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RESEARCH PAPER: 1995-3

CONSUMER DEMAND FOR FRESH FRUIT

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Consumer Demand for Fresh Fruit

In the last several decades, consumer demand analysis has moved toward system-wide approaches. There are now numerous algebraic specifications of demand systems, including the linear and quadratic expenditure systems, the Working model, the Rotterdam model, translog models, and the Almost Ideal demand system (AIDS). Generally, different demand specifications have different implications. Two demand systems which have become popular in agricultural economics are the Rotterdam and the AIDS. However, the assumptions used to parameterize these two systems have different implications. For example, marginal expenditure shares and Slutsky terms are assumed constants in the Rotterdam model, while they are assumed functions of budget shares in the AIDS.

Economic theory does not provide criteria to choose *ex ante* between these two systems; instead, researchers often rely on statistical tests and inference. When competing demand systems are nested, statistical tests (Amemiya, p. 142) can be used to choose the model which best represents the data. However, when systems are not nested, one needs an alternative testing procedure for the competing alternatives. Deaton (1978) applied a nonnested test to compare demand systems with the same dependent variables, but his test is not applicable when comparing the Rotterdam and AIDS because they have different dependent variables. Barten (1993) demonstrated that the Rotterdam and the AIDS are special cases of and nested within a more general demand system, and he suggested pair-wise and higher-order tests to choose which of the competing special cases (AIDS, Rotterdam, and hybrids of the AIDS and Rotterdam) best explains the data.¹ Lee et al. used the pair-wise test developed by Barten (1993) to choose between the Rotterdam and a hybrid of the Rotterdam and Working model. Alston and Chalfant also developed pair-wise tests for choosing between the Rotterdam and the AIDS. However,

these studies did not utilize higher-order comparisons such as those developed by Barten (1993).

Thompson et al. studied the demand for fresh fruit using the AIDS, they found that most fresh fruits are complements. In the present paper, we examine how income and prices influenced U.S. consumer demand for fresh fruit during the last two decades, and particularly how fresh fruit demand elasticities have evolved over time. Four versions of the differential demand system examined by Barten (1993) -- the Rotterdam; a differential version of the AIDS; and two mixed models, the CBS system and NBR² system with features of both the Rotterdam and AIDS systems -- are fit to the data. A general model which nests these four is developed to help choose the model which best fits the data.

The Differential Approach

The Rotterdam model, due to Barten (1964) and Theil (1965), takes the form (with time subscripts omitted for convenience)

$$(1) \quad w_i \, d\log q_i = \theta_i \, d\log Q + \sum_j \pi_{ij} \, d\log p_j, \quad i=1, 2, \dots, n;$$

where w_i represents the average budget share of commodity i ; p_i and q_i are the price and quantity of good i , respectively; $d\log p_i$ and $d\log q_i$ represent dp_i/p_i and dq_i/q_i , respectively; and $d\log Q$ is an index number (Divisia volume index) for the change in real income

$$(2) \quad d\log Q = \sum_i w_i d\log q_i.$$

Demand parameters θ_i and π_{ij} are given by

$$(3) \quad \theta_i = p_i(\partial q_i / \partial m); \quad \pi_{ij} = (p_i p_j / m) s_{ij}; \quad s_{ij} = \partial q_i / \partial p_j + q_j \partial q_i / \partial m;$$

where m is total outlay or the budget and s_{ij} is the $(i, j)^{\text{th}}$ element of the Slutsky substitution matrix, parameter θ_i is the marginal budget share of commodity i , and π_{ij} is a compensated price effect. The constraints of demand theory can be directly applied to the Rotterdam parameters.

In particular, we have

$$(4) \quad \text{Adding-up} \quad \sum_i \theta_i = 1, \sum_i \pi_{ij} = 0;$$

$$(5) \quad \text{Homogeneity} \quad \sum_j \pi_{ij} = 0; \text{ and}$$

$$(6) \quad \text{Slutsky Symmetry} \quad \pi_{ij} = \pi_{ji}.$$

The Rotterdam is a particular parameterization of a system of differential demand equations, where demand parameters θ_i 's and π_{ij} 's are assumed to be constant. However, there is no strong a priori reason that the θ_i 's and π_{ij} 's should be held constant. An alternative parameterization is based on the Working model:

$$(7) \quad w_i = \alpha_i + \beta_i \log m, \quad i=1, 2, \dots, n.$$

As the sum of the budget shares is unity, it follows from (7) that $\sum \alpha_i = 1$ and $\sum \beta_i = 0$. To derive the marginal shares implied by the Working model, one multiplies (7) by m and differentiates with respect to m ,

$$(8) \quad \begin{aligned} \partial(p_i q_i) / \partial m &= \alpha_i + \beta_i (1 + \log m) \\ &= w_i + \beta_i. \end{aligned}$$

Hence, under this formulation the i^{th} marginal share differs from the corresponding budget share by β_i . The budget share is not constant with respect to income, and neither is the associated marginal share.

