Japanese Consumer Demand for Dairy Products

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Abstract: We econometrically estimate consumer demand for dairy products in Japan using time series data for 1960-2003. We identify economic, cultural, and demographic forces that have been influencing dairy consumption patterns. We use the Almost Ideal (AI) Demand System by Deaton and Muellbauer and its variant, the Semiflexible Almost Ideal (SAI) Demand System developed by Moschini to impose concavity locally by reducing the rank of the Hessian of the expenditure function. We estimate three specifications: a full system comprising of four dairy products (fluid milk, powder milk, cheese, and butter), and an all other-goods aggregate; a subsystem for food made of four dairy goods and an all-other-food aggregate; and a sub-system of the four dairy products. The minimum distance estimator is used to estimate the demand system. We find that expenditure responses are positive, except for butter demand; own-price responses are large in absolute value; and non-price factors are important determinants of Japanese dairy consumption.

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Keywords: dairy demand, Japan, demand system, cheese, fluid milk.

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1. Introduction

Since the end of WW II, the Japanese diet has profoundly changed away from rice-based traditional food to Western food higher in animal-protein content, especially dairy. Prior to WW II rice accounted for about 60 % of the caloric needs of average Japanese consumer. Rice consumption fell and accounted only for about 34% of calorie needs by 1970. Consumption of dairy products, eggs, and convenience food increased dramatically. Eating out also expanded. The proportion of eating out in the household food budget increased from 7 % in 1963 to 17% in 2003. Similarly, the food budget allocated to processed foods has risen from 20 % in 1963 to 30 % in 2003 including cheese-intensive products such as pizza. The share of the food budget spent on fresh products (fresh meat, vegetables, and fruits) declined from 37 % in 1970 to 27 % in 2003 (Schluep Campo and Beghin).

These changes in food consumption patterns are worth investigating as many Asian countries are following the footsteps of Japan especially with fast emerging dairy consumption (Dong). These changes in Japan were likely caused by higher incomes, changes in relative prices and also a variety of non-price factors such as urbanization, population increase, education, occupation, access to information, changes in the employment structure and in particular the number of women in the labor force, an increasingly aging society, and the structure of the household units. We econometrically estimate consumer demand for four dairy products in Japan using time series data for 1960-2003. We identify economic and demographic forces that have been influencing dairy consumption patterns. We use the Almost Ideal (AI) Demand System (Deaton and Muellbauer) and its variant, the Semiflexible Almost Ideal (SAI) Demand System (Moschini) to impose concavity locally by reducing the rank of the Hessian of the expenditure function. We estimate three specifications: a full system comprising of four dairy products (fluid milk, powder milk, cheese, and butter), and an all-other-goods aggregate; a subsystem for food made of four dairy goods and an all-other-food aggregate; and a sub-system of the four dairy products. The minimum distance estimator is used to estimate the demand system. We find that expenditure responses are generally positive, except for butter demand; own-price responses are large in absolute value; and non-price factors are important determinants of dairy consumption.

Previous estimations of the Japanese dairy demand include the derived demand for imported cheese products into Japan by Christou et al.; Watanabe, Suzuki, and Kaiser (1999) who relied on qualitative data from a final-consumer survey; and Watanabe, Suzuki, and Kaiser (1997) who looked at the role of health concerns in decisions to consume milk. Our study usefully complements this incomplete knowledge on Japanese dairy consumption.

2. Dairy product consumption in Japan

Table 1 shows that the highest average annual growth rates of per-capita consumption for milk and dairy products were recorded between 1963 and 1970. Cheese consumption per person grew the fastest in the period 1963-1975. The rate of growth began to decline around 1975. Powdered milk and butter consumption actually declined between the early 1970s and 2003, whereas cheese consumption increased by sevenfold and milk consumption more than doubled between early 1960s and 2003.

