

# Food-at-home expenditures of Asian households

*Differences in weekly average expenditures suggest a race effect in spending on food-at-home items; Asian households spend more than other households on fresh fruits, fresh vegetables, rice, and seafood and less on dairy products and oils*

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Asian Americans are one of the fastest growing racial groups in terms of percentage increase in the United States.<sup>1</sup> According to Census estimates, the Nation's Asian and Pacific Islander population grew 43.0 percent to 10.8 million between 1990 and 1999; projections to 2050 are for a tripling in size to 33.4 million.<sup>2</sup> The growth of the Asian American population, together with the growing interest in healthful and diverse diets, has contributed to Asian food becoming more popular. Aside from the proliferation of Asian eateries in local neighborhoods, restaurants in major metropolitan areas such as New York, Los Angeles, San Francisco, Washington, D.C., and Seattle are offering Asian-influenced recipes from different Asian countries, served with an upscale American style.

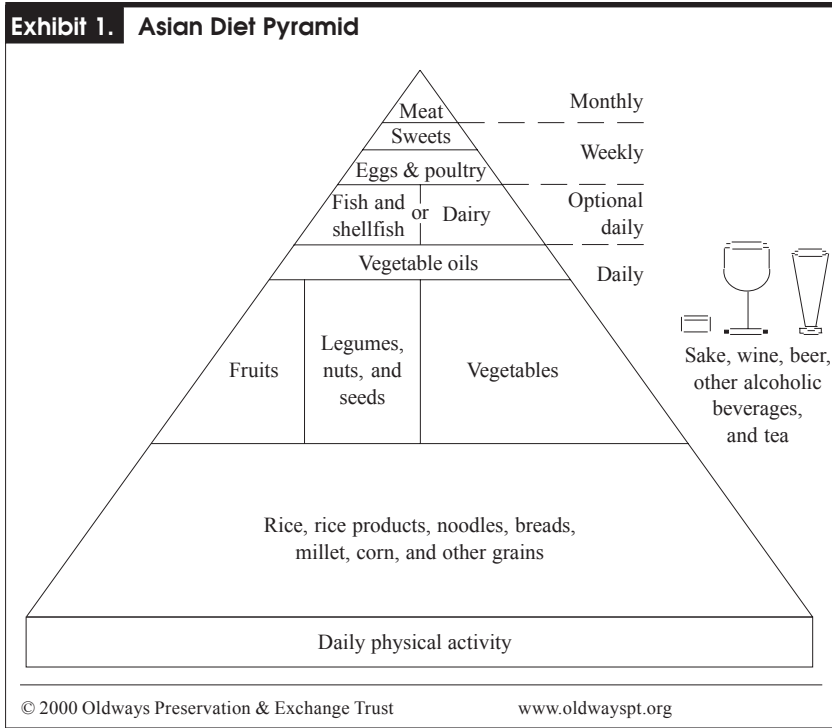
The traditional plant-based rural diets of Asia are reflected in the Asian Diet Pyramid. (See exhibit 1.) Researchers at Cornell and Harvard University teamed up with other experts and the non-profit foundation, Oldways Preservation & Exchange Trust, to unveil the Asian Diet Pyramid. The Asian Diet Pyramid was based on a survey of more than 10,000 families in mainland China and Taiwan that studied diet, lifestyle, and disease across the far reaches of China. The pyramid emphasizes rice, rice products, noodles, breads, and grains (preferably whole grain and minimally processed foods), topped by another large band of

fruits, vegetables, legumes, nuts, and seeds. Small daily servings of low fat dairy products or fish are optional; sweets, eggs, and poultry are recommended no more than weekly, and red meat no more than monthly.

Does the allocation of food-at-home spending by Asian households in the United States differ from households of other races? Does the food-at-home spending by Asian households reflect the plant-based traditional diets of rural Asia? This article compares national estimates of food-at-home expenditures by Asian households in the United States with non-Asian households, using data from the 2003 Consumer Expenditure Diary Survey. Food expenditure shares are further examined by regression analyses to study the race effect after controlling for other demographic characteristics.

## Data

The Consumer Expenditure Survey (CE) is an ongoing nationally representative survey of the noninstitutionalized, civilian population of consumer units (CU's).<sup>3</sup> For the purpose of this article, CU's are treated, and will henceforth be referenced, as households. The CE consists of two independent components, the quarterly Interview Survey and the weekly Diary Survey. Each survey has its own independent sample, and each col-



lects data on income and demographic characteristics of the consumer unit. The Interview Survey includes monthly out-of-pocket expenditures such as housing, apparel, transportation, healthcare, insurance, and entertainment. The Diary Survey includes weekly expenditures of frequently purchased items such as food and beverages, tobacco, personal care products, and nonprescription drugs and supplies. In the Diary Survey, respondents are asked to record all their daily expenditures over 1 week in a paper diary, for 2 consecutive weeks. Information on the quantity of purchase is not captured. In the analysis data set, each observation represents one diary (that is, a household's recorded expenditures for 1 week). Each diary is treated as an independent observation.

This article is based on data from the 2003 Consumer Expenditure Diary Survey. The sample of 15,827 observations represented 115.1 million households of which 3.1 percent were Asian households.<sup>4</sup> In this article, an Asian household is defined as a household where all its members are reported as Asians.<sup>5</sup> The overall response rate in the 2003 Diary was 76.2 percent, with a response rate of 85.9 percent among Asian households and 75.9 percent among other households.<sup>6</sup> In the diary, respondents are asked to indicate if the purchase was made for the household or as a gift. The data used in this article is for food-at-home purchases made only for the household.

**Demographics.** Asian households on average are slightly

larger in size (2.6 members versus 2.5 members for other households), with younger members (average member age of 38.5 years versus 42.2 years for other households), and a lower proportion of them have no earners (13.9 percent versus 19.7 percent). (See table 1.) There are more husband and wife with children and/or other related or unrelated members among Asian households (36.2 percent versus 29.2 percent for other households). Almost half of all Asian households live in the West (47.7 percent versus 21.2 percent for other households), in urban central cities (47.5 percent versus 29.4 percent for other households), and more than 90 percent live in a metropolitan statistical area. Less than half of Asian households are home-owners (46.8 percent versus 67.4 percent for other households).

Asian households have a higher proportion of male reference persons (57.3 percent versus 42.8 percent for other households) and reference persons who are college graduates (52.5 percent versus 27.4 percent of other households).<sup>7</sup> The average reference person of Asian households is younger (43.6 years versus 48.2 years for other households).

**Food categories.** The food categories formed for analyses in this article were based on MyPyramid, a tool developed by the U.S. Department of Agriculture (USDA) to assist consumers make healthy food choices.<sup>8</sup> MyPyramid provides suggested serving sizes to control the amount of calories, fat, saturated fat, cholesterol, sugar, or sodium, based on basic food groups. Food categories developed for this article—grains, meats, vegetables, fruits, dairy, and oils—were created to match the MyPyramid food categories where possible. (See exhibit 2.) One discrepancy is that the vegetables category in this article includes beans (by definition of the Diary Survey food item elements), whereas beans are included in MyPyramid's meats category.

## Descriptive statistics

Reporting rates, average weekly expenditure shares, and share of total food-at-home expenditures are examined in this section. Data are weighted to reflect the U.S. population.

