鷲田［1998］66）

このことは、身体である私が生きていること（アクチュアリティ）の喪失につながってくる。同時に、食料のみならず、食べることもシンボル化、ファッション化していることが、食におけるアクチュアリティをますます不明確なものとしている。このような事態は、家族関係にまで及び、家族のアクチュアリティをも浸食している。

最後に、本稿のインプリケーションについて述べよう。（上野千鶴子［1994］が指摘するように）家族が社会の基本構成単位であるという考え方は、近代社会が要求するイデオロギー的発想に基づくものであり、「食の個別化」はそのことを露わにする現象であると思われる。また、食の個別化をも含む家族の「個別化」はあくまで近代

的な社会理論が前提とする「家族」といういわば擬似的な公共空間に依拠した現象であって、家族の解体を意味する家族構成員が家族内で個人として自立することを意味するわけではない。むしろ、通信技術の革新に代表される技術のシステム化の下で、「家族」という保険財（上野［1994］）は依然として必要とされているとみることができる。「食の個別化」の現象もまたこのような前提の下に成立している。

注

1）このような享受の解釈は港道［1997］による。
2）この点については竹田青嗣［1995］や中沢新一［1994］が指摘している。なお、技術哲学におけるハイデガー技術論の位置づけについては村田純一［2001］を参照のこと。
3）本稿では、室井尚［2000］がハイデガーの用語である「立て組み」にシステムをあてているのを参考に、人間にとっての有用性という観点から捉えられる近代技術の特徴を「技術のシステム化」と呼ぶことにした。
4）長谷部［2001］で引用している藤沢令夫(1993：176)を参照のこと。
5）「世話をする」という言葉は、守田志郎［1976］による。
6）言葉（情報）による技術支配については秋富克哉［1999］に依拠している。
7）上野［1994］を参照のこと。

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追記

本稿は、長谷部［2002］、長谷部［2001］をそれぞれ第１部、第２部とする同一研究テーマの第３部に相当するものである（ただし、それぞれ独立して発表する企画のもとに作成されたため、互いに重複する部分がある。

XVII　水と食文化　－日欧の比較－

石田正昭（三重大学）

1. はじめに

本章の第一の目的は，消費生活における水の重要性に着目し，家計レベルの水需要関数の計測などを通して，1980年以降の水利用の変化を明らかにすることである。第二の目的は，わが国の食文化を根底から支えている資源を水とみなし，その水質（硬度，安全性）と賦存量の違いが日欧間（主としてドイツとの比較）の食生活にどのような違いをもたらしているかを定性的・定量的に明らかにすることである。

言うまでもなく，水は生活上必須の消費財であるが，これに対する人々の利用態度は永い歴史の中で形成されたものである。わが国では歴史的に水は安全でタダであるとの認識が広がっているが，西欧ではそのような常識は通用しない。この認識の違いは利用面における大きな違いをもたらしていると考えられる。また，水の硬度の違いによって生鮮品の利用や料理のおいしさも異なるために，わが国と西欧とでは食生活のあり方が大きく異なっていると考えられる。われわれはこの 2 点に着目して，水と食文化の関係を解明したいと思う。

以上のような研究ビジョンにもとづいて，本章では 2 つの計測を行った。一つはベルヌーイ・ラプラス型（ギアリー型）効用関数を用いて，水そのもの（水道水）の需要関数の計測を行い，1980年以降の水需要の変化を価格，所得，家計規模，習慣形成の要因によって説明しようとする。もう一つは，食料消費（正確には料理選択）における水の役割を発見しようとするもので，この分析は製造（工場レベル）・調理（家計レベル）面における水利用の違いに着目して食品群をグループ化し，それらグループ財の1980年以降の購入量・価格変化を統計的に解析するものである。

残念ながら，今回は資料上の制約から，定量的というよりは定性的な分析が中心をなし，また水と日本料理（煮る食文化）との関連に議論を絞らざるを得なかった。本格的な解明，とりわけ西洋料理（焼く食文化）や中華料理（揚げる文化）との関連については今後の課題としたい。

2. 世界の水資源

水は，純粋なものは無色，無味，無臭で，常温では液体である。天然には海水，湖沼水，河川水，地下水，氷雪および大気中の水蒸気などとして存在し，地球の表面近くにもっとも豊富に存在している。地球上の水は海水と陸水に分けられ，他に少量の水が大気中に存在する。海水は地球表面の 70.8%を覆い，地球上の水資源の 97.5%を占めている。陸水のうちで，湖沼水や河川水などの地表水は陸地面積の 3%を覆うにすぎない。しかし，地表水

の量は水の総量に比べると少ないが，循環が速く，水資源として最も重要な物質である。地下水は氷河についで量が多く，その分布範囲は陸地のほぼ全域に及ぶものの，総量の正確な推定はきわめてむずかしい。

大気中の水蒸気をすべて凝結させた場合の水の量を可降水量という。全地球の平均可降水量は 25 mm にすぎない。また，可降水量の地理的分布は緯度すなわち気温と，水陸配置によって決定され，湿潤な熱帯気団に覆われる地域では 40mm を超えるが，乾燥した寒冷気団中では 2 mm 以下にすぎない。