Table 1: Annual percentage changes of dairy product per-capita consumption in Japan

Period	63-65	66-70	71-75	76-80	81-85	86-90	91-95	96-2000	01-03
Fluid Milk	6.8%	6.1%	-2.1%	3.1%	1.8%	3.2%	1.1%	-0.3%	-0.8%
Powder	4.1%	9.7%	-4.5%	-6.5%	-2.1%	-4.5%	3.8%	-0.7%	-6.7%
Butter	8.3%	0.2%	-1.9%	-6.3%	-1.5%	0.4%	2.9%	0.7%	-1.9%
Cheese	13.2%	17.1%	5.9%	1.5%	1.0%	3.7%	5.1%	2.8%	0.1%

Source: Derived from the Japanese Family Income and Expenditure Survey. Average rates between in years computed as $(x_{t+n}/x_t)^{(1/n)} - 1$

Table 2 compares consumption levels in the Western world based on USDA FAS disappearance data. Compared to other industrialized countries, per-capita consumption of fluid milk, butter, and cheese in Japan is much lower, whereas per-capita milk-powder consumption is surprisingly at par or slightly higher. The per-capita consumption of fluid milk in Japan is roughly 43% of that of its OECD partners. Butter is about 24% of that of the OECD partners and cheese consumption is 15% of that of its industrialized partners. It is worth noting that in Japan, unlike in Europe, the U.S. and other Western countries, milk and other dairy products are not widely used in cooking. The Japan Dairy Council notes that increased consumption would rely on more dairy products being incorporated into Japanese cuisine. As Japan's income compares favorably to most of its industrialized partners, income differences will not be able to explain such between-country differences in consumption patterns, although the evolution of dairy consumption within Japan is strongly linked to its income growth. Price and demographic factors may explain these Japanese patterns of dairy consumption.

Table 2: International comparison of dairy food consumption 2004 (per capita, annual)

Country	Fluid milk (kg)	Butter (kg)	Cheese (kg)	SMP (kg)
Switzerland	93.8	6.0	17.1	2.1
EU-25	79.2	4.7	14.1	2.4
Australia	102.2	2.9	11.9	1.7
New Zealand	90.1	6.5	7.0	1.3
Canada	87.7	2.9	10.7	1.5
US	92.1	2.0	14.1	1.3
Japan	39.0	0.7	2.0	1.7

Sources: USDA FAS PS&D database.

School lunches were introduced in elementary schools in the 1950s; children began drinking milk, and milk consumption at home increased first through home delivery. Supermarkets took over in the mid 1960s. Around 1975, convenience stores also began handling milk. By 2000, supermarkets and convenience stores accounted for 70% of total milk sales; schools accounted for 9%; small stores for 2.0%, vending machines for 0.5%, consumer cooperatives for 13.1%, and home delivery service for 5.2% (Schluep Campo and Beghin). Everybody has convenient access to milk.

Milk in Japan is still extremely expensive although prices have fallen tremendously relative to other Japanese consumer prices and to dairy prices in other countries. In the last ten years, the average retail price of a liter of milk has been around ¥200. Japanese consumers have been paying a lot more for dairy products than consumers in other countries have, about 4 times what New Zealanders pay for fluid milk. (OECD (2003), (2004)). Twenty years ago, Japanese consumers paid as much as six times the New-Zealand price. Such high prices must have inhibited consumption.

Non-price factors and dairy consumption

Milk is a regular food staple in about 87% of all Japanese households, and is consumed by persons of all ages and both genders. Consumption, however, varies greatly by age and gender. As children advance from nursery school to kindergarten and to elementary school, where milk is a part of all school lunches, per capita consumption continues to increase. However, after elementary school, school lunches are no longer provided and consumption rapidly decreases. For young adults, the average daily per capita consumption is only 1.4 dl, less than half the daily average of elementary school students. Although young working Japanese have substantial disposable incomes, they tend to follow prevailing trends to consume more "sophisticated" beverages, and milk consumption drops (Schluep Campo and Beghin).

The Annual Report on the Family Income and Expenditure Survey (FIES) provides data on the consumption of dairy products according to the age group of the household head and shows that consumption has been declining steadily for consumers less than 30 years, but has been increasing for all other age groups across time with some tapering after 2000. Cheese has experienced an increasing popularity over the years among all age groups. Powdered milk is consumed mostly among younger age groups and shows a decreasing trend over the years. Butter consumption although never high, has been declining sharply across all groups since 1990.