**Reporting rates.** The reporting rate of a food item or category is defined here as the proportion of households who report making at least one purchase of the item during the

**Table 1. General demographic characteristics of Asian households, 2003 Consumer Expenditure Diary Survey**

Characteristic	All households	Asian households	Other households
Sample .....	15,827	532	15,295
Population (in thousands) .....	115,077	3,565	111,511
<b>Household characteristics</b>			
Income before tax <sup>1</sup> .....	\$50,343	\$58,943	\$50,076
Average member age (years) .....	42.1	38.5	<sup>2</sup> 42.2
Number of persons under age 18 .....	.6	.5	<sup>2</sup> .6
Number of persons older than age 64 .....	.3	.2	<sup>2</sup> .3
Number of members .....	2.5	2.6	<sup>2</sup> 2.5
Number of earners .....	1.3	1.4	1.3
Homeowner (percent) .....	66.8	46.8	67.4
Live in a metropolitan statistical area (percent) .....	79.6	93.7	79.2
Percent distribution:			
Household composition			
Singles .....	28.8	27.6	28.8
Husband and wife only .....	22.1	19.8	22.2
Husband and wife with children .....	26.2	28.8	26.1
Husband and wife – other .....	3.2	7.4	3.1
Single parent with children .....	6.0	1.4	6.2
Other .....	13.7	15.0	13.7
Earner composition			
Reference person only .....	30.6	33.3	30.5
Spouse only .....	6.3	5.7	6.3
Reference person and spouse .....	23.7	23.5	23.7
No earners .....	19.5	13.9	19.7
Other .....	19.9	23.6	19.8
Region of residence			
Northeast .....	19.3	22.9	19.1
Midwest .....	23.6	12.9	24.0
South .....	35.1	16.5	35.7
West .....	22.0	47.7	21.2
Area type			
Urban – central city .....	30.0	47.5	29.4
Urban – other .....	57.6	51.9	57.7
Rural .....	12.5	.7	12.9
<b>Reference person characteristics</b>			
Age (years) .....	48.1	43.6	<sup>2</sup> 48.2
Male (percent) .....	48.9	57.3	42.8
Educational attainment (percent distribution):			
Less than high school .....	13.7	9.3	13.9
High school graduate .....	28.9	17.8	29.3
Some college .....	29.1	20.5	29.4
College graduate .....	28.2	52.5	27.4

<sup>1</sup> Income before tax for complete income reporters only; excludes meals as pay and rent as pay.

<sup>2</sup> Indicates significant difference at 5 percent between Asian and other

consumer units.

NOTE: An Asian consumer unit consists of all Asian members.

survey week, or an item in the category; it does not indicate the frequency of purchase nor the quantity consumed. By food categories, a larger proportion of Asian households reported purchasing fruits (70.2 percent versus 62.4 percent for other households) and vegetables (68.5 percent versus 60.6 percent for other households), and a smaller proportion of Asian households reported purchasing dairy (59.9 percent versus 69.1 percent for other households) and nonalcoholic beverages (47.1 percent versus 57.5 percent for other households). (See table 2.) Reporting rates on grains (68.8 percent versus 71.6 percent for other households) and meats (68.7 percent versus 67.2 percent) were comparable between

Asian and other households. Differences in reporting rates at a lower level of aggregation show Asian households' reporting rates on the purchase of seafood, fresh fruits, and fresh vegetables are 10 or more percentage points higher than other households. (See chart 1.) Their reporting rates on cereals other than rice, processed vegetables, sweets, milk and other dairy products, oils, carbonated drinks, and other meat are 10 or more percentage points lower than other households.

*Average weekly expenditures.* Table 2 also shows that Asian households spend on average \$60.16 per week on food at

**Exhibit 2. Composition of food categories used in this article**

USDA MyPyramid category	MyPyramid category descriptions	Consumer Expenditure Diary Survey food items used to form the food groups in this article
Grains	Any food made from wheat, rice, oats, cornmeal, barley, or another cereal grain is a grain product. Bread, pasta, oatmeal, breakfast cereals, tortillas, and grits are examples of grain products.	Cereals, rice, cereal products, pasta, and bakery products
Meat <sup>1</sup>	All foods made from meat, poultry, fish, dry beans or peas, eggs, nuts, and seeds are considered part of this group. Dry beans and peas are part of this group as well as the vegetable group.	Beef, pork, other meat, poultry, seafood, and eggs
Vegetables <sup>1</sup>	Any vegetable or 100 percent vegetable juice counts as a member of the vegetable group. Vegetables may be raw or cooked; fresh, frozen, canned, or dried/dehydrated; and may be whole, cut-up, or mashed.	Fresh and processed vegetables, including juices, beans, and peas
Fruits	Any fruit or 100 percent fruit juice counts as part of the fruit group. Fruits may be fresh, canned, frozen, or dried, and may be whole, cut-up, or pureed.	Fresh and processed fruits, including juices
Dairy products	All fluid milk products and many foods made from milk are considered part of this food group.	Milk, cream, cheese, butter, ice cream, and other dairy products
Oils	Oils are fats that are liquid at room temperature, like the vegetable oils used in cooking. Foods that are mainly oil include mayonnaise, certain salad dressings, and soft (tub or squeeze) margarine with no trans fats.	Margarine, fats and oils, salad dressings, nondairy cream and imitation milk, and peanut butter

<sup>1</sup> For this article, the vegetables category includes beans, whereas beans are included in MyPyramid's meats category.

NOTE: The six food groups used in this article were formed by grouping

food items according to the U.S. Department of Agriculture's (USDA) MyPyramid. More information on MyPyramid is available on the Internet at <http://www.mypyramid.gov/pyramid>.

home, comparable with other households who spend \$59.45 per week. Among food categories, Asian households spend significantly more on fruits (\$7.54 versus \$5.30 for other households) and vegetables (\$7.48 versus \$4.84 for other households), and significantly less on dairy (\$4.54 versus \$6.36 for other households) and oils (\$1.10 versus \$1.67 for other households). At lower levels of food aggregation, Asian households spend less on sweets (\$1.69 versus \$2.31 for other households), but four times more than other households on rice (\$1.25 versus \$0.28 for other households), two times more on seafood (\$5.88 versus \$2.28 for other households), and almost two times more on fresh vegetables and fresh fruits. Asian households' higher spending on seafood and poultry accounted for their higher overall expenditure on meats.

*Shares of total food-at-home expenditures.* Almost one-quarter of the Asian households' food-at-home expenditures was allocated to fruits and vegetables, and mostly to fresh fruits (8.8 percent) and fresh vegetables (10.4 percent). (See chart 2.) In contrast, fruits and vegetables composed about one-sixth of other households' food-at-home expenditures. Meats made up 30.1 percent of Asian households' food-at-

home expenditures, with seafood composing 9.8 percent. In contrast, meats composed 26.6 percent of other households' food-at-home expenditures, with a smaller share to seafood (3.8 percent). The shares of dairy (7.5 percent versus 10.7 percent for other households), beef (5.7 percent versus 8.0 percent for other households), and oils (1.8 percent versus 2.8 percent for other households) were significantly less for Asian households.

The descriptive statistics show that, compared with other households, more Asian households report purchases of fresh fruits, fresh vegetables, seafood, and rice; Asian households also spend more on and allocate a larger share of food-at-home expenditures to these food items compared with other households. Fewer Asian households report purchases of dairy products, beef, and oils; Asian households also spend less on and allocate a smaller share of food-at-home expenditures to these food items.