水は地球上でさまざまな存在形態をとるが，それらは独立して存在するのではなく，地球上の水循環の一部として，相互に関連して存在している。地球上の水の大部分を占める海からは，太陽エネルギーによって絶えず蒸発が行われる。低緯度地帯では太陽エネルギーが多く，海洋の面積も広いので，海面から蒸発する水の総量の 80%弱は緯度 40 度よりも低緯度の海域から蒸発する。蒸発した水蒸気は凝結して雲となり，さらに雨や雪となって，その 90%近くは直接海上へ落下する。残りの水蒸気は風によって陸地に運ばれて地上に落下する。

地域と時間を決めて水の出入りを計算することを水収支という。ヨーロッパ，アジア，全陸地の水収支を比較すると，表 1 のとおりである。

表 1　　地球上の水収支

（単位；mm/年）

	アジア	ヨーロッパ	全陸地
降水量	726	734	834
流水量	293	319	294
直接流出量	217	210	204
地下水流出量	76	109	90
蒸発散量	433	415	540
全湿潤量	509	524	630

3. 日本の水資源

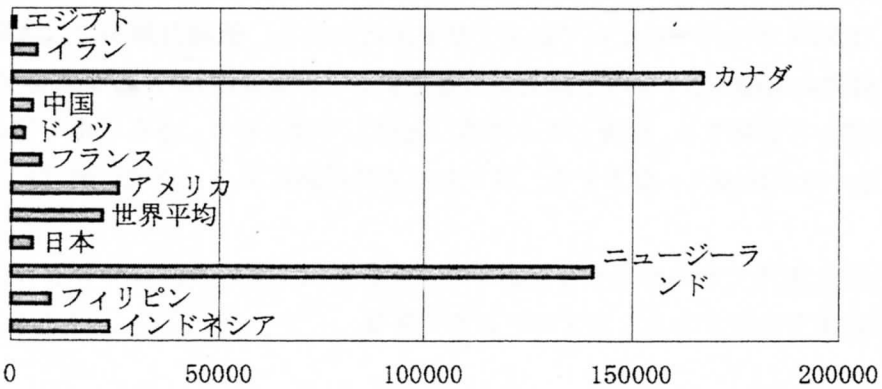
水を資源として評価する場合，量とともに質も重要である。上水道用水としては，病原菌や毒物を含まないこと，異常な酸性やアルカリ性を呈しないこと，無色透明で臭みがなく，不快感や不安感を与えないことなどが要求される。

日本の各地の年降水量は約 1800 mm で，全陸地の平均の 2 倍以上もあり，蒸発による損失も年間に 600～700 mm と乾燥地域や熱帯地域に比べて少ないため，水資源には恵まれている。しかし，図 1 に示すように，人口 1 人当たりの年平均降水量は約 5,200m^3 で，世界平均である 23,000 m^3 の約 5 分の 1 しかなく，諸外国に比べて必ずしも豊富ではない。加

えて，日本は狭い列島に山岳が発達しているために地形が急で，短時間で河川の水が海に流出してしまうという特徴がある。

また，わが国の降水量は地域および季節によっても大きな差がある。地域的にみると瀬戸内海沿岸部，関東（内陸），東北（太平洋側）および北海道の諸地域の降水量が少なく，季節的にみると，太平洋側の地域にあっては夏季多雨・冬季乾燥型であり，日本海側の地域にあっては冬季多降水量型となっている。

図1　人口一人当たり年降水総量



単位：立方m／年・人
平成１３年版　日本の水資源．より作成

4. 日本の水利用

水は私たち人間を含む地球上の生命の維持のみならず，社会経済の発展に不可欠な資源をなす。経済活動と水資源の関わりについても生活水準の向上と生活様式の変化，経済産業活動の変化の中で大きく変わってきた。

日常生活における水利用についてみれば，かつては井戸水や川の水などを直接利用していたが，明治20年代に始まり大正期に本格化した上水道の整備により，徐々に「蛇口」を通しての利用に変化していった。水道の普及は昭和30年代から40年代にかけて急速に進み，昭和53（1978）年度には普及率が90%を超えた。平成10（1998）年度になると，全国の総人口約1億2600万人に対して，水道の給水人口は約1億2200万人に達し，普及率はさらに伸びて96.3%となった。

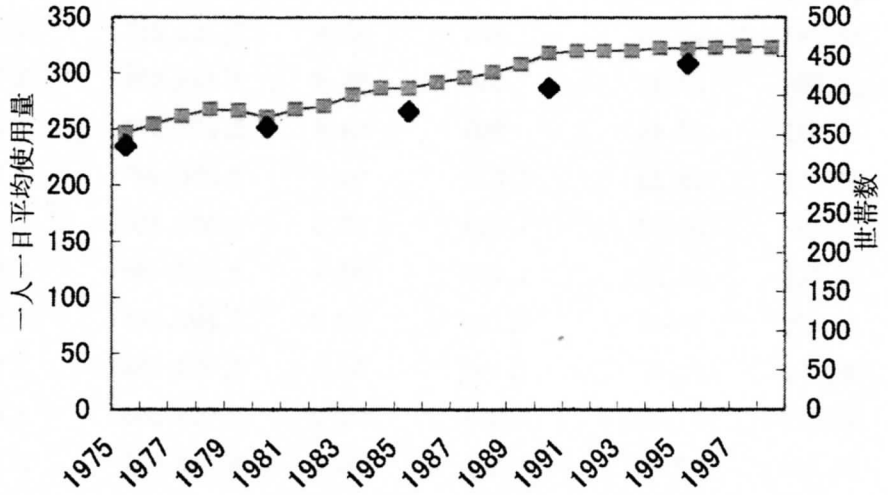
普及率の向上に伴い，昭和30年代以降「浴室の設置」「台所からダイニングキッチンへの変化」「水洗トイレの普及」などが急速に進み，さらに浴室にはシャワーが設置され始めた。昭和40年代前半から平成10（1998）年にかけて，浴室保有率は約70%からほぼ100%に，またトイレの水洗化率も約10%から80%以上に高まるなど，家庭生活における水使用量は増えつづけ，都市生活用水を含む生活用水使用量も着実に増大した。加えて，図2に示すように，核家族化の進行により世帯数が増加したことも一人当たり水使用量を増大さ