Butter is not used in cooking and mostly consumed as a spread on bread. Several conjectures emerge from these stylized patterns of consumption. First, the inward shifts (decrease) of powdered-milk demand could be explained with rising incomes making milk an affordable substitute for powdered milk. Further, powder milk remains an item for children; with the aging population, its consumption should decrease, other things being equal. Second, fluid-milk demand may have experienced a major initial outward shift caused by the introduction of the school lunch program in the 1960s, followed by some inward tapering as Japanese population aged.

3. The Demand System

The linear Almost Ideal (AI) Demand System

The AI model gives an arbitrary second-order approximation to any expenditure system. Deaton and Muellbauer (1980) show that it satisfies the axioms of choice, aggregates over consumers without a need to assume parallel Engel curves, and has a functional form consistent with known household budget data. Applying Shepard's Lemma to the expenditure function yields demand functions expressed in expenditure shares:

$$(1) \qquad w_i = \alpha_i + \sum_j \gamma_{ij} \log(p_j) + \beta_i \log\left(\frac{x}{PP^*}\right).$$

where PP^* is a linear approximation of the translog price index, $\log PP^* = \sum_i w_i \log(p_i)$.

Equation (1) is referred to as the linear AI demand system. The i^{th} budget share w_i is expressed in terms of prices p_j and real income or expenditures, (x/PP^*). Intercept α_i is the budget share when all prices and real expenditures are normalized to 1. Parameter γ_{ij} is the change in the i^{th} budget share with respect to a percentage change in the j^{th} price holding real expenditures constant. β_i represents the change in the i^{th} budget share with respect to a percentage change in real income or expenditures with prices held constant. The following three restrictions are imposed on demand parameters: Adding up, $\sum_{\mathrm{i}} \alpha_{\mathrm{i}} = 1$, $\sum_{\mathrm{i}} \gamma_{\mathrm{ij}} = 0$, $\sum_{\mathrm{i}} \beta_{\mathrm{i}} = 0$; homogeneity of degree zero in prices and income, $\sum_{\mathrm{j}} \gamma_{ij} = 0$; and Slutsky Symmetry: $\gamma_{ij} = \gamma_{ji}$. The adding up conditions imply a singular variance-covariance matrix for the disturbances and this is handled by deleting the *n*th equation.

The locally concave Almost Ideal demand model

We follow Moschini's concept of a semiflexible functional form to the AI demand system dealing well with the curvature property and the degrees of freedom problems when the number of coefficients grows faster than available data as goods are added. In the AI model concavity can be checked for but cannot be imposed by restrictions on the parameters alone. Curvature is examined by calculating the eigenvalues of the Slutsky substitution terms $S_{ij} = \partial h_i(p,u)/\partial p_j$, where $h_i(p,u)$ denote Hicksian demands. The ijth term of the Slutsky matrix for the AI model is:

(2) $$S_{ij} = \frac{x}{P_i P_j}\left[\gamma_{ij} + w_i w_j - \delta_{ij} w_i + \beta_i \beta_j \log\left(\frac{x}{PP}\right)\right],$$

where δ_{ij} is the Kronecker delta ($\delta_{ij} = 1$ for $i = j$ and $\delta_{ij} = 0$ for $i \neq j$). Without loss of generality, one can choose the sample mean (point with highest sample information) as the point at which concavity is maintained such that $p_i = x = 1$. The substitution term at the mean point (i.e. $\theta_{ij} = S_{ij}$ when $p = x = 1$) reduces then to $\theta_{ij} = \gamma_{ij} + \alpha_i \alpha_j - \delta_{ij}\alpha_i$. For concavity to hold at the mean point, the matrix $[\theta_{ij}]$ must be negative semidefinite.