### Regression analyses

To assess the effect of race (Asian versus other races) on the allocation of food category expenditures as a share of total

**Table 2. Food at home: reporting rates, average expenditures, and expenditure shares, 2003 Consumer Expenditure Diary Survey**

Food at home	Reporting rates (percent)		Average weekly expenditures		Share of total food-at-home expenditures (percent)	
	Asian households	Other households	Asian households	Other households	Asian households	Other households
Total food at home .....	84.4	83.1	\$60.16	\$59.45	100.0	100.0
Grains <sup>1</sup> .....	68.8	71.6	7.98	8.51	13.3	14.3
Other cereal .....	34.8	45.9	2.08	2.59	3.5	4.4
Rice .....	15.7	9.1	1.25	<sup>3</sup> 2.28	2.1	<sup>3</sup> 5.5
Baked products .....	60.4	67.4	4.65	<sup>3</sup> 5.64	7.7	<sup>3</sup> 9.5
Meat <sup>1</sup> .....	68.7	67.2	18.11	15.79	30.1	26.6
Beef .....	30.4	38.1	3.43	<sup>3</sup> 4.76	5.7	<sup>3</sup> 8.0
Pork .....	35.6	35.2	3.12	3.29	5.2	5.5
Other meat .....	21.1	34.0	1.44	<sup>3</sup> 1.98	2.4	<sup>3</sup> 3.3
Poultry .....	36.1	32.4	3.44	2.76	5.7	4.6
Seafood .....	39.7	23.9	5.88	<sup>3</sup> 2.28	9.8	<sup>3</sup> 3.8
Eggs .....	32.4	35.0	.82	.71	1.4	1.2
Dairy <sup>1</sup> .....	59.9	69.1	4.54	<sup>3</sup> 6.36	7.5	<sup>3</sup> 10.7
Milk products .....	47.4	58.4	2.08	<sup>3</sup> 2.44	3.5	<sup>3</sup> 4.1
Other dairy .....	39.3	51.6	2.46	<sup>3</sup> 3.92	4.1	<sup>3</sup> 6.6
Fruit <sup>1</sup> .....	70.2	62.4	7.54	<sup>3</sup> 5.30	12.5	<sup>3</sup> 8.9
Fresh fruit .....	64.3	53.0	5.32	<sup>3</sup> 3.22	8.8	<sup>3</sup> 5.4
Processed fruit .....	42.0	41.7	2.22	2.08	3.7	3.5
Vegetables <sup>1</sup> .....	68.5	60.6	7.48	<sup>3</sup> 4.84	12.4	<sup>3</sup> 8.1
Fresh vegetables .....	64.7	53.0	6.26	<sup>3</sup> 3.21	10.4	<sup>3</sup> 5.4
Processed vegetables .....	28.3	38.7	1.22	1.63	2.0	2.7
Fats and oils <sup>1</sup> .....	22.4	36.4	1.10	<sup>3</sup> 1.67	1.8	<sup>3</sup> 2.8
Sweets <sup>2</sup> .....	33.3	43.2	1.69	<sup>3</sup> 2.31	2.8	<sup>3</sup> 3.9
Nonalcoholic beverages <sup>2</sup> .....	47.1	57.5	4.55	5.18	7.6	8.7
Carbonated drinks .....	26.2	43.1	1.40	<sup>3</sup> 2.61	2.3	<sup>3</sup> 4.4
Coffee .....	8.4	12.9	.53	.74	.9	1.2
Tea .....	9.2	8.9	.63	.33	1.1	.6
Other nonalcoholic drinks .....	30.5	29.2	1.98	1.50	3.3	2.5
Miscellaneous food <sup>2</sup> .....	61.1	64.1	7.16	<sup>3</sup> 9.49	11.9	<sup>3</sup> 16.0
Frozen and prepared .....	14.5	24.2	1.19	<sup>3</sup> 2.04	2.0	<sup>3</sup> 3.4
Packaged and canned soup .....	12.4	20.3	.62	.68	1.0	1.1
Snacks .....	29.5	37.7	1.73	2.04	2.9	3.4
Condiments .....	36.7	38.2	1.62	1.74	2.7	2.9
Other prepared food .....	32.8	40.2	2.00	<sup>3</sup> 2.99	3.3	<sup>3</sup> 5.0

<sup>1</sup> These are food items belonging to the six U.S. Department of Agriculture (USDA) food categories described in exhibit 2.

<sup>2</sup> Sweets, nonalcoholic beverages, and miscellaneous food are other food groups in addition to the six USDA food categories.

<sup>3</sup> Indicates difference between Asian households and other households is statistically significant at 5 percent. Standard errors for mean expenditures

and expenditure shares are shown in table A-1 in the Appendix.

Notes: The average weekly expenditure for households shown in the table is the average overall households in the sample. The conditional average weekly expenditure (conditioned on households purchasing a particular item) can be computed by dividing the average weekly expenditure by the reporting rate.

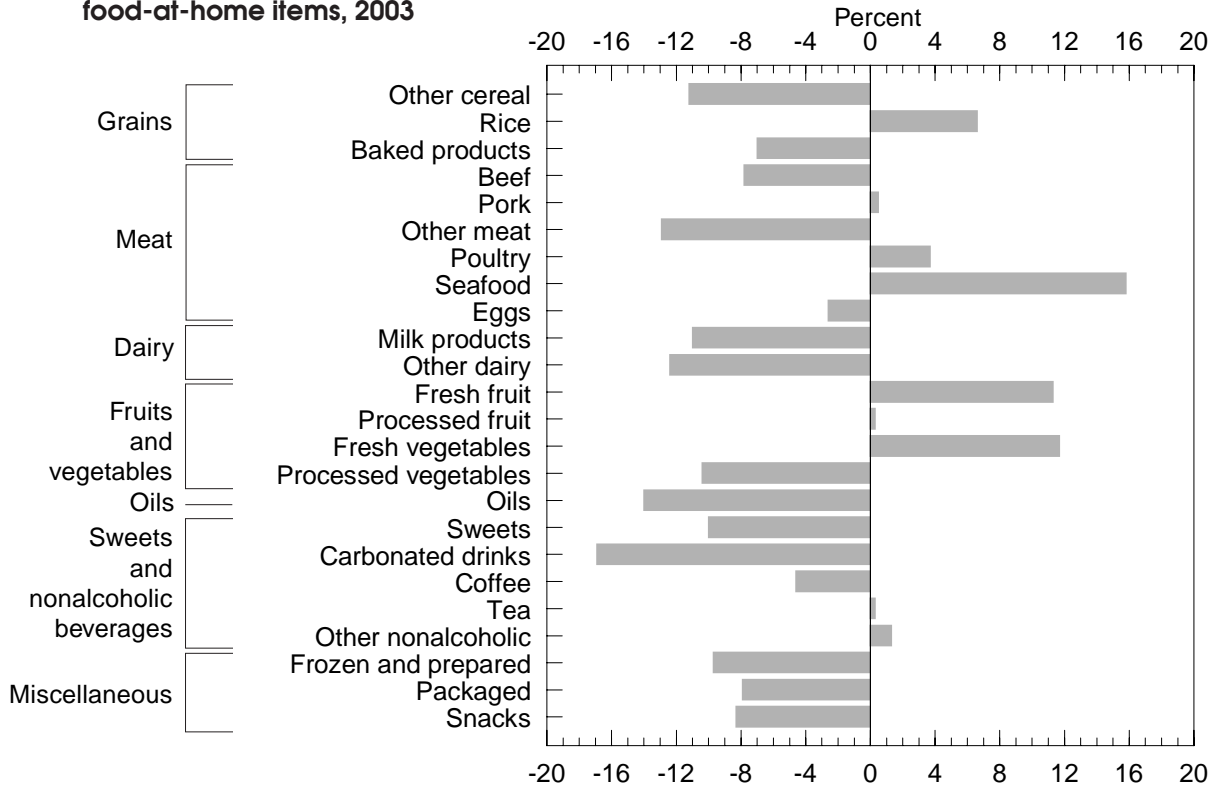
food-at-home expenditures, three regressions (Ordinary Least Squares (OLS), Heckman two-stage estimation procedure, and Tobit model) were performed, with controls for demographic characteristics expected to affect food expenditures. (See exhibit 3 for the independent variables used in the regressions.) About 16 percent of the households in the sample did not report any food-at-home items for the survey period; they were dropped, leaving a sample of 13,275 used in regression analyses. The regressions were performed on unweighted data.<sup>9</sup>