せた大きな要因である。

日常の家庭生活の中で，成人が一日に摂取する水の量は，飲料水として最低1リットル，食物とともに1.5リットル，合計2.5リットル程度と言われている。この他にも炊事，洗面，入浴，洗濯等にも水は必要である。

生活用水使用量の変動については，種々の要因が考えられるが，水道の給水人口の増加，核家族化による世帯数の増加，生活水準の向上，都市化の進展などは，使用量の増加要因として働き，節水意識の高揚，水利用の合理化などは減少要因として働いている。水需要の中長期的な動向は，このような要因が複合されて定まると考えられる。

図2 世帯数と一人一日あたり水使用量の変化



一人一日平均使用量は、国土交通省水資源部による。
世帯数は、総務庁統計局「日本統計年鑑」による。

—■— 生活用水の一人一日平均使用量（l／人・日）
—◆— 世帯数（全国）（１０万世帯）

5. 水需要関数の計測

以上のわが国における水利用の実態を踏まえて，ここでは家計レベルの水需要に着目し，ベルヌーイ・ラプラス型（ギアリー型）の効用関数を用いて水（水道水）の需要関数の計測を行うこととする。

まず，表2に示すように，分析のための下準備として，「水道統計」を利用して上水道の水価格（10 ㎥当たり）の事業体平均を求め，『家計調査年報』の支出金額（水道料金）をその価格で除すことによって水使用量を算出した。これは『家計調査年報』では支出金額である水道料金しかデータが得られないためである。

以上の方法によって算出された時系列データを見ると，水使用量，水価格ともにほぼ同じような傾きで増加していることが分かる。また，水使用量の決定要因となる 1 世帯当たり年間消費支出は 90 年頃までは上昇していたが，それ以降は減少傾向を示し，世帯人員は分析期間全体にわたって低下していることが分かる。

表 2　水需要関数計測の基礎データ

年	水道料金 (円)	水使用量 (10 ㎥)	水価格 (円／10 ㎥)	消費者物価指数 (90 年=100)	1 世帯当たり年間消費支出 (円)	世帯人員 (人)	前年までの水利用量 (10 ㎥)
1980	19,241	24.05	800	81.7	3,038,024	3.82	0.00
1981	21,794	24.79	879	85.6	3,114,247	3.79	24.05
1982	25,568	27.32	936	88.0	3,195,829	3.78	48.85
1983	27,092	27.48	986	89.6	3,277,373	3.76	76.16
1984	30,353	29.30	1,036	91.7	3,316,493	3.72	103.64
1985	33,397	30.67	1,089	93.5	3,371,326	3.71	132.94
1986	34,548	31.21	1,107	94.1	3,493,468	3.69	163.60
1987	35,472	31.42	1,129	94.2	3,592,205	3.67	194.81
1988	36,292	31.56	1,150	94.9	3,734,084	3.63	226.23
1989	38,274	31.82	1,203	97.0	3,925,358	3.61	257.79
1990	40,203	32.93	1,221	100.0	4,003,931	3.56	289.61
1991	41,593	33.84	1,229	103.3	4,022,955	3.57	322.53
1992	43,041	34.54	1,246	105.0	4,006,086	3.53	356.37
1993	45,373	35.61	1,274	106.4	3,948,741	3.49	390.92
1994	47,199	36.62	1,289	107.1	3,946,187	3.47	426.53
1995	48,342	36.87	1,311	107.0	3,999,759	3.42	463.15
1996	49,826	37.18	1,340	107.1	3,938,235	3.34	500.02
1997	53,116	38.13	1,393	109.1	3,876,091	3.34	537.21
1998	55,602	39.32	1,414	109.7	3,805,600	3.31	575.34

水道料金，消費者物価指数，年間消費支出，世帯人員は「家計調査年報」による。
水の価格は，厚生労働省「水道統計」による。
水の使用量は，水道料金を水の価格で除して求めた。

ベルヌーイ・ラプラス型効用関数は，家計の消費全体を，水の消費（P_1, Q_1）と，その他の消費（P_2, Q_2）に分割するもので，その需要関数は以下のような構造方程式を解くことに

よって求めることができる。

(ベルヌーイ・ラプラス型効用関数)

$U=b_1\log(a_1+Q_1)+b_2\log(a_2+Q_2)$

(収支均等式)