To impose curvature, first, the γ_{ij} can be rewritten in terms of $\{\theta_{ij}, \alpha_i\}$. Homogeneity of demand implies $\sum_j \gamma_{ij} = \sum_j \theta_{ij} = 0$. Concavity of the (n-1)x(n-1) matrix $\Theta \equiv [\theta_{ij}]$ can be maintained by using the version of the Cholesky decomposition, such that $\Theta = -T'T$ where $T \equiv [\tau_{ij}]$ is an (n-1)x(n-1) upper triangular matrix. Hence, the θ_{ij} parameters are rewritten in terms of the τ_{ij} parameters and so $\Theta = -T'T$.

Taking all these reparametrizations into account, the locally concave AI model can be written as:

(3) $$w_i = \alpha_i + \alpha_i \log\left(\frac{p_i}{P^\alpha}\right) - \sum_{s=1}^{i} \tau_{si} \log(P_s^\tau) + \beta_i \log\left(\frac{x}{PP}\right),\ i = 1,2,\dots,n-1.$$

where n is the number of goods, P^α is a price function homogeneous of degree plus one, with $\log P^\alpha = \sum_i \alpha_i \log p_i$. The aggregator functions are homogenous of degree zero in prices and satisfy $\log P_s^\tau \equiv \sum_{j=s}^{n-1} \tau_{sj} \log\left(\frac{p_j}{p_n}\right),\ s = 1,2,\dots,n-1.$ To simplify the estimation procedure the Stone price index is used to approximate the translog price index that is of the form:

(4) $$\log PP = \log P^\alpha - \tfrac{1}{2}(\log P^\alpha) + \tfrac{1}{2}\sum_{i=1}^{n} \alpha_i (\log p_i)^2 - \tfrac{1}{2}\sum_{s=1}^{n-1}(\log P_s^\tau).$$

Imposing Concavity

The degrees of freedom problem is alleviated by restricting the rank of the substitution matrix (i.e. the substitution possibilities across goods) of the locally concave AI system. This yields the SAI demand system. Also, the SAI model can handle violations of local concavity. When the unrestricted model (1) yields positive eigenvalues of the Slutsky matrix, then the estimation of the locally concave model (1) may be difficult. A possible solution to this problem may be a model with a substitution matrix of rank $K < (n - 1)$ such that convergence of the parameters of the locally concave model can be achieved. Rank $K < (n - 1)$ can be accomplished by setting $\tau_{ij} = 0$ for all $i > K$. The Semiflexible Almost Ideal (SAI) system of rank K is then:

(5) $$w_i = \alpha_i + \alpha_i \log\left(\frac{p_i}{P^\alpha}\right) - \sum_{\substack{s=1 \\ s\le K}}^{i} \tau_{si} \log(P_s^\tau) + \beta_i \log\left(\frac{x}{PP}\right),$$

where P^α and P_s^τ are defined previously. The restrictions $\tau_{si} = 0$ for all $s > K$ imply $\log(P_s^\tau) \equiv 0$ for all $s > K$.

4. Evidence on Japanese dairy consumption decisions

Using equations (1) and (5), we estimate three specifications: first a full system comprising of four dairy products (fluid milk, powder milk, cheese, and butter), and an all-other-goods aggregate; second a subsystem for food made of five goods (the four dairy goods and an all-other-food aggregate; and finally a sub-system of the four dairy products. The minimum distance estimator is used to estimate the demand system. It is an approximation to maximum likelihood developed by Malinvaud. The software package "TSP 4.5 trough the looking glass" is used to carry out the econometric analysis.

Both, the expenditure and the price data are taken from the Annual Report on the Family Income and Expenditure Survey published by the Statistics Bureau, Management and Coordination Agency, Japan. There are 41 years of observation from 1963 to 2003 available. The survey covers most consumer household types in Japan with few exceptions. About 8,000 households are randomly selected for the survey out of about 31 million qualified households. The sample households are selected based on a three-stage stratified sampling method.

The study involves four dairy food groups and two aggregates of other goods. Expenditures are per annum in yen. Dairy goods and the all-other (food) aggregate expenditures are deflated by the consumer price index (CPI). The CPI is a proxy for the price of the all-other goods aggregate and the food price index one for the all-other food aggregate.

