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Hiroshi Mori, Dennis Clason, Kimiko Ishibashi, William D. Gorman, and John Dyck*

Abstract

Japan is a leading market for U.S. oranges. Since 1995, orange consumption in Japan has declined. This report summarizes an analysis of household survey data to assess various factors that may be related to the decline. Consumption of oranges in Japan differs markedly across generations, with younger generations (cohorts) eating fewer oranges than older generations. However, within generations, as individuals in Japan grow older, they eat more oranges. On balance, the effects on consumption associated with aging and birth cohort membership are mostly offsetting. Orange prices affect consumption levels, but household income does not. Even after the analysis accounts for price and demographic variables, a strong downward trend is evident in orange consumption in Japan. Results suggest that orange consumption could decline even more in the future.

Keywords: Japan, oranges, consumption, age/period/cohort analysis

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Contents

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Summary

Japan, a leading market for U.S. oranges, has registered declining consumption of oranges, and fresh fruits in general, in recent years. At the same time, Japan's economy has seen little growth and its demographic changes have been profound as its elderly population has increased rapidly as a share of the country's total population. The effects of aging and of generational change on food consumption appear to be major factors affecting orange consumption in Japan.

What Is the Issue?

Since about 1995, orange consumption (in aggregate and per person) has fallen in Japan. One theory attributes that decline to the aging of the population and the fact that younger Japanese eat fewer fresh oranges than older Japanese. Orange prices and income levels are also cited as factors that may be contributing to the dropoff in orange consumption over time. Suppliers to Japan's orange market, largely U.S. growers, may benefit from information on factors triggering the decline as they plan future market strategies in Japan and in such countries as South Korea, which is also characterized by an aging population.

What Did the Study Find?

As individuals in Japan grow older, they eat more oranges; however, older generations of Japanese are being steadily replaced by younger generations who, overall, eat fewer oranges. On balance, the effects on consumption associated with aging and birth cohort membership are mostly offsetting. Prices affect orange consumption in Japan, but household income does not. Even after the analysis accounted for price and demographic variables, a strong downward trend was evident in Japanese orange consumption.

Specific findings include the following:

- Studies show that as Japanese age, they eat more oranges. Thus, today's Japanese youth are likely to increase their orange consumption as they grow older. The aging of Japan's population therefore has a positive effect on orange consumption.

- This analysis estimates, however, that, even in old age, today's younger Japanese will not match the level of orange consumption of today's elderly Japanese. The generational replacement of older birth cohorts by younger birth cohorts therefore has a negative effect on orange consumption in Japan.

- Orange prices in Japan dropped during 1987-95, the first half of the period studied. Orange consumption increased until 1995, perhaps partly in response to the price drops. Price changes since 1995 have been slight. Orange prices have a significant effect on consumption.

- The analysis revealed a strong trend away from orange consumption over time, which was not explained by the effects of demographic variables, prices, or household income.

How Was the Study Conducted?

The study relied on data from Japan's *Family Income and Expenditure Survey*, which collects information on daily expenditures from 9,000 households each month. The survey has gathered information on orange consumption since 1987. The data are reported based on age of the head of the household. Aggregate household orange consumption, rather than consumption by each household member, is reported. The study used detail on the ages of the members of each household to estimate consumption by individual members of different ages. These data were the basis for estimates of age/period/cohort effects. Estimates of consumption per person with the age and cohort (generation) effects netted out were used to investigate "period effects": events, such as price and income changes, that could affect consumption in a given year. These time-series regressions (on own price, income, and a measure of time) determined an estimate of the price elasticity of oranges, as well as a time trend.

Since income elasticity was not significantly different from zero in the time series investigation, various cross-sections of the household data were sorted by income for further study. These cross-sections also failed to show a strong influence of income on orange consumption in Japan. Demographic variables were used to project consumption to 2017, to examine the extent to which they could lead to further declines in consumption, in the absence of other changes.

Introduction

Most fresh oranges (oranges, hereafter) in Japan are imported, and the primary import source is the United States, which accounted for three-quarters of the total in 2004-06. Japan's own citrus production consists principally of a kind of mandarin or tangerine that is not regarded as a close substitute for navel oranges.[1] Japan liberalized its rules for imports of oranges as a result of the 1988 Beef-Citrus agreement with the United States. After a 3-year transition period, Japan replaced existing import quotas with ad valorem tariffs in 1991.[2] The tariffs vary seasonally. Originally set at 20 percent for June through November and 40 percent for December through May, the tariffs were further reduced gradually to 16 percent and 32 percent, respectively, by 2000.

Japan's total imports of oranges, predominantly from the United States, increased steadily from about 111,600 tons in 1985 to 190,400 tons in 1994, the peak year, and then gradually declined to about 136,200 tons in 2000 and 120,900 tons in 2006, respectively (table 1).[3] During this period, Japan fell from the top overseas market for U.S. oranges to the third highest position.

Consumption of oranges in Japan mirrors the product's import history there. The most reliable source of information about orange consumption in Japan is the annual report of the *Family Income and Expenditure Survey* (*FIES*) by Japan's Statistics Bureau (see box, "*Family Income and Expenditure Survey*"). Oranges, apart from mandarins and other domestic

[1]Partly because of seasonal import tariffs, which are higher in December-May, there are strong seasonal differences in citrus consumption in Japan, with most mandarins consumed in October-February, and most navel oranges consumed in March-September. For more information, see Mori et al., 2008.

[2]See Mori et al., 2008.

[3]Declines in imports in 1991 and 1999 reflected short supplies caused by harvest failures in California.

Table 1
Japan's imports of fresh oranges and country shares

Calendar year	Total	CIF price	From: U.S.	Chile	S. Africa	Australia
	Metric tons	*Yen/kg*	*Metric tons*			
1985	111,635	195.2	110,462	0	0	848
1986	117,300	140.9	115,968	0	0	938
1987	123,425	142.2	122,192	0	0	887
1988	115,347	141.6	114,810	0	0	482
1989	128,372	144.5	125,913	0	0	1,942
1990	145,188	143.7	143,118	0	0	1,833
1991	82,017	220.5	75,161	0	0	3,119
1992	171,701	114.2	166,398	0	1,518	3,366
1993	165,420	104.7	155,728	0	5,151	4,539
1994	190,376	99.7	182,517	0	3,667	3,668
1995	179,960	96.3	169,579	0	4,374	5,866
1996	154,086	111.5	135,683	38	5,905	11,960
1997	171,269	105.3	147,624	87	14,161	8,385
1998	150,470	117.7	131,866	25	9,210	7,357
1999	89,703	152.5	46,204	539	13,846	12,460
2000	136,150	82.3	116,951	1,153	8,547	6,245
2001	126,203	103.7	104,152	3,680	9,337	7,238
2002	103,873	105.1	79,611	4,958	8,028	8,765
2003	117,087	94.9	88,068	6,120	13,276	9,238
2004	112,937	97.2	85,524	10,408	10,216	6,493
2005	115,433	99.6	84,269	11,382	10,960	8,443
2006	120,875	113.0	88,179	9,440	7,714	15,522

Note: CIF means cost, insurance, freight.

Source: USDA, Economic Research Service, using trade data of Japan.

citrus varieties, were first itemized in *FIES* in 1987. As measured by *FIES*, per person, at-home consumption of oranges increased from 830 and 737 grams (g) in 1987 and 1988, respectively, to 924-940 g in 1994-96 and then gradually declined to 533-585 g in 2005-06 (table 2). It is estimated that at-home consumption accounts for approximately 70 percent of the total distribution of oranges in Japan.[4]

Like consumption of oranges, consumption of fresh fruit in general has been declining steadily in Japan since the mid-1970s. Per capita at-home consumption of aggregate fresh fruit declined consistently from 49.7 kg in 1975 to 27.8 kg in 2006 (fig. 1). Per capita consumption of mandarins declined from 19.97 kg in 1975 to 4.55 kg in 2006.