$Y=P_1Q_1+P_2Q_2\cdots①$

U:効用関数

Q_1:水の1世帯当たり年間消費量

Q_2:その他の財の年間消費量

P_1:水の価格

P_2:その他の財の価格

Y:1世帯当たり年間消費支出

a_1 a_2 b_1 b_2:構造パラメーター

構造方程式を解いた誘導形方程式が需要関数となるが，それは

$$Q_1=\pi_{10}+\pi_{11}(Y/P_1)+\pi_{12}(P_2/P_1)$$

という形になり，これをOLSで推定すれば求めるパラメーターが出てくる。

しかし，この需要関数の推定に当たっては，水使用量と水価格は一貫して上昇しているが，家計消費支出は前半上昇し，後半低下しているというデータ上の問題がある。そこで，新たな説明変数として世帯人員Mと，習慣形成効果の代理変数としての累積水利用量Hを追加し，また分析期間を家計消費支出が上昇する1980年～1989年と，低下する1990年～1998年の前後期に区分して計測を行うこととした。その結果，OLS推定式は

$$Q_1=\pi_{10}+\pi_{11}(Y/P_1)+\pi_{12}(P_2/P_1)+\pi_{13}M+\pi_{14}H$$

となる。

推計された需要関数は次のとおりである。ただしカッコ内はt値である。

〔全期間:1980年～1998年〕

$Q_1=-38.67414-0.003208(Y/P_1)-87.86362(P_2/P_1)+21.9608M+0.03708H$

(1.2274) (2.7375) (1.9156) (2.7037) (5.0195)

R^2=0.9860 DW=1.9386

$U=-0.0032081\log(38.5505+Q_1+M+H)+1.0032081\log(27388+Q_2)$

〔前期:1980年～1989年〕

$Q_1=-82.46266-0.01432(Y/P_1)+628.9652(P_2/P_1)+25.2390M+0.074586H$

(0.9149 (2.3929) (1.3814) (1.1265) (2.3685)

R^2=0.9759 DW=3.4418

$U=-0.014321\log(81.29846+Q_1+M+H)+1.014321\log(-43922+Q_2)$

〔後期:1980 年～1989 年〕

Q_1=7.64483-0.002828(Y/P_1)+145.9711(P_2/P_1)+6.3102M+0.02448H

(0.3672) (1.0312) (1.2781) (1.0192) (2.9330)

R^2=0.9871 DW=1.6227

U=-0.0028281og(-7.6233+Q_1+M+H)+1.0028281og(-51615+Q_2)

まず，全期間の計測式については水価格の符号条件，したがって水の限界効用の正値条件を満たしていないことから，需要関数としては適切でないことが指摘できる。次に，前後期に分割した需要関数は，ともにこうした理論的要請を満たしていることから，ほぼ期待どおりの結果であることが分かる。しかし，前期についてはDWが高く負の系列相関が発生しており，なお検討の余地が残されている。

以上の限定条件のもとで計測結果を経済学的に解釈すると，①所得弾力性は前後期ともに負であり，水は劣等財的性質を持っている，②価格弾力性も全後期ともに負であるが，その推定パラメーターは 0 と有意差がないことから，価格に反応しない，すなわち非弾力的な性質を持っていることが指摘できる。このうち②については首肯できるものの，①については，水需要の多くが風呂，トイレ，洗濯に使われると想定されるので，経済学的に解釈しずらい結果となっている。

それ以上に経済学的に意味のある結果が得られているのは，世帯人員と累積水利用量の推定パラメーターについてである。この値は，前者にあっては世帯人員の限界消費量，後者にあっては習慣形成の限界消費量を表すが，前期と比較して後期のそれらは 1/4～1/3 程度低下しており，家計レベルで節水意識が高揚していることを示唆している。これは，近年の省資源型消費生活への移行を反映した結果と考えられる。

6. 硬度と食文化の関係

水はきわめてものをよく溶かす性質を持ち，天然に存在する水も多くの物質を溶かしている。雨は，空気中に浮遊する塵埃をはじめ，酸化窒素や二酸化炭素などを溶かしており，河川の水は，流れている間にカルシウムイオン，マグネシウムイオンをはじめ，各種の無機塩類および有機物を溶かしている。これらの水が自然に土壌，砂層などを通過している間に不純物が除かれるが，清浄にされた泉や井戸の水でもある程度のカルシウムイオン，マグネシウムイオンなどが溶けているのが普通である。カルシウムイオンやマグネシウムイオンが多量に溶解しているときを硬水といい，少ないときを軟水という。

水中に溶けているカルシウムイオンとマグネシウムイオンの合計量を硬度という。通常，これを炭酸カルシウムの量に換算して，mg／リットル（または ppm）という形で表している（算出方法はカルシウムイオンを 2.5 倍し，マグネシウムイオンを 4 倍したものを合計する）。硬水か軟水かを決める硬度の基準は様々にあるが，WHO の水質基準では，硬度 0～

60ppm 未満を軟水，硬度 60～120ppm 未満を中程度の硬水，硬度 120～180ppm を硬水，硬度硬度 180ppm 以上を非常な硬水と定めている。

日本の水道水の硬度は，多くの場合 10～60ppm の軟水である。一方，ドイツはじめヨーロッパ諸国は，その多くが 200～400ppm という硬水である。硬度のもともとの謂れは，「石けんの泡立ち」を基準としたものであり，硬度の高い水ほど泡立ちが悪い。したがって，日本の石けんをヨーロッパに持ち込むと使えなくなるといった現象が生じる。