Results are shown in Table 3 for the AI model for all goods and table 4 for the SAI model for the food subgroup with rank 3 imposed because of concavity violations (full results are reported in Schluep Campo, and Beghin). Expenditure elasticities are positive for fluid milk, powder milk and cheese in the six estimated systems. The positive response of milk powder to income is a surprise, as consumption has remained pretty flat. The expenditure elasticity of butter demand is negative for four out of the six estimations (positive in the food-expenditure system under SAI shown; and the dairy expenditure system with AI). The significance of the expenditure coefficients is variable. It is the highest in the food sub-expenditure system. These results also suggest that the ratio between aggregate expenditure and food expenditure could be approximated by a proportional move. This does not hold between food expenditure and dairy-only expenditure as the expenditure response of butter changes signs, illustrating the tenuous link between the sub-expenditure system and total expenditure.

The demands are price elastic, but cross-price responses are small in absolute value. Fluid

Table 3.a. Parameter estimates of the linear unrestricted AI model with four dairy products and an all-other goods aggregate (concavity not satisfied)

Parameter	Estimate	std error	t-statistic	P-value
Intercept $\alpha_{Af\&nf}$	0.989775***	1.94E-04	5112.87	[.000]
α_{Fm}	8.36E-03***	1.57E-04	53.2562	[.000]
α_{C}	7.56E-04***	2.76E-05	27.397	[.000]
α_{Pm}	6.49E-04***	2.51E-05	25.8872	[.000]
Real Income $\beta_{Af\&nf}$	2.52E-03	1.90E-03	1.32915	[.184]
β_{Fm}	-1.73E-03	1.55E-03	-1.11538	[.265]
β_{C}	-3.55E-04	2.54E-04	-1.39377	[.163]
β_{Pm}	2.87E-05	2.21E-04	0.129565	[.897]
Own relative price $\gamma_{Af\&nfAf\&nf}$	-1.23E-03	2.93E-03	-0.41945	[.675]
Cross relative prices $\gamma_{Af\&nfFm}$	1.29E-03	2.38E-03	0.539337	[.590]
$\gamma_{Af\&nfC}$	2.02E-04	3.98E-04	0.50841	[.611]
$\gamma_{Af\&nfPm}$	-2.41E-04	3.46E-04	-0.69661	[.486]
Time trend $D_{Af\&nf}$	-2.79296***	0.580916	-4.80784	[.000]
Female share in labor $E_{Af\&nf}$	0.040043***	0.014517	2.7583	[.006]
Population density $F_{Af\&nf}$	5.60E-04***	1.27E-04	4.39452	[.000]
Dependency ratio $L_{Af\&nf}$	1.33E-03***	2.72E-04	4.88999	[.000]
Own relative price γ_{FmFm}	-8.90E-04	1.98E-03	-0.44941	[.653]
Cross relative prices γ_{FmC}	-4.15E-04	3.22E-04	-1.28999	[.197]
γ_{FmPm}	1.68E-04	2.91E-04	0.575209	[.565]

Time trend D_{Fm}	2.06***	0.473806	4.34777	[.000]
Female share in labor E_{Fm}	-0.03007**	0.012046	-2.49597	[.013]
Population density F_{Fm}	-4.19E-04***	1.04E-04	-4.04277	[.000]
Dependency ratio L_{Fm}	-1.02E-03***	2.22E-04	-4.59674	[.000]
Own relative price γ_{CC}	-2.46E-04	1.54E-04	-1.59534	[.111]
Cross relative price γ_{CPm}	-3.31E-05	1.56E-04	-0.21219	[.832]
Time trend D_{C}	0.335189***	0.078645	4.26204	[.000]
Female share in labor E_{C}	-6.18E-03***	2.11E-03	-2.92456	[.003]
Population density F_{C}	-6.10E-05***	1.73E-05	-3.52677	[.000]
Dependency ratio L_{C}	-1.47E-04***	3.66E-05	-4.02229	[.000]
Own relative price γ_{PmPm}	-3.53E-04	2.31E-04	-1.53026	[.126]
Time trend D_{Pm}	0.284396***	0.068212	4.16927	[.000]
Female share in labor E_{Pm}	-1.38E-03	2.02E-03	-0.68262	[.495]
Population density F_{Pm}	-5.04E-05***	1.50E-05	-3.36185	[.001]
Dependency rAtio L_{Pm}	-1.25E-04***	3.17E-05	-3.94059	[.000]

Af&nf=aggregate other food and nonfood; Fm=fluid milk; C=cheese; Pm=powder milk.