Given the 2-week survey period, households can be expected to report zero expenditures on some food items and categories. In the sample, zero expenditures ranged from

13.8 percent (of all records with food-at-home expenditures greater than zero) for grains to 56.7 percent for oils. (See table 3.) Zero expenditures for a specific food category may occur because (1) the timing of the survey period did not capture the cu's purchase on a specific food category<sup>10</sup> or (2) the result of personal preferences (for example, vegetarians will not purchase any meat). Thus, households that make a purchase may have different preference structures from nonpurchasers, raising the possibility of sample selection bias so that inference to the population is not appropriate.<sup>11</sup>

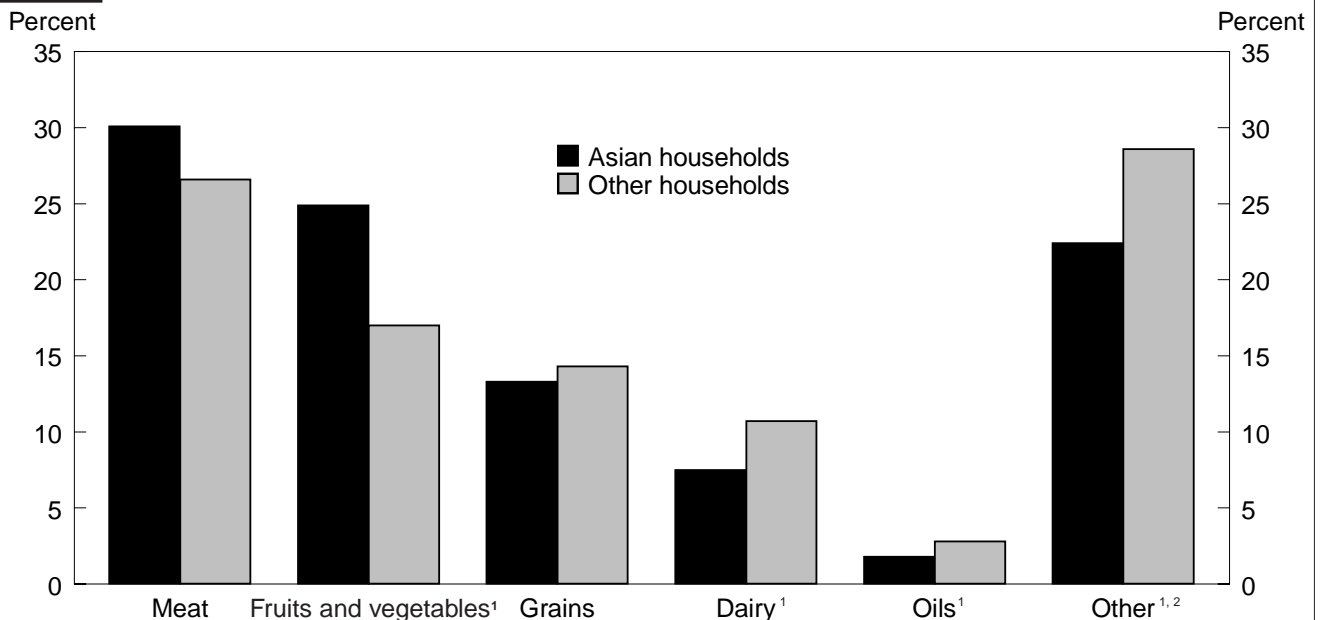
Using OLS estimation on censored dependent variables (the expenditure shares) could yield inconsistent parameter estimates.<sup>12</sup> The Heckman two-stage estimation procedure as-

**Chart 1. Difference in reporting rates between Asian households and other households of selected food-at-home items, 2003**



NOTE: Difference in reporting rate defined as (Asian household reporting rate — other household reporting rate). Chart data based on table 2.

**Chart 2. Shares of food categories in total food-at-home expenditures, 2003**



<sup>1</sup> Indicates difference between Asian households and other households is significant at 5 percent.

<sup>2</sup> The "Other" food category refers to sweets, nonalcoholic beverages, and miscellaneous foods (such as frozen, prepared, packaged, canned soup, snacks, and condiments).

NOTE: Chart data based on table 2.

**Exhibit 3. Description of variables used in the regressions**

Variable name	Type	Description
DASIAN	Binary	Asian household (all members are Asians)
DRURAL	Binary	Urbanization status of the consumer unit dwelling - Rural
FAM_SIZE	Numeric	Size of the consumer unit
DFAMCOMP1	Binary	Family relationship within household - Single
DFAMCOMP2	Binary	Family relationship within household - Husband and wife only
DFAMCOMP3	Binary	Family relationship within household - Husband and wife with children
DFAMCOMP4	Binary	Family relationship within household - Single parent with children
DNORTHEAST	Binary	Region of residence of the household - Northeast
DSOUTH	Binary	Region of residence of the household - South
DWEST	Binary	Region of residence of the household - West
AVGAGE	Years	Average age of all members in the household
LN_INC	Numeric	Log (consumer unit income before tax); if consumer unit income before tax is less than or equal to 1 then LN_INC = 0.
NO_EARNR	Numeric	Number of earners in the consumer unit
PERSLT18	Numeric	Number of persons under age 18
PERSOT64	Numeric	Number of persons older than age 65
SCALE	Numeric	Scale parameter of a vector of errors assumed to come from a known distribution from the Tobit model
EDUCREF	Categorical	Educational attainment of the reference person; 1 = Less than high school, 2 = High school graduate, 3 = Some college, 4 = College graduate
GENDER	Categorical	Gender of the reference person - Male
LAMBDA	Numeric	Represents the Inverse Mills ratio from Heckman Two-Stage Estimation Model. If the t-statistic on the estimated Inverse Mills ratio is significant, then it implies that there is a selectivity problem and one should not rely on Ordinary Least Squares (OLS) estimate results.

sumes the decisions to make a purchase and how much to purchase are made simultaneously, and that zero expenditures represent the decision not to make a purchase.<sup>13</sup> If there is sample selection effect, the Heckman estimates are appropriate.<sup>14</sup> The Heckman procedure can also be used to test for sample selection bias. If there is no sample selection bias, the Tobit model captures the corner solution of zero expenditure shares as the optimal decision.<sup>15</sup> Parameter estimates from OLS, Tobit, and the Heckman models were compared. The estimated regression coefficients for the six food category expenditure shares are presented in table 4.