ドイツの飲料水は，30%が河や湖などの地表水から，70%が地下水（湧き水を含む）から作られている。言うまでもなく，その水は硬水（例えば，カールスルーエの水道水はカルシウムイオンが平均値で 111ppm 含まれていると公表されており，これだけでも硬度は 278ppm となる）で，これを沸かすと，お湯の表面にうっすらとカルシウムの白い膜ができる。湯沸し器，皿洗い機，洗濯機などもすぐに真っ白になる。このため，「カルシウム落し」の器具や錠剤・液体が家庭の必需品となっている。

また，硬度と飲食の関係では，硬水で豆や野菜を煮ると硬くなる，硬水はコーヒーにはあうが緑茶にはあわない，硬水は肉の灰汁（アク）を除去するので肉の臭み除去する，したがってポトフを硬水で作るとおいしいが湯豆腐はまずい，硬水で炊いたごはんはまずい，などと言われている。このように硬度は調理方法や水利用に大きな影響を及ぼしており，食文化との関連が指摘できるのである。

一般に，硬度 100ppm 未満の水は炊飯や和風だしをとるなど日本料理全般，そして緑茶に適しており，硬度 100～300 程度の水は洋風だしや，煮物，鍋物に向いており，硬度 300 以上の水はスポーツ後のミネラル補給や妊娠婦のカルシウム補給，そして便秘解消やダイエットに役立つとされている。

水（硬度）と食文化の関係は，例えばドイツ人の食生活をみても一目瞭然である。われわれ日本人から見ると，彼らの食生活は想像以上に質素であり，朝食はトーストにバターかジャム，ゆで卵かヨーグルト，そしてコーヒーまたは紅茶がつき，夜食はパンにチーズ，ハム，サラミ，それにビールかガス入りのミネラルウォーターがつくが，カルテ・エッセン（冷たい食事）と呼ばれるこの食事パターンが一年中繰り返される。一日の食事の中で中心をなすのは昼食であるが，そこではサラダ，スープ，そしてメインディッシュの肉料理がふるまわれる。彼らはこれをウォルメ・エッセン（暖かい食事）と呼んでいるが，この食事パターンをみても分かるように，水道水はほとんど使われないか，使われたとしても硬水に適した料理が作られていると言ってよいだろう。

われわれ日本人にとって，どんな水がおいしいかという要件は，小島貞男『水道水　安心しておいしく飲む最新常識』（宙出版）によれば，次のような水であるという。

蒸発残留物	30～200	ミリリットル／リットル
硬度	10～100	〃
遊離炭酸	3～ 3	〃
過マンガン酸カリウム消費量	3	ミリグラム／リットル以下

臭気度	3以下（普通の人は感じない程度）
残留塩素	0.4ミリグラム／リットル以下
水温	20度以下

以上から分かるように，われわれ日本人がおいしいと感じる水は，硬度 100 以下の軟水である。ドイツ人がどんな水をおいしいと感じているかは分からないが，以下で述べるように，彼らが日常的に飲む水は硬度の高いミネラルウォーターである。こうした日本人とドイツ人の味覚の差は，生まれながらに DNA レベルで継承されているのではなく，日常の食生活の中で作られる習慣形成によるものと考えられる。

7. 食生活におけるミネラルウォーターの地位

ヨーロッパではミネラルウォーターに対して殺菌処理をすることが禁じられている。殺菌をするということは，善玉の細菌もなくなり，必ずしも人間にとって有益ではないという医学的見解による。しかし，そうではあっても細菌数が基準以内にあることなど，厳しい条件が設けられており，このため水源地の周辺では建造物，ゴルフ場，産業廃棄物処理場などの環境規制がある。これに対して，わが国では採水場に関する規定がないので，市街地の地下水でも採水，製品化が可能となっている。

こうしたことを背景として，日本のミネラルウォーターと外国（とくにヨーロッパ）のミネラルウォーターとでは，かなり中味が違う。ヨーロッパでは，厳重に管理された，無菌の水を，殺菌せずに容器に入れているものを言う。また硬度も高い。これに対して，日本のものは，硬度の低い水を加熱殺菌して提供されることが多く，本当の意味でミネラルウォーターとは言いがたいものが多い。

市販されているミネラルウォーターの硬度を調べると，わが国のものは「こんこん湧水」26，「南アルプス天然水」30，「六甲のおいしい水」84，「高千穂の水」150 というように，硬度の低い水が提供されている。その商品コンセプトは「ミネラル豊富な」というよりも，上述の基準からみて「おいしさ」に置かれていると言ってよいだろう。これに対して，輸入品は「ペリエ」365，「ビッテル」307，「エビアン」298，「バルベール」177 というように，硬度の高い水が提供されている。これらは「おいしさ」というよりも，「ミネラル豊富な」に基本コンセプトが置かれているように思われる。

日本では，レストランで提供される水やお茶は通常料理代に含まれていて，いくら飲んでもタダである。これに対して，ヨーロッパでは，水といえどもビールやジュース類と同様に有料である。筆者の体験では，イギリス地方都市のインド料理店でタダの水を飲んだ経験があるだけである。おそらくレストラン側は，水といえども価値（ミネラル）を売るという姿勢に徹しており，また客側も価値を買うという姿勢に徹しているように思われる。ここに商品としての水の存在理由がある。