This report assesses various factors that may be related to the decline in at-home orange consumption in Japan since 1995. It is difficult to attribute the decrease to either an income or a price factor because neither factor has changed much in recent years. Living expenditures per person (a proxy for household income that is reported in *FIES*) in Japan increased slightly from 1987 to 1995 and then remained at about the same level through 2006 (all in constant 2005 yen). The price index for oranges reported in the CPI declined from 153.3 in 1987 to 100.9 in 1996 (deflated by 2005 aggregate CPI) and remained at the same level since then (fig. 2).[5]

The real price index for fresh fruit (deflated by aggregate CPI) increased slowly from 102.7 in 1975 to 108.1 in 1995 and then slightly decreased to 104.0 in 2006 (2005=100) (fig. 3).

[4]Ito, 2006: at-home consumption (*FIES* per person consumption times total population) is estimated at 60-65 percent of imports. Ito surmises that 10-15 percent of total imports may not be suitable for normal fresh marketing due to spoilage, and the like. At-home consumption of the marketable share would thus be about 70 percent.

[5]Price spikes in 1991 and 1999 reflected short supplies caused by harvest failures in California.

Table 2

Household purchases of fresh orange in Japan

	Quantity		Real price
	Per household	Per person	index[1]
	Grams	*Grams*	*2005=100*
1987	3,046	830	153.33
1988	2,676	737	134.83
1989	2,671	740	138.55
1990	2,882	810	135.28
1991	1,835	514	167.83
1992	2,972	842	128.21
1993	3,114	892	102.30
1994	3,208	924	98.41
1995	3,216	940	95.53
1996	2,575	771	100.60
1997	2,844	851	100.88
1998	2,458	743	99.42
1999	1,257	381	137.18
2000	2,059	622	94.62
2001	1,981	604	97.44
2002	1,733	535	100.00
2003	1,807	561	101.10
2004	1,610	505	97.31
2005	1,691	533	100.00
2006	1,848	585	101.60

[1]Orange Consumer Price Index (CPI) deflated by CPI for all goods.

Source: USDA, Economic Research Service, using data from *FIES*, various issues.

Family Income and Expenditure Survey

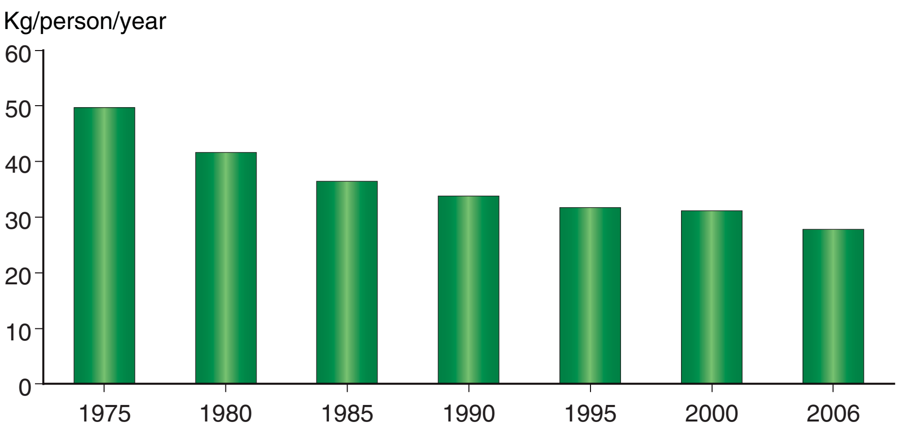
The *Family Income and Expenditure Survey,* or *FIES,* is used to depict households' monthly finances and to produce basic statistical data on expenditures of all households by cities, regions, income classes, etc., for planning national economic and social policies. *FIES* has been conducted since 1946 with ongoing modifications but with time-series consistency maintained as much as possible.

The survey questions approximately 9,000 households, selected by random sampling from all consumer households in all prefectures of Japan, excluding one-person student households. Each household records daily expenditures for 6 months and is then replaced by another household. Each month, one-sixth of the households are replaced.

For many food items, the survey records both expenditure and quantity purchased. In addition, it collects information relating to income and household composition and type. Results are conveyed in monthly and annual reports, published by the Consumer Statistics Division of the Statistics Bureau, Ministry of Internal Affairs and Communication.

Figure 1

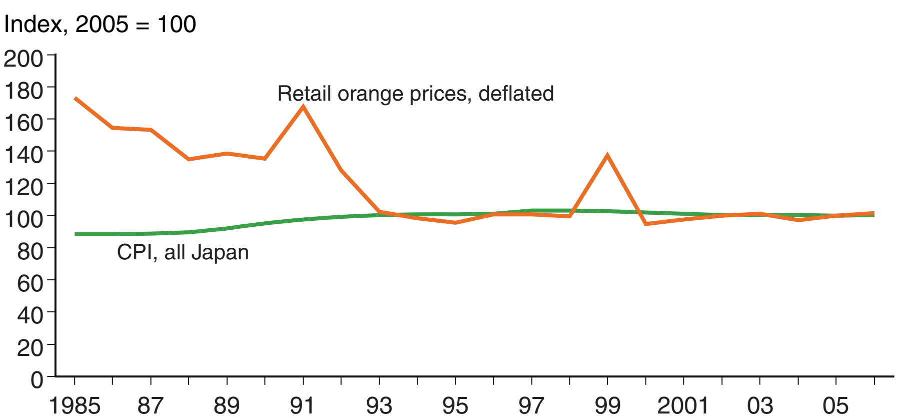
At-home consumption of fresh fruit in Japan



Source: USDA, Economic Research Service, using FIES household survey data.

Figure 2

Orange prices in Japan



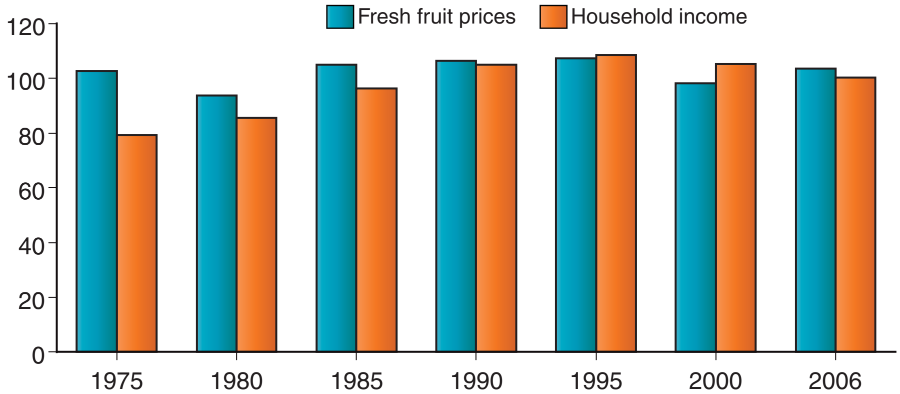
Notes: CPI = Consumer Price Index.

Source: USDA, Economic Research Service, using data from the Statistics Bureau, Ministry of Internal Affairs and Communication, Japan.

Figure 3

Real prices of fresh fruit and real household income in Japan

Index, 2005=100



Note: Fresh fruit CPI deflated by aggregate CPI.

Source: USDA, Economic Research Service, using consumer price indexes (CPIs) from Japan's monthly CPI Report.