***=significant at 1%, **=significant at 5%, *=significant at 10%

Table 3.b. Marshallian elasticities at the mean point, AI total expenditure model

Elasticity of		With respect to					
		$p_{Af\&nf}$	p_{fm}	p_{c}	p_{pm}	p_{b}	Income
(1)	Af&nf	**-1.00**	0.00	0.00	0.00	0.00	1.00
(2)	Fluid milk	0.36	**-1.10**	-0.05	0.02	-0.02	0.79
(3)	Cheese	0.76	-0.55	**-1.33**	-0.04	0.65	0.53
(4)	Powdered milk	-0.42	0.26	-0.05	**-1.54**	0.71	1.04
(5)	Butter	0.96	-0.32	1.08	1.01	**-2.72**	-0.01

Table 4.a. Parameter estimates of the rank 3 SAI model with four dairy products and an all-other food aggregate (concavity imposed)

Parameter	Estimate	Std Error	t-statistic	P-value
Intercept α_{Of}	0.948094***	7.34E-03	129.116	[.000]
α_{Fm}	0.038245***	6.17E-03	6.19579	[.000]
α_{C}	6.85E-03***	1.46E-03	4.70387	[.000]
α_{Pm}	5.72E-03***	2.12E-03	2.69832	[.007]
Real expenditure β_{Of}	-0.0198***	7.29E-03	-2.71442	[.007]
β_{Fm}	0.011988*	6.13E-03	1.95539	[.051]
β_{C}	4.35E-03***	1.45E-03	3.00562	[.003]
β_{Pm}	3.61E-03*	2.11E-03	1.71617	[.086]
price response τ_{OfOf}	-0.26906***	0.026918	-9.99562	[.000]
Cross relative prices τ_{OfFm}	0.186246***	0.027182	6.85181	[.000]
τ_{OfC}	0.045859***	9.72E-03	4.71641	[.000]
τ_{OfPm}	0.030545**	0.014431	2.11666	[.034]
Time trend D_{Of}	-5.31215***	1.83774	-2.89059	[.004]
Female share in labor E_{Of}	0.114318**	0.056669	2.01729	[.044]
Population density F_{Of}	1.30E-03***	3.63E-04	3.59253	[.000]
Dependency ratio L_{Of}	2.20E-03**	9.20E-04	2.38919	[.017]
Own price under concavity τ_{FmFm}	0.091089***	0.010422	8.73991	[.000]
Cross price under concavity τ_{FmC}	-0.04199***	0.010393	-4.04023	[.000]
τ_{FmPm}	-0.05902***	0.016405	-3.5975	[.000]
Time trend D_{Fm}	3.48384**	1.38125	2.52224	[.012]
Female share in labor E_{Fm}	-0.06553	0.045798	-1.43076	[.152]
Population density F_{Fm}	-8.35E-04***	2.69E-04	-3.11121	[.002]

Dependency ratio L_{Fm}	-1.58E-03**	6.94E-04	-2.27206	[.023]
Own price under concavity τ_{CC}	0.064344***	0.010338	6.22411	[.000]
Cross price under concavity τ_{CPm}	-0.06519***	0.02026	-3.21743	[.001]
Time trend D_C	0.639101	0.452869	1.41123	[.158]
Female share in labor E_C	-0.02901**	0.014276	-2.03187	[.042]
Population density F_C	-1.94E-04**	8.72E-05	-2.21958	[.026]
Dependency ratio L_C	-1.84E-04	2.24E-04	-0.82151	[.411]
Time trend D_{Pm}	0.765673	0.513373	1.49146	[.136]
Female share in labor E_{Pm}	-3.28E-03	0.016482	-0.19902	[.842]
Population density F_{Pm}	-1.66E-04*	9.36E-05	-1.77234	[.076]
Dependency ratio L_{Pm}	-2.67E-04	2.43E-04	-1.09798	[.272]