The income elasticity corresponding to (8) is

$$(9) \quad \eta_i = 1 + \beta_i / w_i.$$

This expression indicates that a good with positive (negative) β_i is a luxury (necessity). Since the budget share of a luxury increases with income (prices remaining constant), it follows from (9) that increasing income causes the η_i for such a good to fall toward one and as the consumer

becomes more affluent, luxury goods become less luxurious, a plausible outcome. The income elasticity of a necessity also declines with increasing income under (9), and, if $\beta_i=0$ the good is unitary elastic and the budget share will not change in response to income changes (again, prices held constant).

Replacing θ_i in (1) with (8) and rearranging terms, one obtains

$$(10) \quad w_i \text{ dlog } q_i = (\beta_i + w_i) \text{ dlog } Q + \sum_j \pi_{ij} \text{ dlog } p_j,$$

where β_i and π_{ij} are constant coefficients (Keller and van Driel; Theil and Clements). Equation (10) is referred to as the CBS, following Keller and van Driel.

The AIDS has the same intercept and income term as equation (7) but also includes price effect and is specified as

$$(11) \quad w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log (m/P)$$

where P is a price index defined by

$$(12) \quad \log P = \alpha_0 + \sum_k \alpha_k \log p_k + \frac{1}{2} \sum_k \sum_l \gamma_{kl} \log p_k \log p_l.$$

The adding-up restriction requires that

$$\sum_i \alpha_i = 1, \quad \sum_i \beta_i = 0, \quad \sum_i \gamma_{ij} = 0;$$

homogeneity is satisfied if and only if

$$\sum_i \gamma_{ji} = 0;$$

and symmetry is satisfied provided that

$$\gamma_{ij} = \gamma_{ji}.$$

The differential form of equation (11), based on Deaton and Muellbauer's suggestion of substituting the Divisia Price index $\sum w_i \text{ dlog } p_i$ for $\text{dlog } P$ [the differential form of equation (12)]³ is

$$(13) \quad dw_i = \beta_i d\log Q + \sum_j \gamma_{ij} d\log p_j,$$

or

$$(13a) \quad w_i d\log q_i = (\beta_i + w_i) d\log Q + \sum_j (\gamma_{ij} - w_i(\delta_{ij} - w_j)) d\log p_j.$$

where δ_{ij} is the Kronecker delta equal to unity if $i = j$ and zero otherwise [Barten (1993)]. To derive (13a) from (13), use the relations $dw_i = w_i(d\log p_i + d\log q_i - d\log m)$ and $d\log m = d\log P + d\log Q$. Further,

$$(14) \quad \beta_i = \theta_i - w_i, \text{ and } \gamma_{ij} = \pi_{ij} + w_i\delta_{ij} - w_iw_j.$$

A fourth alternative, the NBR (Neves), can be derived by substituting $\theta_i - w_i$ for β_i in (13) so that it has the Rotterdam income coefficients but the AIDS price coefficients. Specifically, the NBR is

$$(15) \quad dw_i + w_i d\log Q = \theta_i d\log Q + \sum_j \gamma_{ij} d\log p_j.$$

Similarly, equation (15) can be rewritten as

$$(15a) \quad w_i d\log q_i = \theta_i d\log Q + \sum_j (\gamma_{ij} - w_i(\delta_{ij} - w_j)) d\log p_j.$$

The four models [equations (1), (10), (13a), and (15a)] have the same left-hand-side variable $w_i d\log q_i$ and right-hand-side variables $d\log Q$ and $d\log p_j$ s. These models can be considered as four different ways to parameterize a general model: marginal budget shares are assumed to be constant (i.e., θ_i) in the Rotterdam and the NBR but variable (i.e., $\beta_i + w_i$) in the AIDS and CBS. The Slutsky terms are considered to be constants (i.e., π_{ij}) in the Rotterdam and CBS and variables [i.e., $\gamma_{ij} - w_i(\delta_{ij} - w_j)$] in the AIDS and NBR. The CBS and the NBR can be considered as income-response variants of the Rotterdam and the AIDS, respectively.