On the surface, it appears that at-home consumption of fresh fruit decreased markedly at the same time that income increased substantially (and then remained the same), while fresh fruit consumer prices did not change appreciably over the period. However, a previous study, which analyzed panel data by household types for 96,000 households annually from 1982 to 2001, demonstrated that fresh fruit is an income-positive good (Mori et al., 2006b)—the wealthier the household, the greater the quantity of fresh fruit consumed. The consistent decline in fresh fruit consumption in Japan over the past three decades stems from factors that go beyond household income and price. So, too, does the decrease in orange consumption in the past decade.[6]

Based on recent findings (Mori et al., 2006a; Mori et al., 2006b), this study hypothesizes that the decline in consumption might be at least partially attributed to generational change: more concretely, that today's younger cohorts of Japan's population have moved away from eating fresh fruit, and oranges as well, for unknown reasons (MAFF, 1995).

[6]See "Economic Analysis of Period Effects on Orange Consumption—Are Oranges Normal Goods in Japan?", on page 14, for an economic analysis of orange consumption.

Household Purchases of Oranges by Age of Household Head

Since 1979, *FIES* annual reports have included information on household purchases of various specific goods and services categorized by the age group of the household head (HH). As mentioned earlier, oranges were added to the survey items in 1987.

Examination of *FIES* data shows prima facie evidence of two effects on orange consumption (see selected years in table 3): individual aging and cohort effects. During 1987-2006, households with HHs in their forties, fifties, and sixties ate substantially more oranges than those with HHs in their twenties and under age 35. This is a pattern: as households age, they eat more oranges.

Also, data from the 1987 and 1990 surveys show that the households with HHs under age 35 bought fewer oranges than households with older HHs. In 2000-06, the HHs who were under age 35 in 1987 and 1990 were in their forties and their early fifties. They still purchased fewer oranges than households headed by older HHs. This is also a pattern: tracing a cohort diagonally through table 3 reveals that the cohort generally purchases fewer oranges than older cohorts, and more oranges than younger cohorts.

The two patterns pertain to *households* categorized by the age of the HH and may not require further analysis: the *FIES* data give clear indications that cohorts of such households have different purchase levels for oranges, and that each cohort of households increases orange consumption as it ages. However, the household data by HH age group do not necessarily represent the consumption patterns over time by the same cohorts of *individuals*.[7] Individual consumption by age should be separated or derived from household data classified by HH age groups.

[7]Deaton and Paxson, 1994; Deaton and Paxson, 2000.

Table 3

Household purchases of fresh oranges, by age of household head

HH age	1987	1990	1995	2000	HH age	2004	2005	2006
	Grams/year					Grams/year		
~24	1,027	774	627	906				
25-29	1,300	1,136	1,483	880	~29	497	874	445
30-34	2,161	1,789	1,576	879				
35-39	3,163	2,473	2,306	1,504	30-39	765	780	927
40-44	3,299	3,310	2,958	1,962				
45-49	3,427	3,610	4,067	1,933	40-49	1,450	1,310	1,475
50-54	3,553	3,455	3,480	1,938				
55-59	3,046	2,890	3,128	2,663	50-59	1,905	1,879	2,109
60-64	2,880	2,915	3,656	2,297	60-69	1,901	1,957	2,069
65~	3,186	2,694	3,904	2,706	70~	2,312	2,385	2,601
average	3,046	2,882	3,216	2,077	average	1,648	1,691	1,848

Note: HH means household head.
~ means younger than or equal to, before a number, and older than or equal to, after a number.

Source: USDA, Economic Research Service, using data from *FIES*, various issues.

Deriving Individual Consumption From Household Data

The *FIES* data provide information on the number of members in the households surveyed and on total household purchases of various foods. The data do not provide information about how much each person in the household consumes. One way to estimate consumption per person would be to divide each household's purchases by the number of people in the household (referred to as "simple division"). Another way would be to use additional information to estimate consumption by individuals of different ages.

To illustrate these two approaches, assume that a three-person household headed by an adult in his/her mid-twenties (age 25) consumed 30 kg of some food, a four-person household headed by a middle-aged adult in his/her late forties (age 47) consumed 60 kg of food, and a three-person household headed by an old adult in his/her mid-sixties (age 65) consumed 80 kg of food.

One could estimate individual consumption by simply dividing household consumption by the number of persons in the household and assigning the result as individual consumption by an individual with the age of the household head. For example, consumption by the young adult age 25 should be 30/3 = 10 kg; consumption by an adult age 47 should be 60/4 = 15 kg; and consumption by an older adult age 65 should be 80/3 = 26.7 kg. However, these results do not take into consideration the age variation among household members.

To show how information about the ages of household members can be used to estimate consumption, consider the households used in the previous example. The first household may comprise two young adults and one infant, the second two adults in their forties and two young adults around age 20, and the third two older adults in their sixties and one adult in his/her thirties (e.g., age 32). Then, the analysis will have a set of equations as follows:

$$2X_{25} + 1\,X_{0} = 30 \qquad (1)$$

$$2X_{47} + 2\,X_{20} = 60 \qquad (2)$$

$$2X_{65} + 1\,X_{32} = 80 \qquad (3)$$

where X_i denotes individual consumption by a person *i* years of age.

The three equations have six unknowns, making it impossible to find a solution. If it can be assumed, however, that infants do not consume this product: $X_0 = 0$; people in their twenties and early thirties eat, on average, about the same amount: $X_{20} = X_{25} = X_{32}$, then one will have the following solutions:

$$2X_{25} = 30 \rightarrow X_{25} = 15 \qquad \text{(vs. 10 by simple division)}$$

$$2X_{47} + 2 \times 15 = 60 \rightarrow X_{47} = (60-30)/2 = 15 \qquad \text{(vs. 15 by simple division)}$$

$$2X_{65} + 15 = 80 \rightarrow X_{65} = (80-15)/2 = 32.5 \qquad \text{(vs. 26.7 by simple division)}$$

The simple division approach implicitly assumes that all members of the household are in the same age group as the HH, or, in an extreme example, that infants eat as much as their parents. The *FIES* panel data of nearly 96,000 households each year provide complete details on the age composition by HH age groups of the households surveyed.[8]

Using simple supporting constraints such as $X_0 = 0$, $X_{20} = X_{25} = X_{32}$, as above, one can obtain more realistic estimates of individual consumption by age from household data than from the simple division approach.

With respect to the supporting constraints, the analysis uses the intuitively natural assumptions of gradual changes between successive age groups (i.e., the difference in consumption between individuals a year apart in age will be approximately zero ($X_i - X_{i+1} \approx 0$), which cover the entire range of age groups, instead of arbitrary *a priori* assumptions, such as $X_0 \approx 0$, $X_{17} \approx X_{22}$, or $X_7 \approx 0.6\, X_{12}$).[9] Individual consumption by age is estimated, minimizing the sum of squared residuals (4) and (5) below.[10]

$$H_j - \sum C_{ij} X_i = E_j \qquad (i = 1\text{-}16\,;\, j = 1\text{-}10) \qquad (4)$$

$$X_k - X_{k+1} = E_k \quad (k = 1\text{-}15) \qquad (5)$$

where

H_j : consumption by household headed by someone *j* years of age

C_{ij} : number of individuals of *i* years of age in household with HH *j* years of age

X_i : estimated consumption by individuals of *i* years of age

X_k : estimated consumption by individuals of *k* years of age

E_j, E_k : residuals

Table 4 provides estimates of annual individual consumption of oranges by age for the period 1987-2006. The estimates clearly demonstrate that individual consumption of oranges varies substantially by age throughout the survey period: generally, older people eat more oranges than younger people.[11] This effect has intensified over the period. In the late 1980s, individuals in their late thirties and older ate twice as many oranges as those in their twenties and younger, but by the middle of the 2000s, individuals in their late thirties through early fifties decreased their consumption more than 50 percent, whereas those in their late sixties and older kept their consumption at the earlier levels. Also, most strikingly, children under age 20 have reduced their consumption to one-tenth the level of people in their late sixties and older in recent years. Note that those in their forties in 2005, for example, were young adults in their twenties in the mid-1980s, those in their thirties in the mid-2000s were teenagers in the mid-1980s, and so on: everyone ages as time passes. Accordingly, this analysis uses an age/period/cohort (A/P/C) model to separate estimated individual consumption by age into age, period, and generational cohort effects.