*Results from regression analyses.* The race effect (DASIAN) was statistically significant across all food categories. Although sample selection bias was detected for meats, the magnitudes of the parameter estimates for DASIAN from all three models were generally comparable, and the signs of the parameter estimates were consistent across all three models for each food category. (See table 5.) For example, holding other factors constant, fruits as a share of total food-at-home spending is about 4 percentage points higher among Asian households compared with other households, but dairy as a share of total food-at-home spending is 4 to 6 percentage points lower among Asian households compared with other households. The results from all models show that, com-

pared with other households, Asian households allocate a larger share of food-at-home expenditures to vegetables, fruits, and meats, and a smaller share to grains, dairy, and oils; Asian households' larger proportion of food-at-home expenditures on meats is accounted for by higher seafood expenditures. (See exhibit 4). These food expenditure allocation patterns are consistent with the patterns reflected by

**Table 3. Zero expenditures by food categories, 2003 Consumer Expenditure Diary Survey**

Food category	Zero expenditures in the food category	
	Number of households	Proportion of all households in the sample (percent)
Grains .....	1,829	13.8
Vegetables .....	3,552	26.8
Fruits .....	3,217	24.2
Dairy .....	2,253	17.0
Meats .....	2,533	19.1
Oils .....	7,521	56.7

NOTE: The sample used in regression analyses was made up of households with total food-at-home expenditures greater than 0; the sample size was 13,275.

**Table 4. Parameter estimates for food category as share of total food-at-home expenditures, by type of regression, 2003 Consumer Expenditure Diary Survey**

Variable name	Fruits			Grains			Vegetables			Meats			Dairy			Oils		
	ols	Tobit	Heck-man	ols	Tobit	Heck-man	ols	Tobit	Heck-man	ols	Tobit	Heck-man	ols	Tobit	Heck-man	ols	Tobit	Heck-man
INTERCEPT .....	<sup>1</sup> 3.16	<sup>1</sup> -3.34	<sup>1</sup> 2.76	<sup>1</sup> 14.35	<sup>1</sup> 11.67	<sup>1</sup> 14.27	<sup>1</sup> 4.30	-0.89	<sup>1</sup> 4.02	<sup>1</sup> 24.39	<sup>1</sup> 19.88	<sup>1</sup> 23.92	<sup>1</sup> 12.67	<sup>1</sup> 9.50	<sup>1</sup> 12.70	<sup>1</sup> 1.57	<sup>1</sup> -5.70	<sup>1</sup> 1.89
DASIAN .....	<sup>1</sup> 3.88	<sup>1</sup> 4.46	<sup>1</sup> 4.10	<sup>2</sup> -1.41	<sup>2</sup> -1.91	<sup>2</sup> -1.57	<sup>1</sup> 4.31	<sup>1</sup> 5.04	<sup>1</sup> 5.14	<sup>1</sup> 4.51	<sup>1</sup> 4.83	<sup>1</sup> 4.56	<sup>1</sup> -3.91	<sup>1</sup> -5.57	<sup>1</sup> -3.71	<sup>1</sup> -1.79	<sup>1</sup> -3.04	<sup>1</sup> -1.98
DRURAL .....	<sup>1</sup> -1.13	<sup>1</sup> -1.64	<sup>1</sup> -1.23	-0.35	-0.43	-0.39	-0.51	<sup>2</sup> -0.77	<sup>2</sup> -0.72	-0.03	-0.13	-0.09	0.70	0.72	0.70	0.08	0.12	0.08
FAM_SIZE .....	.29	.55	.42	-0.33	-0.24	-0.21	.32	<sup>2</sup> .55	<sup>1</sup> .63	<sup>1</sup> 1.55	<sup>1</sup> 1.93	<sup>1</sup> 2.13	-0.05	0.06	-0.11	<sup>1</sup> .32	<sup>1</sup> .93	<sup>1</sup> 1.44
DFAMCOMP1 .....	<sup>2</sup> 1.20	.29	<sup>1</sup> 1.10	-0.34	<sup>1</sup> -1.62	-0.48	-0.28	<sup>1</sup> -1.40	-0.73	<sup>1</sup> -3.55	<sup>1</sup> -5.72	<sup>1</sup> -3.50	.72	-0.49	.78	.21	<sup>1</sup> -1.15	.16
DFAMCOMP2 .....	-0.10	.03	.00	<sup>2</sup> -1.02	<sup>2</sup> -1.20	<sup>2</sup> -.98	.19	.31	.43	-0.67	-0.94	-0.56	.56	.63	.48	.22	.43	.27
DFAMCOMP3 .....	-0.21	.23	-0.13	.45	.82	.60	.44	<sup>1</sup> 1.08	<sup>2</sup> .39	<sup>2</sup> -1.17	-0.85	<sup>2</sup> -1.24	.38	.79	.29	-0.10	.15	-0.09
DFAMCOMP4 .....	-0.53	.00	-0.32	-0.06	.36	.22	.12	.66	.73	-0.44	-0.18	-0.43	-0.92	-0.69	-0.97	-0.24	-0.10	-0.23
DNORTHEAST .....	<sup>1</sup> 1.31	<sup>1</sup> 1.87	<sup>1</sup> 1.43	.69	.80	.73	<sup>2</sup> .63	<sup>1</sup> .91	<sup>1</sup> .81	<sup>1</sup> 1.65	<sup>1</sup> 2.07	<sup>1</sup> 1.80	-0.45	-0.35	-0.51	-0.19	-0.35	-0.20
DSOUTH .....	.49	<sup>2</sup> .85	<sup>2</sup> .56	-0.09	.03	-0.04	<sup>1</sup> .57	<sup>1</sup> .83	<sup>1</sup> .73	<sup>1</sup> 2.46	<sup>1</sup> 2.99	<sup>1</sup> 2.67	<sup>1</sup> -1.59	<sup>1</sup> -1.88	<sup>1</sup> -1.54	.00	.21	.03
DWEST .....	<sup>1</sup> 1.53	<sup>1</sup> 2.29	<sup>1</sup> 1.72	.03	-0.01	.01	<sup>1</sup> .88	<sup>1</sup> 1.29	<sup>1</sup> 1.18	-0.57	-0.65	-0.61	<sup>1</sup> -.93	<sup>1</sup> -1.09	<sup>1</sup> -.91	.04	.02	.03
AVGAGE .....	<sup>1</sup> .05	<sup>1</sup> .11	<sup>1</sup> .07	<sup>2</sup> .03	<sup>1</sup> .06	<sup>2</sup> .04	<sup>1</sup> .05	<sup>1</sup> .10	<sup>1</sup> .08	<sup>1</sup> .08	<sup>1</sup> .13	<sup>1</sup> .09	<sup>1</sup> -.03	-0.01	<sup>2</sup> -.03	<sup>1</sup> .01	<sup>1</sup> .05	<sup>1</sup> .02
LN_INC .....	-0.01	-0.02	-0.01	-0.06	-0.07	-0.06	-0.01	-0.01	-0.01	<sup>1</sup> -.16	<sup>1</sup> -.19	<sup>1</sup> -.17	.01	.00	.02	-0.01	-0.03	-0.01
NO_EARNR .....	-0.17	-0.25	-0.20	-0.09	-0.16	-0.12	-0.16	-0.18	-0.20	<sup>1</sup> -.03	-0.05	-0.14	-0.01	.01	-0.01	-0.04	-0.09	-0.05
PERSLT18 .....	.09	.22	.08	<sup>1</sup> .94	<sup>1</sup> 1.09	<sup>1</sup> .92	<sup>2</sup> -.48	-0.45	<sup>1</sup> -0.60	<sup>2</sup> -.86	-0.82	<sup>1</sup> -1.18	.34	.56	.29	-0.19	-0.29	<sup>2</sup> -.23
PERSOT64 .....	-0.25	-0.57	-0.28	<sup>2</sup> .77	.60	<sup>2</sup> .74	-0.34	<sup>1</sup> -.75	<sup>2</sup> -.58	<sup>1</sup> -1.86	<sup>1</sup> -2.52	<sup>1</sup> -2.13	<sup>1</sup> 1.14	<sup>1</sup> 1.10	<sup>1</sup> 1.15	-0.03	-0.44	-0.28
EDUCREF .....	1.74	<sup>1</sup> 1.08	<sup>1</sup> .84	.12	.19	.16	.14	<sup>2</sup> .27	<sup>2</sup> .27	<sup>1</sup> -1.69	<sup>1</sup> -1.82	<sup>1</sup> -1.70	.23	<sup>1</sup> 1.40	.18	-0.08	-0.08	-0.08
GENDER .....	.34	<sup>2</sup> .62	.40	.05	.14	.08	.20	<sup>2</sup> .44	<sup>2</sup> .39	<sup>1</sup> -1.01	<sup>1</sup> -1.06	<sup>1</sup> -1.03	.20	.29	.20	-0.01	.07	.00
SCALE .....	...	14.08	...	...	15.92	...	...	11.85	...	...	21.92	...	...	15.77	...	...	9.11	...
LAMBDA .....	...	...	-0.27	...	...	-0.12	...	...	-0.92	...	...	<sup>1</sup> -.34	...	...	.12	...	...	-0.62