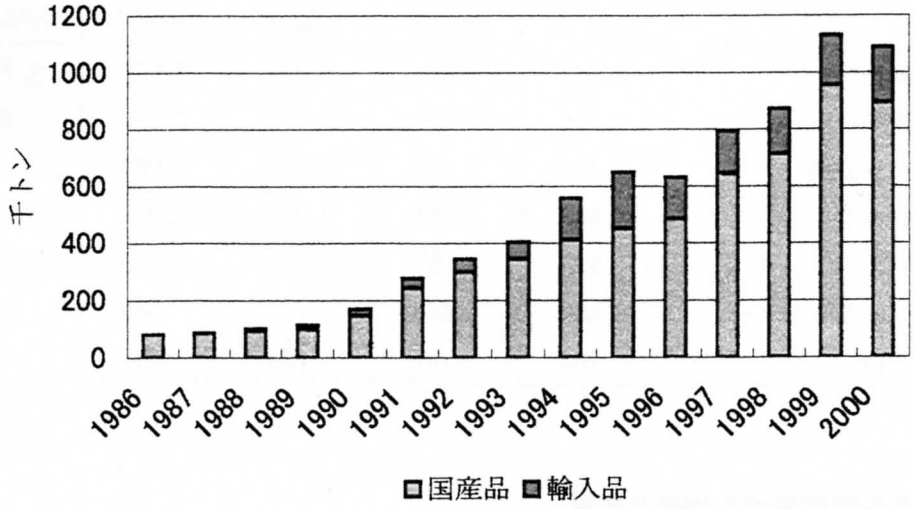
しかし，ヨーロッパの歴史を考えるとき，事態はそれほど簡単ではない。ヨーロッパの

水の多くが地下水から作られており，かつては汚染された地下水を飲むことによって伝染病が蔓延し，多数の死者を出したという記録が数多く残されている。ヨーロッパ人は日本人と違って，疑い深い人々であるから，タダの水ではどんな水を飲まされるか分からないという猜疑心があり，このため客側から有料の水を要求し，またレストラン側もその要求に応じるという構図を描くことができる。つまり，レストランで提供される水（ミネラルウォーター）は，ミネラルばかりでなく，安全を売っていることになる。

おそらく，日本人には「水は危険」という認識はまずない。もしあれば，魚や生ものは，ほとんど口に入れることができないからである。和食文化は，「水循環の早い地表水から作られる水は安全である（安全であった）」という歴史的認識を基礎とし，それをうまく活用した料理，飲み物の体系から出来あがっている。その典型が刺身（お造り）であり，寿司であり，汁もの（おすまし）である。

わが国では，歴史的にみて，いつでも，どこでも，安全な水がある，という保障が確立している（正確には確立していた）。この保障を基礎として安全な水はタダで入手できるから，わざわざお金を払ってそれを買う必要はない。もし買うとすれば，水のもう一つの機能である「おいしさ」を求めていることになる。われわれが有料のミネラルウォーターに求めているのはこの機能である。

図3　ミネラルウォーターの消費量



日本のミネラルウォーターの歴史は浅い。1970 年代前半に業務用市場で出回りはじめたのが最初で，そして 1980 年代後半に入って家庭用市場に浸透しはじめた。これは，自然・健康ブームに加えて，海外旅行の増加によってミネラルウォーターに接する機会が増えたこと，水道水の質が低下したことによるものとされている。しかし，家庭用市場が本格的に拡大したのは 1990 年代に入ってからで，マンションの貯水タンクの汚れや水道水の問題

が，マスコミで大きく取り上げられるようになったことが影響している。

2000年のミネラルウォーターの輸入量は195千トンで，98年の159千トン，99年の175千トンと比べて順調に推移している。また，2000年の輸入金額は118百万ドルで，これも98年の80百万ドル，99年の97百万ドルと比べて順調に増加している。輸入金額を輸入量で除した輸入価格は，2000年602.6ドル/トンで，約1リットル0.6ドルとなる。国別の輸入量では，フランスが全体の80.8%を占め，ついでアメリカ13.1%，カナダ2.4%となっている。フランス産は日本に輸入された歴史も古く，日本人になじみの深いブランドが揃っているという強みがある。

しかしながら，わが国の飲料全体に占めるミネラルウォーターの地位は必ずしも高くない。表3に示すように，(社) 全国清涼飲料工業会の調べによると，2000年のわが国飲料生産量は全体で14,661千トンにのぼり，そのうちミネラルウォーターは894千トン，比率にして6.1%を占めるにすぎない。このうちで最大の生産シェアを持つのが茶系飲料であるが，この生産量が近年急速に拡大している。消費者は茶系飲料に本ものの「お茶の味」を求めているのではなく，水代わりに飲んでいるのが実態であり，その需要の本質は水と何ら変わるものではない。その意味から，飲用としての水道水は，茶系飲料とミネラルウォーター，とりわけに茶系飲料に代替されつつあると言うことができる。

表3　日本のミネラルウォーター・清涼飲料の国内生産量

(単位;千トン)

	1996年	1997年	1998年	1999年	2000年
茶系飲料	3,449	3,876	3,990	4,057	4,380
炭酸飲料	2,925	3,006	2,853	2,892	2,804
コーヒー飲料	2,483	2,568	2,562	2,600	2,610
果実飲料等	1,892	1,814	2,056	2,214	2,255
スポーツドリンク	993	1,068	1,065	1,156	1,378
ミネラルウォーター	486	646	715	956	894
野菜飲料	204	187	254	310	340