[8]These data are not usually available to the public but were made available for this study. The actual family age compositions by HH age groups are made public only partially in *FIES* annual reports, and, if then, on a sporadic basis. The data are much more complex than that illustrated in the example, and thus, may require difficult supporting constraints.

[9]Hendrickson et al., 2001, pp. 107-08.

[10]Mori and Inaba, 1997; Tanaka et al., 2004.

[11]Estimates for younger age groups, the early twenties and the late twenties in particular, are less stable or less dependable than those for older age groups above the thirties because the HH age groups under age 25 and age 25-29 (in recent years) are small in sample size. The estimates of nonadults under age 20 are also not dependable because, unlike a married couple of two adults in the same age brackets, these individuals do not represent the principal components of age matrices of family structure by HH age groups, C_{ij}, in equation (4). Also, they are more prone to be subject to the supporting constraints of gradual changes between successive age groups (i.e., $X_{17} - X_{22} \approx 0$, $X_{12} - X_{17} \approx 0$, etc.) in deriving individual consumption from the household data organized by HH age groups.

Table 4

Estimates of average individual consumption of fresh oranges in Japan, by age

	Age of consumers (in years)							
	0~4	5~9	10~14	15~19	20~24	25~29	30~34	35~39
	Grams/person/year							
1987	243	372	450	477	472	469	797	1,086
1988	277	390	448	398	381	403	526	1,128
1989	261	342	422	467	502	534	736	776
1990	197	340	486	534	477	439	634	861
1991	121	190	247	255	242	253	383	505
1992	225	361	514	577	594	563	594	813
1993	193	328	486	524	471	471	562	846
1994	104	181	304	414	489	535	597	803
1995	206	301	422	493	510	523	589	774
1996	165	247	337	382	384	392	471	869
1997	136	215	302	338	344	398	542	711
1998	60	112	169	212	265	336	425	778
1999	25	66	105	123	131	155	285	456
2000	139	183	238	278	317	356	410	497
2001	56	108	151	166	170	199	343	493
2002	25	47	87	134	187	243	305	389
2003	108	133	175	217	261	301	316	369
2004	17	53	108	156	192	221	278	375
2005	120	129	157	211	285	344	348	367
2006	7	45	84	126	163	199	326	447
	Age of consumers (in years)							
	40~44	45~49	50~54	55~59	60~64	65~69	70~74	75 & older
	Grams/person/year							
1987	1,124	1,210	1,272	1,167	1,163	1,265	1,281	1,207
1988	1,083	988	977	986	1,036	1,056	1,031	936
1989	935	1,016	1,139	1,150	1,035	1,083	1,080	999
1990	1,166	1,268	1,245	1,146	1,202	1,161	1,097	996
1991	623	685	754	765	895	927	915	862
1992	1,133	1,185	1,269	1,157	1,125	1,223	1,238	1,180
1993	1,188	1,281	1,191	1,314	1,390	1,401	1,370	1,281
1994	1,325	1,449	1,516	1,533	1,510	1,581	1,623	1,565
1995	968	1,146	1,217	1,260	1,591	1,716	1,777	1,746
1996	950	1,046	1,028	1,035	1,134	1,354	1,410	1,387
1997	945	1,086	1,147	1,375	1,510	1,601	1,649	1,619
1998	846	931	1,020	1,213	1,332	1,402	1,435	1,406
1999	510	551	558	603	609	617	624	609
2000	609	715	815	910	1,011	1,161	1,325	1,341
2001	627	732	817	910	1,020	1,168	1,318	1,342
2002	496	609	727	849	975	1,090	1,185	1,192
2003	459	553	648	742	847	1,071	1,336	1,392
2004	514	626	724	784	831	929	1,063	1,117
2005	411	505	639	735	821	940	1,082	1,139
2006	552	684	826	880	902	1,004	1,171	1,237

~ means younger than or equal to, before a number, and older than or equal to, after a number.

Source: USDA, Economic Research Service, using Tanaka et al. model with *FIES* household data.

Decomposing Individual Consumption by Age From 1987 to 2006 Into Age, Cohort, and Period Effects

Applying the A/P/C analysis to the estimates of individual consumption by age group in table 4 allows for quantifying age effects for different age groups as such, cohort effects for different birth cohorts as such, and (pure) period effects for different years as such. This analysis uses the Bayesian cohort model first developed by Nakamura (1986) and modified by Clason (Mori, 2001). To overcome the "identification problem" inherent in the linear additive A/P/C model (Mason and Fienberg, 1985), Nakamura introduced *zenshintekihenka* (gradual changes) between successive parameters for the entire range of each of three effects, instead of equality of a few chosen parameters of either age, cohort, or period effects (Rodgers, 1982; Smith, 2004). These identifying constraints of zenshintekihenka are calibrated by hyperparameters ranging from 2^8 to 2^{-8} subject to ABIC (Akaike's Bayesian Information Criteria). Mathematically, the Nakamura model can be expressed as follows:

$$X_{it} = B + A_i + PE_t + C_k + E_{it} \qquad (6)$$

X_{it} : average consumption by person of i years of age at period t

B: grand mean effect

A_i : age effect to be attributed to age i years old

PE_t : period effect to be attributed to period t

C_k : cohort effect to be attributed to cohort k [12]

E_{it} : random error

Minimize:

$$\Sigma\left[X_{it} - (B + A_i + PE_t + C_k)\right]^2 \qquad (7)$$

Minimize:

$$\frac{1}{\sigma_A^2}\Sigma(A_i - A_{i+1})^2 + \frac{1}{\sigma_P^2}\Sigma(PE_t - PE_{t+1})^2 + \frac{1}{\sigma_C^2}\Sigma(C_k - C_{k+1})^2 \qquad (8)$$

$$\Sigma_i A_i = \Sigma_t PE_t = \Sigma_k C_k = 0 \qquad (9)$$

In the particular case of oranges, where the differences in consumption per person between the younger and older age groups have widened in recent years (to the order of 1 to 10), the logarithms of X_{it} perform significantly better than the untransformed variables. Table 5 provides estimates of age, period (annual year), and (birth) cohort effects on top of the grand mean effect, all in logs, which explain the changes in individual consumption of oranges by age from 1987 to 2006. For easier visual assessment, estimated cohort parameters in actual numbers are presented in table 6, although the statistical fits are substantially inferior.

[12]In the case of a standard cohort table, in which the survey period matches the age classification, a cohort in a particular age cell moves down to the next age cell at the subsequent survey period—that is, every cohort follows a diagonal line in the table. In the data used by this study, age is classified by 5-year intervals, and data are available for each year (period) from 1987 to 2006. A moving average operator in the design matrix apportions the cohorts into annual age cells. Consider cohort k in the ith age cell in 1987, for example. It is assumed that 20 percent of cohort k has moved to the next age cell (i + 1) in 1988 and that the ith age cell in 1988 comprises 20 percent of the next younger cohort (k + 1) and 80 percent of the remaining cohort k. Nakamura (1986) pioneered this general cohort analysis, and further details on the methods used in the current study are given in chapter 10, "Age in Food Demand Analysis" (pp. 323-34 in particular) in Mori (ed.), *Cohort Analysis of Japanese Food Consumption* (2001).