Number of observations = 41. Trace of Matrix = 54.3867. Of=Other food

Table 4.b. Marshallian elasticities at the mean point, rank 3 SAI food expenditure model

Elasticity of		With respect to					
		p_{of}	p_{fm}	p_c	p_{pm}	p_b	expenditure
(1)	Other food	**-1.00**	0.02	0.01	0.00	0.00	0.98
(2)	Fluid milk	0.06	**-1.17**	-0.13	-0.02	-0.06	1.31
(3)	Cheese	0.25	-0.75	**-1.18**	0.04	0.01	1.63
(4)	Powdered milk	-0.11	-0.12	0.04	**-1.52**	0.08	1.63
(5)	Butter	0.78	-1.97	0.06	0.41	**-0.13**	0.86

milk and cheese are complements in all specifications. Butter and milk powder are substitutes in all specifications. Other cross price effects are less robust. The fluid milk to powder milk substitution (positive in 4 of the 6 specifications) is consistent with stylized facts of consumption patterns away from milk powder towards fluid milk.

The demographic and trend variables bring interesting results. Cheese is positively influenced by aging of the average household (rising dependency ratio). All the other per-capita consumptions of other products are negatively influenced by aging. The aging result is consistent with the tapering of the initial boom created by school programs in the early 1960s. Population density, a linear transformation of population, has been growing faster than consumption per capita as suggested by the negative influence of this variable on per-capita consumption. The variable capturing the female share in labor force has a negative impact on all dairy products in the full expenditure specifications and less significantly in the food expenditure specifications, indicating that expenditure has been directed towards other goods than dairy as women joined the labor force.

The trend variable positively influences fluid milk, and cheese and milk powder consumption. However, its impact on butter is negative. This persistent result indicates that some fundamental influence has been at work, which is not explained by prices, expenditure, and demographic dynamics (aging, population density, female participation in the labor force) included in the specification. The positive trend result is consistent with the positive influence of promotion and health awareness campaigns. Some eigenvalues of the substitution matrix are positive but most of these positive eigenvalues are near zero, except for the AI and SAI food expenditure systems for which the eigenvalue associated with other food is a bit larger. Given that these violations of curvature are minor their correction induce limited changes in qualitative results as shown when comparing AI and restricted SAI specifications of any given expenditure system.

5. Conclusions

We econometrically investigated dairy consumption in Japan over the past four decades. Consumption patterns have evolved with increasing individual consumption of cheese and fluid milk. The individual consumption of butter and milk powder has been stagnating, as butter is not widely used in cooking. Milk powder has been partially substituted by fluid milk. Total dairy consumption per capita has increased substantially over time but has recently tapered. This increase in per capita consumption is linked to a decline in real dairy prices, rising incomes, changes in taste, and information about the positive health impacts of dairy product consumption. The income and own-price responses of individual dairy consumption are large; real prices, although still very high by international standards, have been falling substantially since 1960. Income growth has also been tremendous between 1960 and 2003, even though income stagnated in the last decade. As dairy prices would fall with further trade liberalization, further increases in dairy consumption would follow.

Although higher cheese consumption is further linked to the increasing consumption of convenience and processed foods by Japanese consumers, we found that as women join the labor force, all dairy consumptions including cheese fall. As Japan's population has been increasing in the last 40 years, aggregate market consumption has been rising, although not as fast as population has. We also found that the aging of the population has affected dairy consumption negatively. Finally, we found that fluid milk, and cheese consumptions are trending up over time while butter is trending down, other things being equal. Japan consumes much less dairy products than other OECD countries with comparable purchasing power. High consumer prices are a major part of the explanation but lower preference for dairy products is also a reason.

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