<sup>1</sup> Indicates significant difference from 0 at 1 percent.  
<sup>2</sup> Indicates significant difference from 0 at 5 percent.

NOTE: Regressions were performed with unweighted data. Standard errors are shown in table A-2 in the Appendix.

the descriptive statistics in chart 2.

In addition to the race of the household, family composition and member age were consistently significant in the regressions of food-at-home spending shares, although their effects vary across the different food categories. For example, the regression coefficients for the dairy category in table 4 show that Asian households have a lower expenditure share in dairy (DASIAN < 0), but this effect is dampened with the presence of more younger (PERSLT18 > 0) and more elderly (PERSOT64 > 0) members in the household.

DIFFERENCES IN WEEKLY AVERAGE EXPENDITURES between Asian households and other households on food-at-home items were suggestive of a race effect in spending on these items. Regression analyses on food category expenditure shares with controls for other demographic characteristics showed race to be a significant factor in accounting for differences in all six food category expenditure shares. Does food-at-home spending by Asian households in the United States reflect the traditional plant-based diets of Asia? As the Consumer Expenditure Survey does not collect information on quantity purchased and consumed, this article cannot address consumption patterns; however the analysis of the expenditure data indicated that, compared with other households, Asian households allocate a higher expenditure share to fresh fruits,

fresh vegetables, rice, and seafood, and a lower expenditure share to dairy products and oils. It would be interesting to see how Asian households' length of residence in the United States affect food-at-home spending, as well as to see if there are differences by Asian country of origin. Although the Consumer Expenditure Survey does not collect data on length of U.S. residence, it has begun to collect data on Asian country of origin starting with the 2004 survey.

**Table 5. Summary of regression analyses on food category expenditure as share of total food-at-home expenditures, sample selection bias and race effect (Asian households versus other households)**

Food category	Evidence of sample selection bias (LAMBDA)	DASIAN parameter estimates		
		OLS	Tobit	Heckman 2-stage
Fruits .....	NO	<sup>1</sup> 3.88	<sup>1</sup> 4.46	<sup>1</sup> 4.10
Grains .....	NO	<sup>2</sup> -1.41	<sup>2</sup> -1.91	<sup>2</sup> -1.57
Vegetables .....	NO	<sup>1</sup> 4.31	<sup>1</sup> 5.04	<sup>1</sup> 5.14
Meats .....	YES <sup>2</sup> (-.34)	<sup>1</sup> 4.51	<sup>1</sup> 4.83	<sup>1</sup> 4.56
Dairy .....	NO	<sup>1</sup> -3.91	<sup>1</sup> -5.57	<sup>1</sup> -3.71
Oils .....	NO	<sup>1</sup> -1.79	<sup>1</sup> -3.04	<sup>1</sup> -1.98

<sup>1</sup> Significant difference at 1-percent level.  
<sup>2</sup> Significant difference at 5-percent level.



**Exhibit 4. Ranking of food-at-home items by expenditure shares**

Ranking	Asian households	Other households
1	Fresh vegetables	Baked products
2	Seafood	Beef
3	Fresh fruit	Other dairy
4	Baked products	Pork
5	Poultry	Fresh fruit
6	Beef	Fresh vegetables
7	Pork	Other prepared food
8	Other dairy	Poultry
9	Processed fruit	Carbonated drinks
10	Other cereal	Other cereal
11	Milk products	Milk products
12	Other prepared food	Sweets
13	Other nonalcoholic drinks	Seafood
14	Snacks	Processed fruit
15	Sweets	Snacks
16	Condiments	Frozen and prepared
17	Other meat	Other meat
18	Carbonated drinks	Condiments
19	Rice	Processed vegetables
20	Processed vegetables	Other nonalcoholic drinks
21	Frozen and prepared	Coffee
22	Eggs	Eggs
23	Tea	Packaged and canned soup
24	Packaged and canned soup	Tea
25	Coffee	Rice

NOTE: The food item rankings are based on the expenditure share data for Asian households and other households in table 2.

## Notes

ACKNOWLEDGMENTS: We thank John Rogers, Steve Henderson, and Jonathan Fisher for their helpful comments.

<sup>1</sup> See Jessica S. Barnes and Claudette E. Bennett, "The Asian Population: 2000," *Census 2000 Briefs and Special Reports*, C2KBR/01-16 (U.S. Census Bureau, February 2002); and Frank Hobbs and Nicole Stoops, "Demographic Trends in the 20th Century," *Census 2000 Briefs and Special Reports*, CENSR-4 (U.S. Census Bureau, November 2002), figure 3.6.

<sup>2</sup> See [http://cnstudentnews.cnn.com/2000/US/08/30/minority\\_population/](http://cnstudentnews.cnn.com/2000/US/08/30/minority_population/). Also see "Table 1a: Projected Population of the United States, by Race and Hispanic Origin: 2000 to 2050," *U.S. Interim Projections by Age, Sex, Race, and Hispanic Origin*, (U.S. Census Bureau) on the Internet at <http://www.census.gov/ipc/www/usinterimproj/>.

<sup>3</sup> A consumer unit includes (1) members of a household related by blood, marriage, adoption, or other legal arrangement; (2) a person living alone or sharing a household with others but who is responsible for at least

two of the following three major types of expenses: food, housing, and other expenses; or (3) two or more persons living together who pool their income to make joint expenditure decisions. This report treats each consumer unit as a household. It should be noted that a household may contain more than one consumer unit, such as grandparents or in-laws who live independently along with another consumer unit.