The data in table 4 cover all age groups from age 0 to 4 to age 75 and older. Using all the age cells from the youngest to the oldest provides more degrees of freedom in running the least square estimation of equation (7), subject to the identifying constraints of equation (8). However, previous research has shown that estimates of individual consumption by age are less stable for the younger age groups, particularly children under age 15.[13] Including these young age groups could change the size of the period effects and, consequently, other effects in the row. Therefore, the three youngest age groups, 0-4, 5-9, and 10-14, were excluded from this cohort analysis of orange consumption.

[13]For example, Ishibashi, in two publications from 2007, found several cases of negative consumption estimates for the younger age groups, using methods and data similar to those used in this study. Also, for the case of ages 0-9, in particular, see Mori, Hiroshi, and William D. Gorman, "A Cohort Analysis of Japanese Food Consumption—Old and New Generations," chapter 8 in Mori (ed.), 2001, pp. 265-6.

Table 5

Changes in individual consumption of fresh oranges, decomposed into age, period, and cohort effects

Age effects: A_i		Period effects: P_t		Cohort effects: C_k	
Age groups (years)	*Logarithm*	Calendar year	*Logarithm*	Years born	*Logarithm*
15-19	-0.1725	1987	0.1123	~ 1912	-0.1453
20-24	-0.2076	1988	0.0378	1913-17	-0.0783
25-29	-0.2221	1989	0.0693	1918-22	0.0206
30-34	-0.1494	1990	0.0933	1923-27	0.0949
35-39	-0.0534	1991	-0.1232	1928-32	0.1349
40-44	-0.0088	1992	0.1127	1933-37	0.1689
45-49	0.0050	1993	0.1167	1938-42	0.1781
50-54	0.0170	1994	0.1543	1943-47	0.1699
55-59	0.0415	1995	0.1347	1948-52	0.1695
60-64	0.0853	1996	0.0573	1953-57	0.1050
65-69	0.1518	1997	0.0860	1958-62	0.0450
70-74	0.2276	1998	0.0210	1963-67	-0.0065
75 ~	0.2855	1999	-0.2561	1968-72	-0.0289
		2000	-0.0249	1973-77	-0.0614
		2001	-0.0830	1978-82	-0.1606
		2002	-0.1168	1983-87	-0.2599
		2003	-0.0895	1988 ~	-0.3459
		2004	-0.1229		
		2005	-0.0930		
		2006	-0.0862		

Note: Grand mean effects = 0.7912 (original unit: 100 grams).
~ means lower than or equal to, before a number, and older than or equal to, after a number.
Source: Estimates from minimization exercise with original quantity data transformed into logarithms.

Discussion of Age, Period, and Cohort Effects

Results of the A/P/C analysis (tables 5 and 6) indicate that the cohort effects are roughly as important as age effects and that both are substantially more important than "pure" period effects in explaining the changes in individual at-home consumption of oranges during the past decades in Japan. Period effects are the residual after the age and cohort effects are subtracted from the estimates of individual consumption at various ages. Period effects are, thus, not an ordinary time trend but a quantity variable unique to each year with age and cohort effects controlled.

Japanese consumers eat more oranges as they age to the oldest group, 75 and older, whereas those younger than the mid-thirties, in particular, eat substantially fewer oranges than those older than age 60. At the same time, the younger generations born after the mid-1960s are found to consume many fewer oranges than the older generations who were in their late thirties through sixties in the mid-1980s. For easier visual interpretation, the following examples draw on table 6. All consumers can be thought to begin with 782 grams, the grand mean of orange consumption over the whole sample. Membership in the age group 15-19 (column 1, table 6) is estimated to subtract 252 grams (g) from orange consumption, just by virtue of being young. Someone in the group age 75 and older is estimated to add 332 g to consumption. In addition to the other factors, birth cohort membership also

Table 6

Changes in individual consumption of fresh oranges, decomposed into age, period, and cohort effects

Age effects: A_i		Period effects: P_t		Cohort effects: C_k	
Age groups (years)	*Grams*	Calendar year	*Grams*	Years born	*Grams*
15-19	-251.5	1987	146.6	~ 1912	-165.2
20-24	-241.4	1988	7.7	1913-17	-20.5
25-29	-222.7	1989	41.2	1918-22	186.8
30-34	-143.3	1990	111.5	1923-27	255.0
35-39	-12.7	1991	-222.9	1928-32	301.1
40-44	50.6	1992	141.8	1933-37	302.8
45-49	40.6	1993	183.9	1938-42	256.4
50-54	9.1	1994	306.3	1943-47	181.7
55-59	1.3	1995	242.4	1948-52	133.8
60-64	44.4	1996	75.9	1953-57	-42.9
65-69	138.3	1997	177.8	1958-62	-154.7
70-74	255.4	1998	62.9	1963-67	-209.7
75 ~	331.8	1999	-355.6	1968-72	-189.3
		2000	-63.5	1973-77	-187.3
		2001	-91.7	1978-82	-232.6
		2002	-154.7	1983-87	-184.2
		2003	-138.4	1988 ~	-231.2
		2004	-183.5		
		2005	-175.6		
		2006	-112.2		

Note: Grand mean for the sample is 781.9 grams.
~ means lower than or equal to, before a number, and older than or equal to, after a number.

Source: Estimates based on minimization using original data (not transformed into logarithms).

changes consumption (column 3, table 6). Membership in the peak orange-eating cohort, born in 1933-37, adds 303g to consumption. Membership in the cohort that eats the least oranges, born in 1978-82, subtracts 233g from consumption. Cohorts born before 1950 tend to eat, on average, 300~500g more oranges than those newer cohorts born after the mid-1970s. Those who will reach their forties in 2017 (born 1968-77) are predicted to eat 400g less oranges than those who were in their forties in the mid-1980s, for example.

The period effects plus the grand mean show annual consumption per person, with age and cohort effects excluded. Comparison of the period effects plus the grand mean with the consumption per person derived by simple division shows that the two results moved in the same directions over time (fig. 4). In all years, the period effect plus the grand mean is higher than the result from simple division. The difference is the contribution of the summed age and cohort effects, which must have been negative.[14]

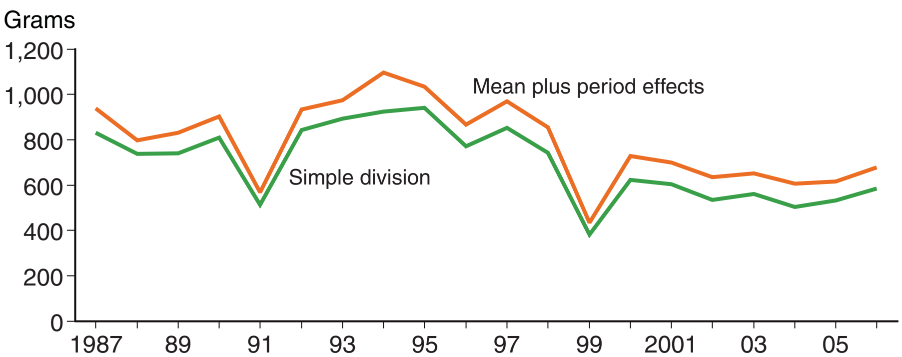
Changes in "pure" period effects derived from the A/P/C analysis seem to be slightly larger in absolute magnitude than those measured in simple consumption per person from the mid-1980s to the mid-1990s on the upward swing, and again somewhat larger in absolute magnitude from the mid-1990s to the mid-2000s on the downward swing. The aging of the population had a positive impact on total consumption, whereas the replacement of the older generations by younger generations had a negative effect (usually with a slightly larger absolute magnitude). On balance, it seems as if the demographic factors—population aging and generational replacement—mostly cancelled each other out in the case of orange consumption in the past two decades. However, will this continue to be the case in the future?