8. 水と食生活における相違と変容

ドイツの食生活が，朝夕の「冷たい食事」を典型として，家庭調理の局面で水に依存しない料理によって構成されていることはすでに述べた。これに対して，日本の伝統的な食生活は，ご飯，味噌汁，野菜の煮物，刺身などを典型として，家庭調理の局面で水（水道水）に大きく依存した料理によって構成されている。しかし，ご飯を炊く，味噌汁を作る，野菜を煮る，お茶を入れて飲む，といった伝統的な食生活パターンから，食パンをトーストする，菓子パンをそのまま食べる，ジュースや牛乳を飲む，ペットボトルの茶系飲料や

ミネラルウォーターを飲むといった，水（水道水）に依存しない西洋的な食生活パターンへと変容していることもまた事実である。ここでは，この日欧間にみられる食文化の相違とわが国食文化の変容とをリアルに描くために，食料品を，家計調理段階と流通加工段階での水利用の相違に着目してグループ化し，それらグループ財の 1980 年以降の消費量変化を統計的に確認したいと思う。

表 4 は，以上の視点に立って，『家計調査年報』で消費量（数量）表示のある食料品についてグループ区分した結果である。

表 4　家庭調理段階・流通加工段階での水利用の有無による食料品分類

分　類	主　要　食　品
○・○群 （家庭調理でも水を使い， 流通加工でも水を使う）	乾うどん　乾そば　中華めん　スパゲッティ　即席めん 煮干し
○・△群 （家庭調理では水を使い， 流通加工では一部に水を使う）	たけのこ　揚げ蒲鉾　ちくわ　蒲鉾　かつお節
○・×群 （家庭調理では水を使い， 流通加工では水を使わない）	米　粉ミルク　キャベツ　ほうれんそう　はくさい もやし　かんしょ　ばれいしょ　さといも　だいこん にんじん　ごぼう　たまねぎ　れんこん　さやまめ かぼちゃ　きゅうり　なす　干ししいたけ　わかめ こんぶ　緑茶　紅茶
△・×群 （家庭調理では一部に水を使い， 流通加工では水を使わない）	レタス　トマト　生しいたけ　牛肉　豚肉 鶏肉　卵　ハム　ソーセージ　ベーコン
×・○群 （家庭調理では水を使わず， 流通加工では水を使う）	食パン　あじ　さんま　塩さけ　たらこ 干しあじ　干いわじ　梅干し　だいこん漬　はくさい漬 昆布つくだ煮
×・×群 （家庭調理では水を使わず， 流通加工でも使わない）	バター　チーズ　ピーマン　りんご　みかん なし　ぶどう　かき　もも　すいか いちご　バナナ

この表は，わが国の『家計調査年報』に記載された食料品を水利用の有無によって区分

したものであるが，残念ながら，これと同レベルで詳細なドイツの消費統計は入手できなかった。そこで，以下ではドイツとの比較は経験的に述べるにとどめたい。

まず，「○・○群（家庭調理でも水を使い，流通加工でも水を使う）」であるが，この食品群でドイツでも容易に購入できるのはスパゲッティ（パスタ）である。そして，その消費量は伝統的なジャガイモに代って急速に伸びている。とくに若者の消費が多いとされる。したがって，この食品群は日本に特徴的であるとは言いがたい。

「○・×群（家庭調理では水を使い，流通加工では水を使わない）」については，主食である米と野菜が中心をなしている。ドイツでの米の消費はきわめてまれで，また野菜を煮るというのもジャガイモ，キャベツに限られている。かりに野菜を食べるとしも温野菜の形態をとる。その意味で，この食品群はわが国に特徴的なものである。

「△・×群（家庭調理では一部に水を使い，流通加工では水を使わない）」については，レタス，トマトなどの生食用野菜と，牛肉，豚肉などの食肉があてはまるが，野菜をサラダとして食べることはドイツでも日常的であり，またトマトは生食用のみならずスープ・シチュー用としても多用される。食肉についてもローストやスープ，シチューの形態で多用されている。したがって，日欧間の差異はない。

「×・○群（家庭調理では水を使わず，流通加工では水を使う）」については，パン，魚が中心をなすが，パンはドイツの主食をなしている。しかし，魚（塩干類のみならず鮮魚）の消費はほとんどない。魚の代わりに肉が大量に消費されているが，この食材の特徴は流通加工段階でも水を使わないことである。ドイツのみならず西欧では，食肉工場で水を多用することは衛生面で危険であると認識されている。したがって，魚に限るならば，この食品群はわが国に特徴的なものである。

最後に，「×・×群（家庭調理では水を使わず，流通加工でも水を使わない）」についてであるが，これは畜産物，同加工品，果実類などから構成されている。食肉については，上述のように，流通加工段階でも水を使わないことが特徴であり，また家庭調理段階でも煮る（水を使う）よりは焼く（水を使わない）ことにアクセントが置かれている。ドイツでの焼きソーセージ（ブラート・ブルスト）の消費量は圧倒的である。また，チーズ・バター・ヨーグルトなどの乳製品についても，チーズの消費が典型であるが，ドイツの消費量はわが国のそれをはるかに上回っている。したがって，この食品群はドイツに特徴的なものである。

以上から明らかなように，日本料理は「○・×群（米や野菜など）」と「×・○群（魚類）」の消費に特徴があり，西洋料理は「×・×郡（肉類）」の消費に特徴があることが分かる。そして，この区分に大きな影響を与えているのが水である。