<sup>4</sup> According to the 2003 American Community Survey, about 3.5 percent of households have an Asian householder. See *2003 American Community Survey* (U.S. Census Bureau) Summary Tables, H005: RACE OF HOUSEHOLDER.

<sup>5</sup> Households with all Asian members accounted for 93.2 percent of all households with an Asian reference person.

<sup>6</sup> There was a total of 20,770 eligible cases, of which 619 were Asian households and 20,151 were other households. Among the eligible Asian households, 532 completed interviews. Among the other households, 15,296 completed interviews. The response rate reported in the text is the ratio of the number of completed interviews divided by the number of eligible cases. Where race was not reported, the race of the reference person was used to classify the households.

<sup>7</sup> A reference person is the first member mentioned by the respondent when asked "to start with the name of the person or one of the persons who owns or rents."

<sup>8</sup> MyPyramid replaced the 1992 Food Guide Pyramid. It incorporates recommendations from the 2005 Dietary Guidelines for Americans, released by the U.S. Department of Agriculture (USDA) and the U.S. Department of Health and Human Services (HHS) in January 2005. More information is available on the Internet at <http://www.nal.usda.gov/fnic/Fpyr/pyramid.html>.

<sup>9</sup> Weighted OLS regression was performed with Proc Regress in SUDAAN using the Balanced Repeated Replication method of variance, with replicate weights for the CE Diary. The race effect was qualitatively the same as the unweighted OLS results; the parameter estimate of the race effect from the weighted OLS regressions are shown in the Appendix table A-3.

<sup>10</sup> See Richard Blundell and Costas Meghir, "Bivariate alternatives to the Tobit model," *Journal of Econometrics*, January-February 1987, pp.179-200; and Ana Maria Angulo, Jose Maria Gil, and Azucena Gracia, "The Demand for Alcoholic Beverages in Spain," *Agricultural Economics*, October 2001, pp.71-83.

<sup>11</sup> Sample selection bias refers to the possibility that those CU's reporting purchases are positively selected into the sample according to some unobserved characteristics.

<sup>12</sup> See G.S. Maddala, *Limited-Dependent and Qualitative Variables in Econometrics* (Cambridge, United Kingdom, Cambridge University Press, 1983).

<sup>13</sup> See James Heckman, "The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator for Such Models," *Annals of Economic and Social Measurement* 5: Fall 1976, pp.475-92; also see Appendix for a technical description of the Heckman two-stage model applied.

<sup>14</sup> If the Heckman LAMBDA parameter is statistically significant, there is sample selection bias.

<sup>15</sup> See James Tobin, "Estimation of Relationships for Limited Dependent Variables," *Econometrica*, January 1958, pp. 24-36; SAS PROC LIFEREG procedure is used for the Tobit model. SAS PROC LOGISTIC with PROBIT Link function is used for creating the c.d.f. and p.d.f. values for the inverse Mills ratios. We use PROC REG to get the Heckman's estimates by regression, the expense ratios on the independent variables, and the inverse Mills ratios.

**APPENDIX: Tables**

**Table A-1. Food at home: standard errors for mean expenditure shares, 2003 Consumer Expenditure Diary Survey**

Food at home	Standard error of average weekly expenditures (dollars)			Standard error of share of total food-at-home expenditures (percent)		
	All households	Asian households	Other households	All households	Asian households	Other households
Total food at home .....	.95	3.78	.93	...	...	...
Grains .....	.13	.59	.12	.11	.63	.12
Other cereal .....	.05	.26	.05	.07	.32	.07
Rice .....	.01	.22	.01	.02	.31	.02
Baked products .....	.09	.3	.09	.08	.45	.09
Meat .....	.39	1.79	.39	.35	1.89	.36
Beef .....	.22	.35	.23	.31	.51	.32
Pork .....	.09	.35	.09	.11	.41	.11
Other meat .....	.04	.18	.04	.05	.23	.05
Poultry .....	.06	.46	.05	.09	.62	.09
Seafood .....	.08	.85	.07	.09	1.13	.09
Eggs .....	.02	.07	.02	.02	.09	.02
Dairy .....	.10	.30	.10	.09	.47	.09
Milk products .....	.04	.18	.04	.05	.30	.05
Other dairy .....	.07	.21	.07	.06	.32	.06
Fruit .....	.09	.64	.09	.09	.84	.09
Fresh fruit .....	.06	.50	.06	.07	.65	.08
Processed fruit .....	.04	.24	.04	.05	.37	.04
Vegetables .....	.09	.66	.09	.08	.70	.08
Fresh vegetables .....	.07	.63	.07	.06	.68	.06
Processed vegetables .....	.03	.23	.03	.04	.38	.04
Fats and oils .....	.04	.15	.04	.03	.19	.04
Sweets .....	.06	.21	.06	.08	.27	.09
Nonalcoholic beverages .....	.08	.47	.08	.12	.74	.12
Carbonated drinks .....	.04	.18	.04	.07	.31	.07
Coffee .....	.03	.11	.03	.04	.18	.04
Tea .....	.02	.27	.02	.03	.42	.03
Other nonalcoholic drinks .....	.04	.30	.04	.06	.56	.06
Miscellaneous food .....	.17	.53	.17	.17	.57	.18
Frozen and prepared .....	.06	.24	.06	.07	.41	.08
Packaged and canned soup .....	.02	.13	.02	.03	.21	.03
Snacks .....	.05	.22	.05	.06	.28	.07
Condiments .....	.04	.12	.04	.05	.16	.05
Other prepared food .....	.08	.23	.08	.12	.34	.12

NOTE: Standard errors were estimated using SUDAAN's Proc Descript with Balanced Repeated Replication replicate weights for the CE Diary survey to account for the CE's complex survey design. SUDAAN is a survey analysis software from Research Triangle Institute, Research Triangle Park, NC.

**Table A-2.** Standard errors of parameter estimates for food category as share of total food-at-home expenditures, by type of regression, 2003 Consumer Expenditure Diary Survey