Cohort effects are quite significant in explaining the changes in orange consumption. Japan's future economy is not easy to predict, but it is quite certain that the older generations born before the mid-20th century—fruit-eating cohorts—will be steadily replaced by newer generations who tend to eat relatively little fresh fruit, for unidentified reasons. To illustrate the implications of cohort changes on orange consumption, the analysis simulates likely individual consumption by age to the year 2017, using the cohort parameters estimated earlier (see table 5 in logs). Table 7 projects individual consumption of oranges by age in 2007 and 2017 (also in 2027, with less confidence), synthesizing estimated cohort

[14]The comparison is made with the estimates using actual weights reported in table 6, rather than results from estimation using logarithms in table 5.

Figure 4

Orange consumption by individuals in Japan



Source: Mean plus period effects from weights reported in table 6 (rather than logarithmic values in table 5); simple division from household observations divided by number of persons in the household.

parameters: grand mean effect + age effect + period effects + cohort effects (and then transformed into actual numbers in grams). The period effects for the years 2007 and 2017 have not been determined, and it is assumed that they will remain at the 3-year average of 2004, 2005, and 2006. The cohort effects for the “newcomers,” who will be ages 15-19 and 20-24 in 2017, have not been estimated, and it is assumed that they will take the same values of the newest two cohorts, who were ages 15-19 and 20-24 in 2006.

In the mid-1980s through the mid-1990s, young Japanese under age 35 consumed on average more than 50 percent fewer oranges than those in their fifties and sixties (fig. 5). The disparity between the young and the old in orange consumption has widened since then, with middle-aged adults also moving away from orange consumption. It is predicted that even those in their fifties will eat less than half the oranges than those in their seventies will eat in 2017, if the demographic tendencies observed during the past two decades are assumed to continue. Trends illustrated in figure 5 suggest that the decline in at-home orange consumption since the mid-1990s will accelerate further in the decades to come.

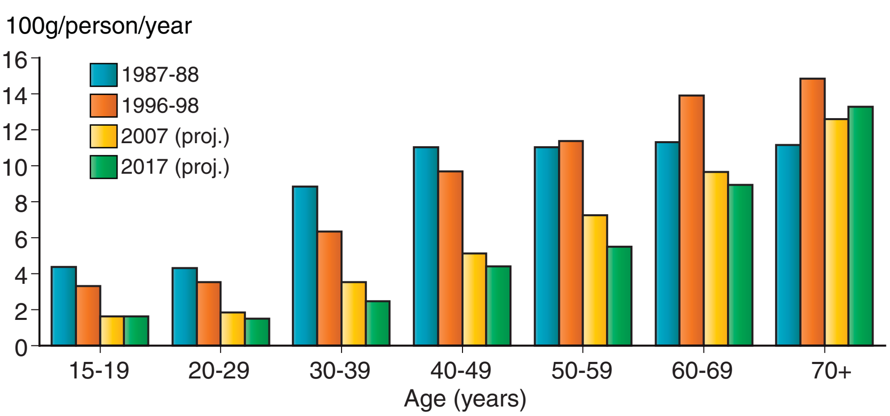
Table 7
Individual consumption of fresh oranges by age groups

Age	Actual 1994-96 average	Projected 2007	Projected 2017	Projected 2027
	Grams/person			
15-19	430	164	164	164
20-24	461	167	151	151
25-29	483	203	146	146
30-34	552	302	191	173
35-39	815	406	300	216
40-44	1,081	473	417	263
45-49	1,214	550	464	342
50-54	1,254	649	502	442
55-59	1,276	797	598	504
60-64	1,412	882	760	586
65-69	1,550	1,048	1,028	769
70-74	1,603	1,222	1,225	1,052
75 and up	1,566	1,291	1,426	1,394

Note: Period effects for the future years are assumed constant at the 2004-06 average.

Source: Synthesis of estimated cohort parameters in table 5.

Figure 5
Individual orange consumption in Japan by age group



Source: USDA, Economic Research Service.

Economic Analysis of Period Effects on Orange Consumption—Are Oranges Normal Goods in Japan?

1. Time-series approach

Japan's orange imports nearly doubled from the mid-1980s to the mid-1990s and then gradually declined to the level of 20 years ago in the mid-2000s (see table 1). Household consumption of oranges as reported in *FIES* followed the same pattern over the period. Did economic variables, such as price and income, influence these patterns?[15]

When simple per person consumption of oranges (from *FIES*, using the simple division method) is regressed against real living expenditures per person (as a proxy for income—from *FIES*) and real prices (the price index as reported in CPI surveys), over the years 1987 to 2006, the following estimates are obtained for income and price elasticities:

$$\log(CapQ_t) = 4.71 - 0.16 \log(CPI\ P_t) - 0.51 \log(LEX_t) \quad (10)$$
$$(0.58) \quad (-0.41) \quad (-0.20) \qquad R^2 = 0.0097$$

where:

$CapQ_t$ = consumption per person in the year t

$CPI\ P_t$ = real price reported by the CPI in the year t (deflated by aggregate CPI, 2005 = 100)

LEX_t = real living expenditures per person in the year t (deflated by the aggregate CPI, 2005 = 100)

The numbers in parentheses denote t-values.

The result indicates that the changes in orange consumption per person during 1987-2006 are not explained by the economic factors, own price and household income. This was anticipated, as discussed in an earlier section. Consumption per person fell after the mid-1990s, while both real price and real income remained nearly the same over the corresponding period. When consumption was regressed on real price, and only on the first 10 years, from 1987 to 1996, however, the own price is a significant variable in explaining orange consumption, with the expected negative sign: an own price elasticity around -0.6. The income variable, however, is still not significant when consumption is regressed against it. See the regression equations, (11) and (12).

$$\log(CapQ_t) = 4.20 - 0.62 \log(CPI\ P_t) \quad (11)$$
$$(9.57) \quad (-2.97) \qquad R^2 = 0.5250$$

$$\log(CapQ_t) = 1.02 + 0.62 \log(LEX_t) \quad (12)$$
$$(0.21) \quad (0.38) \qquad R^2 = 0.0181$$

Data reflect the 10 years from 1987 to 1996.

[15]Prices of possible substitutes were not included because most fresh fruits, including the domestically produced mandarin oranges, showed declines in consumption similar to or greater than those of oranges over this period, and because the annual series of observations is relatively short, making estimation with a larger number of variables difficult. See Mori et al., 2008, for further discussion of possible substitutes for oranges.