以上の食文化の相違を踏まえた上で，つぎにわが国の食文化の変容をみたいと思う。この目的のために，図4ではグループ別の消費量(g)を，また図5ではグループ別の消費金額(円)を構成比で示している。

図4　グループ別食料品の消費量（構成比）

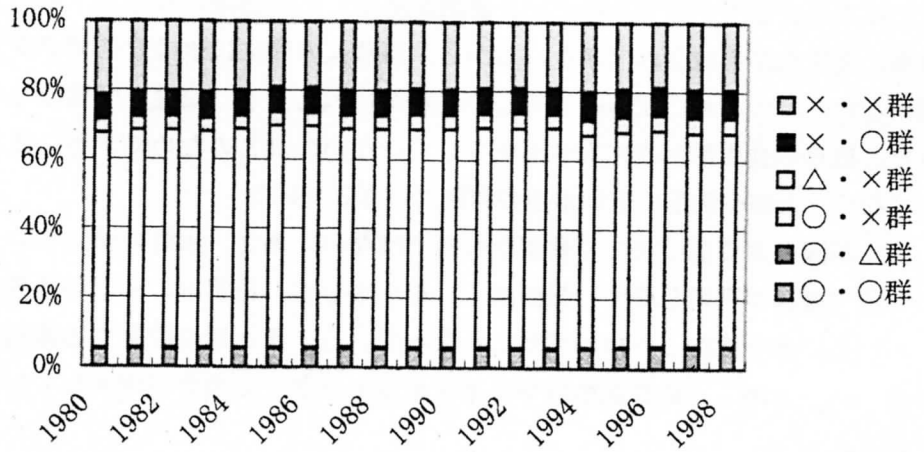


図5　グループ別食料品の消費金額（構成比）

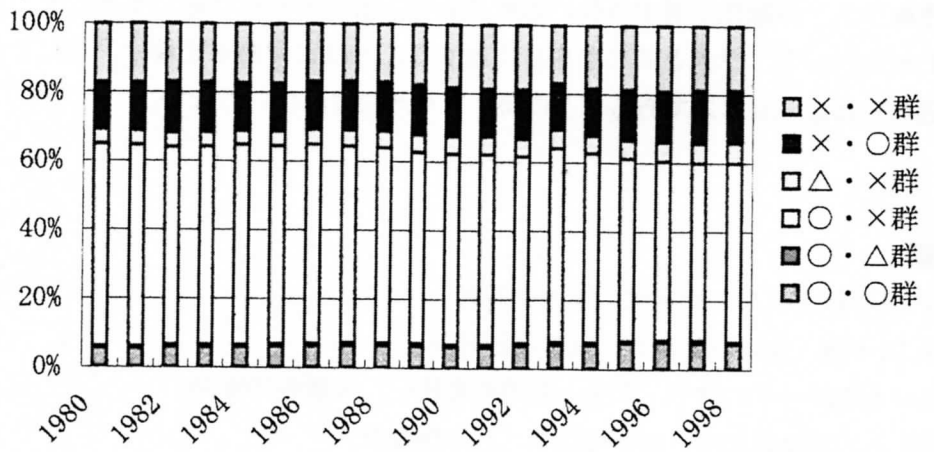


図 4 の消費量の構成比でみる限り，グループ間に大きな変化は見られない。これは，われわれの当初の予想とは異なって，この期間に食文化の大きな変容がなかったことを表している。一方，図 5 の消費金額の構成比では，「○・×群（米や野菜など）」が減少し，その他の食料品グループが増加している。このことは，米や野菜など「○・×群」の重量単価が相対的に低下していることを表している。言うまでもなく，米や野菜は加工度の低い財であり，近年とくに価格上昇が抑制されている財である。このことから，ともすれば減少する可能性の大きい米や野菜の需要量を，価格低下によって食い止めていると理解することが可能であろう。食生活の簡便化とか洋風化，中外食化などが指摘されて久しいが，水と食文化との関係には大きな変容は見られていない。

9. むすび

日本人には水は安全でタダであるという認識がある。この認識のもとで，水に大きく依存した日本の食文化が形成されてきた。しかし，西欧人の間には水は安全でタダであるという認識はない。このため，安全性に細心の注意が払われ，水（安全）は買うものとみなされてきた。彼らの食生活が水に大きく依存していないのはこのためである。また，食生活ばかりでなく，入浴や洗濯にも節水型の利用が定着している。

しかし，わが国の水資源は決して豊富なものではない。また，水質の面においても，高温多湿の気象（細菌が繁殖しやすい気候風土）を反映して，殺菌剤の利用が義務づけられており，おいしい水を飲むことはむずかしくなっている。浄水器を設置する家庭が増えていることや，ペットボトルの茶系飲料やミネラルウォーターの消費が増大しているのはこのためである。

そうであるからといって，ご飯，味噌汁，刺身，魚や野菜の煮付けといった伝統的な食文化に対する嗜好は，水利用の観点からすると，これまで大きな変化はみられていない。みられているとすれば，嗜好の変化ではなく，調理態度，すなわち家庭の調理コストの増大に伴う簡便化，外部化に対する強い志向である。嗜好の変化は起こるとしても時間がかかる。われわれがドイツ人と同じ食生活に達することはまずありえない。われわれは，和食から逃れられない日本人であることに誇りをもたなければいけない。

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