Variable name	Fruits			Grains			Vegetables			Meats			Dairy			Oils		
	ols	Tobit	Heckman	ols	Tobit	Heckman	ols	Tobit	Heckman	ols	Tobit	Heckman	ols	Tobit	Heckman	ols	Tobit	Heckman
INTERCEPT .....	0.79	1.02	0.91	0.98	1.12	0.99	0.65	0.86	0.66	1.28	1.55	1.29	0.95	1.12	0.95	0.34	0.73	0.45
DASIAN .....	.55	.70	.61	.69	.79	.72	.45	.59	.62	.89	1.08	.89	.66	.80	.78	.24	.55	.29
DRURAL .....	.34	.44	.36	.42	.48	.43	.28	.37	.30	.55	.67	.55	.41	.48	.41	.15	.31	.15
FAM_SIZE .....	.22	.28	.27	.28	.31	.33	.18	.24	.24	.36	.43	.40	.27	.31	.30	.10	.20	.14
DFAMCOMP1 .....	.41	.53	.43	.51	.59	.55	.34	.45	.41	.67	.82	.67	.50	.59	.51	.18	.39	.19
DFAMCOMP2 .....	.36	.46	.37	.44	.50	.44	.29	.38	.32	.58	.70	.58	.43	.50	.45	.15	.33	.16
DFAMCOMP3 .....	.33	.42	.34	.41	.46	.46	.27	.35	.38	.53	.64	.53	.39	.46	.44	.14	.29	.14
DFAMCOMP4 .....	.65	.82	.69	.81	.92	.90	.53	.69	.62	1.05	1.26	1.05	.78	.91	.79	.28	.57	.28
DNORTHEAST ....	.30	.39	.33	.38	.43	.38	.25	.33	.26	.49	.59	.49	.36	.43	.37	.13	.28	.13
DSOUTH .....	.26	.34	.28	.33	.37	.33	.22	.29	.23	.43	.52	.43	.32	.37	.33	.11	.24	.12
DWEST .....	.28	.36	.36	.35	.40	.35	.23	.30	.28	.45	.55	.45	.34	.40	.34	.12	.26	.12
AVGAGE .....	.01	.01	.01	.01	.01	.01	.01	.01	.01	.02	.02	.02	.01	.01	.01	.00	.01	.01
LN_INC .....	.03	.03	.03	.03	.04	.03	.02	.03	.02	.04	.05	.04	.03	.04	.03	.01	.02	.01
NO_EARNR .....	.16	.21	.17	.20	.23	.21	.13	.17	.13	.26	.32	.27	.20	.23	.20	.07	.15	.07
PERSLT18 .....	.23	.30	.23	.39	.33	.29	.19	.25	.20	.38	.46	.39	.28	.33	.30	.10	.21	.11
PERSOT64 .....	.25	.32	.26	.32	.36	.32	.21	.27	.24	.41	.50	.42	.31	.36	.31	.11	.23	.12
EDUCREF .....	.10	.13	.15	.13	.14	.14	.08	.11	.10	.16	.20	.16	.12	.14	.15	.04	.09	.04
GENDER .....	.21	.26	.22	.26	.29	.26	.17	.22	.19	.33	.40	.33	.25	.29	.25	.09	.19	.09
SCALE .....	...	.10	...	...	.11	...	...	.09	...	...	.16	...	...	.11	...	...	.09	...
LAMBDA .....	...	...	.31	...	...	.17	...	...	.47	...	...	.10	...	...	.24	...	...	.55

Note: Standard errors shown are from unweighted regressions.

**Table A-3.** Weighted OLS regressions—parameter estimates of race effect (DASIAN)

Food category expenditure share	DASIAN parameter estimates	Standard error	P-value
Fruits .....	4.41	0.99	0.0001
Grains .....	-1.24	.70	.0852
Vegetables .....	4.16	.75	.0000
Meats .....	5.13	2.16	.0221
Dairy .....	-3.85	.65	.0000
Oils .....	-.99	.17	.0000

NOTES: The OLS weighted regression was performed with SUDAAN'S Proc Regress using the Balanced Repeated Replication replicate weights for the CE Diary survey. The other independent variables used in the OLS model used in the weighted regression are identical to the variables used in the unweighted regressions.

## APPENDIX: Application of the Heckman two-stage model

Expenditure ratios at food category levels can only be observed in the case of  $CU$ 's who have made purchases. This creates a possible problem of selection bias in the sense that parameter estimates of the relationship between expenditure ratios and sociodemographic variables are for households who made purchases and are not representative of all households.

In our application of the Heckman two-stage model, we first have a model characterized by a latent purchase decision variable  $d_i$ , which determines the probability of purchasing a certain food category and an expenditure share variable  $y_i$ , which determines

the average propensity to spend:

Purchase decision equation:

$$d_i = 1 \text{ if } z_i \alpha + v_i > 0, \\ = 0 \text{ otherwise, } v \sim N(0,1) \quad (1)$$

Expenditure share equation:

$$y_i = x_i \beta + u_i \text{ if } d_i = 1 \quad (2)$$

where

$d_i$  = a latent variable that takes the value 1 if the cu decides to purchase and 0 otherwise,

$y_i$  = an observed expenditure share variable,

$z_i$  = the explicit set of variables in the purchase decision equation,

$x_i$  = the explicit set of variables in the expense ratio equation, and

$v_i$  and  $u_i$  = error terms with different probability distributions depending on how both purchase and expenditure decisions are considered.

In our application, the set of  $Z$  and  $X$  variables are the same—the list of demographic variables that appear in exhibit 3. Assume that:

- (1) the values of dependent and independent variables in the purchase decision equation are always observed,
- (2) the error terms ( $u_i, v_i$ ) are independent of the independent variables ( $z$ ) with zero mean and  $v \sim N(0,1)$ , and
- (3) the conditional expected value of  $u_i$  given  $v_i$  is  $\gamma v$ , in other words, we assume linearity in the population regression of  $u$  on  $v$ .

To derive an estimating equation, let  $(d, y, z, x, u, v)$  denote a random draw from the population.<sup>1</sup> Because  $y$  is observed only when  $d = 1$  and  $(u, v)$  is independent of  $z$  hence,

$$E(y | z, v) = x\beta + E(u | z, v) = x\beta + \gamma v \quad (3)$$

Equation (3) shows that if  $\gamma = 0$ , then  $u$  and  $v$  are uncorrelated and

$E(y | z, v) = E(y | x) = x\beta$ . Because  $d$  is a function of  $(z, v)$ , it follows that  $E(y | z, d) = E(y | x)$ . This confirms that when  $\gamma = 0$ , there is no sample selection problem and  $\beta$  can be consistently estimated by OLS using the selection sample. Alternatively, if  $\gamma \neq 0$ , then the estimation equation can be written as follows:

$$E(y | z, d) = x\beta + \gamma E(v | z, d) = x\beta + \gamma f(z, d) \quad (4)$$

where  $f(\cdot) = E(v | z, d)$ . Because the selected sample has  $d = 1$ , we need only find  $f(z, 1)$ :

$$F(z, 1) = E(v | z, \alpha + v > 0) = E(v | v > -z\alpha) = \lambda(z\alpha), \quad (5)$$

where

$$\lambda(\cdot) = \frac{\phi(\cdot)}{\Phi(\cdot)}, \quad \phi = \text{the p.d.f. and}$$

$\Phi$  = the c.d.f. of the random variable  $v$ .

We can consistently estimate  $\beta$  and  $\gamma$  using the selected sample by regressing  $y$  on  $x, \lambda(z\alpha)$ .<sup>2</sup> The problem is that  $\alpha$  is unknown, so we cannot compute the additional regressor  $\lambda(z\alpha)$ . Nevertheless, a consistent estimator of  $\alpha$  is available from the first-stage probit estimation of the selection equation:

Step 1. Obtain the probit estimate  $\hat{\alpha}$  from the model

$$P(d_i = 1 | z_i) = \Phi(z_i \alpha)$$

and obtain the estimated inverse Mills ratios  $\hat{\lambda} = \lambda(z_i \hat{\alpha})$ .

Step 2. Obtain  $\hat{\beta}$  and  $\hat{\gamma}$  from the OLS regression on the selected sample,  $y_i$  on  $x_i, \hat{\lambda}$ .

## Notes to the appendix

<sup>1</sup> For the sake of simplicity, we drop the  $i$  subscript.

<sup>2</sup> See James Heckman, "The Common Structure of Statistical

Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator for Such Models," *Annals of Economic and Social Measurement* 5: Fall 1976, pp.475–92.