It was stated in the previous sections that the changes in orange consumption in Japan for the past two decades could be attributed partially to demographic factors, the aging of the population having a likely positive impact and the replacement of the older cohorts by the new having a negative impact. If the period effects estimated in the cohort analysis (the second columns in tables 5 and 6) represent the net period effects in orange consumption free from the demographic factors, price and income elasticities should be more accurately determined by using the period effects plus the grand mean as a dependent variable in regression analysis like that shown earlier (Mori et al., 2006a). The period effects, unique for each year, should reflect the influence of price and income changes on consumption in that year, as well as of other events or changes.

$$\log(PE_t + GM) = 3.08 - 0.08 \log(CPI\ P_t) - 0.69 \log(LEX_t) \quad (13)$$
$$(0.35) \quad (-0.20) \qquad (-0.26) \qquad R^2 = 0.0042$$

where:

PE_t = period effects for the year t, 1987 to 2006

GM = grand mean effect

Results for equation (13) reveal little, other than that the economic variables do not explain changes in orange consumption from the mid-1980s to the mid-2000s, even after accounting for the demographic impacts. When the first 10 years from the mid-1980s to the mid-1990s are examined, the following regression equations, (14) and (15), demonstrate that own price may account for some of the steady increase in orange consumption from 1987 to 1996, at an estimated own price elasticity of around -0.6, whereas income can not be deemed statistically accountable for changes in consumption, at least for the period in question.

$$\log(PE_t + GM) = 2.06 - 0.57 \log(CPI\ P_t) \quad (14)$$
$$(4.03) \quad (-2.34) \qquad R^2 = 0.4062$$

$$\log(PE_t + GM) = 0.21 + 0.22 \log(LEX_t) \quad (15)$$
$$(0.04) \quad (0.13) \qquad R^2 = 0.0020$$

where:

PE_t = period effects for the year t, 1987 to 1996

GM = grand mean effect

The same regression efforts show no significant results for the later period of the data, 1997-2006. As mentioned earlier, Japan's economy has been quite stagnant until recently. Household final consumption expenditures changed slightly from 268 trillion yen in Japan fiscal year (JFY) 1995 to 278 trillion yen in JFY2000, and 287 trillion yen in JFY2003 (all in constant 2000 yen). Thus, the steady decline in actual household orange consumption since the mid-1990s and the substantial declines in (pure) period effects from 1994 (second column, tables 5 and 6) are being contrasted to gradual and small shifts in income (recall that the price of oranges remained the same in trend during the past decade since the mid-1990s, fig. 2). Factors other than income and/or price effects may have led to the steady reduction in Japan's orange consumption in the past 10 years.

One hypothetical explanation is that the increase in consumption of bottled nonalcoholic drinks replaced the expenditures on fresh fruit. Starting in the mid-1990s, a "PET-bottle culture"[16] took root in Japan, and among young people in particular. Production per capita of PET-bottled or canned tea drinks, mainly Chinese tea and Japanese green tea, soared from under 2 liters in 1985 to 12 liters in 1990, 24 liters in 1995, 35 liters in 2000, and 44 liters in 2005. Over the same period, production (=consumption) of soda drinks and fruit drinks did not change appreciably, whereas that of PET-bottled mineral water followed the same growth pattern as tea drinks (fig. 6). The price of a bottle or can of tea drink (350-500 cc) is about the same as the price of one orange, apple, peach, or a large-sized mandarin.

[16]PET is an acronym for polyethylene terephthalate. PET bottles are commonly referred to as plastic bottles.

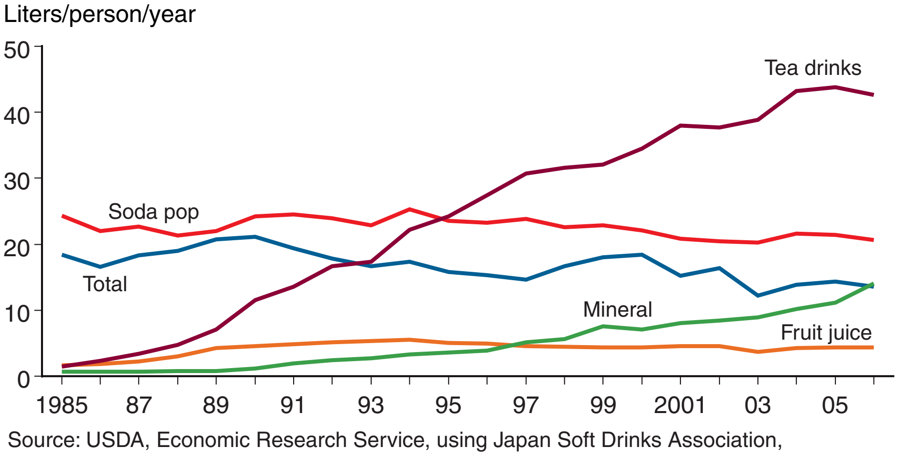
It is difficult to consider PET-bottled soft drinks directly in the category of substitutes for fresh fruit, including oranges. However, it is clear that some forces unfavorable to fresh fruit consumption in the Japanese market have been present during the past decade or so. Adding a simple straight time trend to the regression equations (10) and (13) allows for obtaining the following results of equations, (16) and (17). The results suggest that income elasticities for oranges are not statistically different from zero; that is, oranges are not deemed either an inferior or a normal good, whereas the own-price elasticity is about -1.4, with substantially improved t-values and coefficients of determination.

$$\log(CapQ_t) = 8.40 - 1.37 \log(CPI\,P_t) + 0.25 \log(LEX_t) - 1.42 \log T \quad (16)$$
$$(2.47)(-6.57) \qquad (0.24) \qquad (-9.16) \quad R^2 = 0.8416$$

$$\log(PE_t + GM) = 6.80 - 1.39 \log(CPI\,P_t) + 0.21 \log(LEX_t) - 1.54 \log T \quad (17)$$
$$(1.99)(-6.55) \qquad (0.20) \qquad (-9.68) \quad R^2 = 0.8547$$

Figure 6

Bottled beverage production in Japan



Source: USDA, Economic Research Service, using Japan Soft Drinks Association, Annual Report, various issues.

where:

T = trend dummy starting from 10 at 1987 to increase by 0.5 annually

Data are from 1987 through 2006.

The time trend is quite significant. Its coefficient, -1.5 in equation (17), illustrates the generally declining values of the trend over time. In general, each succeeding year has a smaller period effect or a negative period effect in 1995-2006 (fig. 7).

2. Cross-sectional approach

Differences in demand for oranges can also be seen in a cross-section of households at a given time, as well as in averages of households over a period of years (as examined earlier). Access to the *FIES* panel data of oranges and beef classified by household types provides other opportunities to investigate income effects while circumventing the age factors in consumption (Mori et al., 2006b).

This approach uses the data for four major household types: a married couple with HH in the thirties and two children under age 10; a married couple with HH in the forties and two teenagers; a married couple with HH in the fifties and one child in the twenties; and a married couple with HH in the sixties with no dependents. Each household type includes approximately 2-4,000 samples.

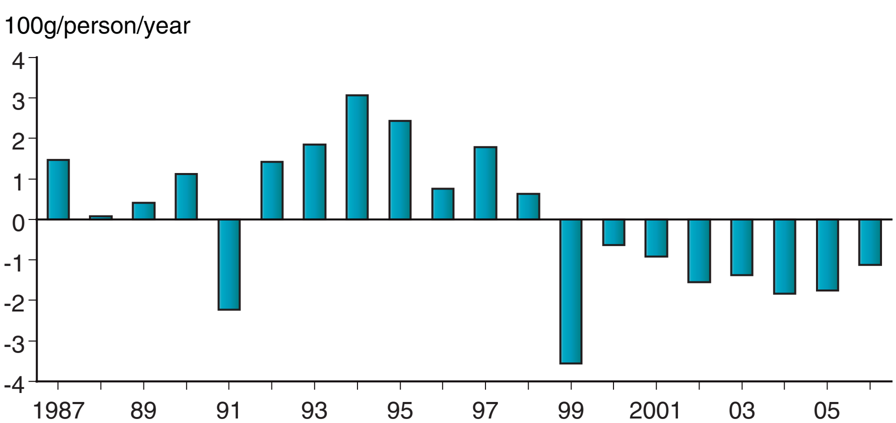
Every household reports monthly purchases of various commodities, including oranges, and annual incomes earned during the 12 months prior to the survey month. This analysis uses the 6 months from March through August because the other months are less important for orange consumption in Japan.

Following the lead of Prais and Houthakker,[17] simple double-log regressions of average consumption (monthly purchases) were run against annual incomes by selected income groups, excluding extremely low and high incomes (roughly the bottom and top 5 percent, respectively).

