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:

$$\log(CapQ_t) = 4.71 \underset{(0.58)}{} - \underset{(-0.41)}{0.16 \log(CPI\ P_t)} - \underset{(-0.20)}{0.51 \log(LEX_t)} \qquad (10)$$

$$R^2 = 0.0097$$

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).

$$\log(CapQ_t) = 4.20 \underset{(9.57)}{} - \underset{(-2.97)}{0.62 \log(CPI\ P_t)} \qquad (11)$$

$$R^2 = 0.5250$$

$$\log(CapQ_t) = 1.02 + \underset{(0.38)}{0.62 \log(LEX_t)} \qquad (12)$$

$$R^2 = 0.0181$$

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.

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

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.

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

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

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.

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.

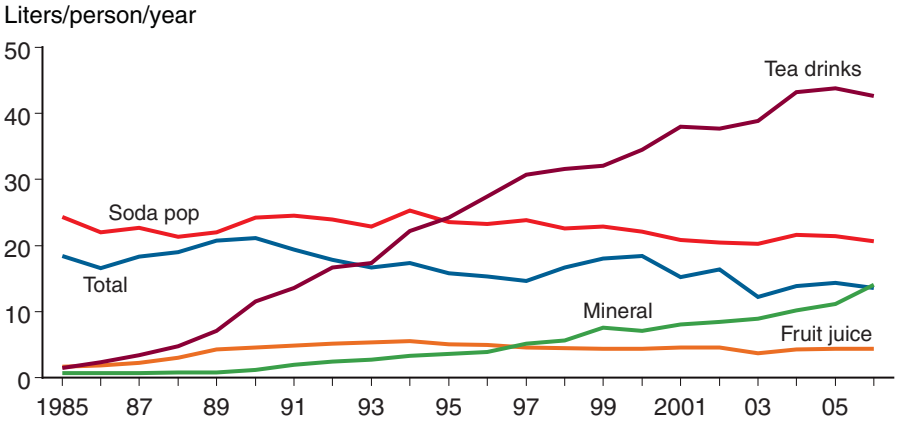
$$\log(CapQ_t) = 8.40 - 1.37\log(CPI\,P_t) + 0.25\log(LEX_t) - 1.42\log T \quad (16)$$
$$(2.47)\quad (-6.57)\quad (0.24)\quad (-9.16)\quad R^2 = 0.8416$$

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

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

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.

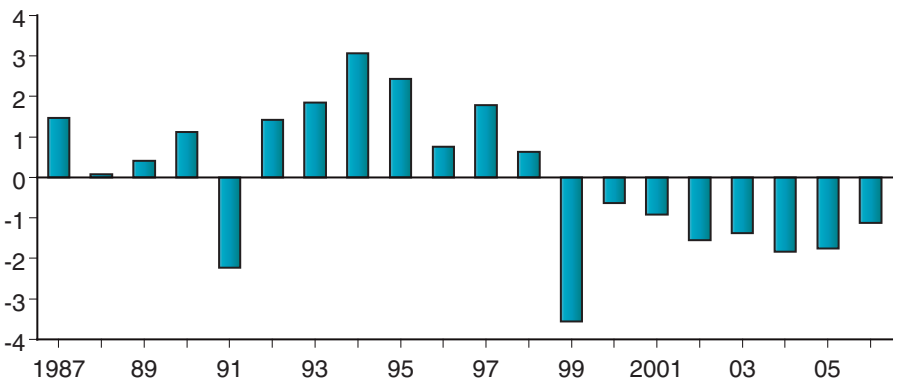
Every household reports monthly purchases of various commodities, including oranges, and annual incomes earned during the 12 months prior to the survey month. This analysis uses the 6 months from March through August because the other months are less important for orange consumption in Japan.

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.