[17]See pp. 79-108.

Figure 7

Period effects on orange consumption in Japan



Source: Values are from estimates contained in table 7.

For 1987, oranges are found to be income positive for all household types, with the elasticity ranging from 0.4 to 0.6, significantly different from zero (table 8). In other years, 1999 and 2001, for example, the elasticities vary from zero to greater than 1.0. For 1997, the estimates are found to be insignificant except for the age group of HHs in the sixties. Generally, oranges are estimated as income positive, but statistically the estimates are not conclusive and not consistent over the period 1987-2006.

As an additional approach, all households are classified into income-quintile groups, by four HH types. Within each quintile group, households are arrayed according to the amount of monthly purchases, from zero to 5 kg of oranges in 2001 (households that purchased more than 5 kg of oranges account for less than 0.5 percent of all households in any household type and are deemed "outliers"). In table 9, the share of households reporting zero purchases in any specific month is found in the first row in each household type. The second row provides the average of monthly purchases by those households that reported more than zero consumption.

Table 10 provides the cross-sectional findings enumerated in the same manner for beef in 1997.[18] The percentages of zero (monthly) purchases are 10 to 30 percent, substantially smaller than the case of oranges, which average slightly over 80 percent. The differences between the two cases are striking: first, the percentage of zero purchases tends to decline as the group income increases for beef, whereas the zero percentage does not vary by income group for oranges; second, the average size of monthly purchases by those households which recorded purchases greater than zero tends to increase as the group income increases for beef, whereas that for oranges does not vary by income group.

It may be safe to conclude that beef should be truly a "normal" good in two senses: as income increases, more households tend to buy beef and in

[18]The year 2001 was not selected for beef because of outbreaks of BSE, or bovine spongiform encephalopathy, that year.

Table 8

Estimates of cross-sectional income elasticities for oranges derived from panel data classified by household types

$Ln(Q) = a + b\, Ln(Y)$ (1)

Age of household head	30s			40s			50s			60s		
Age of spouse	30s			40s			50s			60s		
Age of children	Under 10			10-20			20s					
Number of children	2			2			1			0		
	Income elasticity	Adjusted R^2	t-value	Income elasticity	Adjusted R^2	t-value	Income elasticity	Adjusted R^2	t-value	Income elasticity	Adjusted R^2	t-value
1987	0.39	0.17	1.84	0.64	0.45	3.55	0.44	0.1	1.68	0.45	0.20	2.02
1989	1.39	0.70	4.47	0.62	0.22	2.11	0.79	0.34	3.23	0.18	0.05	1.32
1991	0.37	0.06	1.40	0.86	0.40	3.02	0.99	0.44	3.11	0.07	-0.06	0.29
1997	0.38	0.02	1.11	0.18	-0.02	0.77	-0.04	-0.05	-0.14	0.65	0.38	3.17
1999	1.25	0.41	3.04	0.06	-0.1	0.08	0.79	-0.04	0.72	0.25	0.07	1.56
2001	1.44	0.61	4.05	1.03	0.24	2.45	-0.04	-0.05	-0.14	0.25	0.03	1.30

Note: Q = monthly household purchase; Y = annual household income; b = income elasticity; t-value is for the parameter b.

Source: USDA, Economic Research Service, using equation (1). Households in each household type are grouped by every 0.5 million yen in annual income.

greater amount on average. In contrast, oranges are not income-related in any sense: the share of households that purchases oranges may not respond positively to the increase in average income of the group, and the mean of household purchases may not increase as income increases. Cross-sectionally, oranges are deemed to be neither a "normal" nor an "inferior" good in terms of economics.

Table 9
Household monthly fresh orange purchases by income quintile; frequency of zero-purchase households and average amount of monthly purchases by those registering more than zero purchases in each month, March to August, 2001

	Income quintile groups				
	I	II	III	IV	V
	Parents in 30s and two children under 10:				
Zero-purchase households (*percent*)	89.95	90.23	88.69	86.69	85.85
Average amount of purchases by nonzero households (*kg*)	1.023	0.922	1.088	1.113	1.333
	Parents in 40s and two teenagers:				
Zero-purchase households (*percent*)	85.52	80.92	81.63	77.03	84.45
Average amount of purchases by nonzero households (*kg*)	1.064	1.242	1.233	1.191	1.383
	Parents in 50s and one child in 20s:				
Zero-purchase households (percent)	81.13	83.11	81.13	79.8	84.44
Average amount of purchases by nonzero households (*kg*)	1.249	1.169	1.107	1.482	1.106
	Parents in 60s with no dependents:				
Zero-purchase households (*percent*)	86.53	80.53	82.13	81.73	83.2
Average amount of purchases by nonzero households (*kg*)	1.334	1.476	1.434	1.412	1.532

Source: USDA, Economic Research Service, using *FIES* panel data.

Table 10

Household monthly beef purchases by income quintile; frequency of zero-purchase households and average amount of monthly purchases by those registering more than zero purchases in each month, 1997

	Income quintile groups				
	I	II	III	IV	V
	Parents in 30s and two children under 10:				
Zero-purchase households (*percent*)	24.3	22.5	18	19.5	15.8
Average amount of purchases by nonzero households (*kg*)	0.887	0.891	0.901	1.021	1.091
	Parents in 40s and two teenagers:				
Zero-purchase households (*percent*)	11.3	7.2	9.5	9.5	9.5
Average amount of purchases by nonzero households (*kg*)	1.633	1.493	1.599	1.674	1.787
	Parents in 50s and one child in 20s:				
Zero-purchase households (*percent*)	14.5	15.2	14.6	14.6	15.4
Average amount of purchases by nonzero households (*kg*)	1.215	1.148	1.147	1.134	1.175
	Parents in 60s with no dependents:				
Zero-purchase households (*percent*)	38.9	34	32.6	30.8	26.5
Average amount of purchases by nonzero households (*kg*)	0.792	0.76	0.786	0.822	0.937

Source: USDA, Economic Research Service, using *FIES* panel data.

Conclusions

The orange market in Japan, largely supplied by U.S. growers, has declined since the mid-1990s. Declining consumption per person is difficult to explain using the effects of income and price changes. Consumption per person, defined as simple division of household consumption of oranges by all household members, ignores differences in age, which may affect consumption. In fact, it is readily apparent that both age and cohort membership affect household orange consumption in Japan.

Both cohort and age effects are found to be strong. As individuals age, they generally eat more oranges per year, according to this analysis. Membership in a decadal birth cohort that was born in the first half of the 20th century is associated with relatively high levels of orange consumption; decadal birth cohorts since the mid-20th century have consumed progressively fewer oranges. These two demographic effects have tended to cancel each other out.

The Japanese market is quite important to U.S. producers. This investigation indicates that consumption of oranges may decline further, both as a result of an unexplained, but strong, negative time trend and as a result of generational changes: as today's older cohorts die off, U.S. oranges are losing their best customers.

It appears that the price of oranges does matter to consumers in Japan. Reducing or eliminating tariffs could lead to lower orange prices in Japan. Also, reductions in the margin between import and retail prices would lead to lower retail prices. Substantially reduced retail prices of oranges might appeal particularly to young households, which typically have lower incomes among all households in the Japanese labor market.

Japan's household consumption data provide an excellent opportunity to study consumer behavior. In the case of consumption of fresh fruits, including oranges, it appears that systematic, age-related changes are underway that lead to lower consumption of foods that are generally regarded as good for health. Further studies of consumption of fresh fruits and other foods in other countries may also show strong effects of age and cohort membership. Studies establishing the presence and extent of such effects can provide the basis for consumer surveys that examine why these effects occur and what marketing steps might be effective in addressing them.

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