These four models are not nested but, following Barten (1993, p. 154), a general demand system can be developed which nests all four. The general system is

$$(16) \quad w_i \text{ dlog } q_i = (d_i + \delta_1 w_i) \text{ dlog } Q + \sum_j [e_{ij} - \delta_2 w_i(\delta_{ij} - w_j)] \text{ dlog } p_j; \quad i=1,2,\dots,n;$$

where $d_i = \delta_1 \beta_i + (1 - \delta_1) \theta_i$ and $e_{ij} = \delta_2 \gamma_{ij} + (1 - \delta_2) \pi_{ij}$; δ_1 and δ_2 are two additional parameters to be estimated. Note that (16) becomes the Rotterdam when both δ_1 and δ_2 are restricted to zero; the CBS when $\delta_1 = 1$ and $\delta_2 = 0$; the AIDS when $\delta_1 = 1$ and $\delta_2 = 1$; and the NBR when $\delta_1 = 0$ and $\delta_2 = 1$. The demand restrictions on (16) are

$$(17) \quad \text{Adding-up} \quad \sum_i d_i = 1 - \delta_1 \quad \text{and} \quad \sum_i e_{ij} = 0;$$

$$\text{Homogeneity} \quad \sum_j e_{ij} = 0; \text{ and}$$

$$\text{Symmetry} \quad e_{ij} = e_{ji}.$$

Because (16) with its two additional parameters nests all four, it can be used as a model selection tool. For application to discrete data, the specifications are approximated by replacing w_i by $(w_{it} + w_{it-1})/2$, $\text{dlog } q_i$ by $\log(q_{it}/q_{it-1})$, and $\text{dlog } p_i$ by $\log(p_{it}/p_{it-1})$, where subscript t indicates time.

The likelihood ratio test (LRT) for model selection, is

$$(18) \quad \text{LRT} = -2[\log L(\theta^*) - \log L(\theta)],$$

where θ^* is the vector of parameter estimates of either the Rotterdam, the AIDS, or their variants, θ is the vector of parameter estimates of the general model, and $\log L(\cdot)$ is the log value of the likelihood function (Amemiya, pp. 141-6). For example, under the null hypothesis that the Rotterdam best describes the data, test statistic LRT has an asymptotic $\chi^2(q)$ distribution, in which $q=2$ is the number of restrictions imposed (i.e., the degrees of freedom equal to the difference between the number of parameters in the general model and in the Rotterdam).

Data

U.S. per capita fresh fruit consumption and retail fresh fruit price data during the years 1967 through 1993 were analyzed. The data were reported by the U. S. Department of

Agriculture annually. Per capita consumption and retail price information on five fresh fruits were available, i.e., oranges, grapefruit, apples, bananas, and grapes.

Table 1 shows the budget or expenditure shares of the five fresh fruits for 1967, the sample mean, and 1993. The largest average expenditure share was for apples (0.37) and the lowest was for grapefruit (0.07). In general, the group budget shares were relatively constant over the sample period except for oranges and grapefruit. The expenditure share of bananas decreased the most from 31.5% of total fresh fruit expenditures in 1967 to 23.8% in 1993; the expenditure share of grapes increased from 0.7% to 20.9% during the same period.

Price indices are also reported in Table 1. Although all indices increased from 1967 to 1993, they increased at different rates. The grapefruit price index increased by almost four times while those of oranges and grapes essentially tripled. The price index that increased the least was that of bananas.

Analysis and Results

Choice of Functional Form

Since the four competing systems (i.e., the Rotterdam, AIDS, CBS, NBR) and the general system automatically satisfy the adding-up conditions, only five equations were estimated for the six-good systems (the banana equation was not included; see Barten, 1969). For all five models, i.e., the Rotterdam, the AIDS, CBS, and NBR, the estimated first-order autocorrelation coefficients (Berndt and Savin) were not statistically different from zero, an indication that first-order autocorrelation was not a problem. Therefore, only homogeneity and symmetry were imposed, and the models were estimated by the maximum likelihood method. Log-likelihood values and corresponding test statistics for each of the systems are presented in table 2. Numbers

in the first column of table 2 are the log-likelihoods and the numbers in the second column are the log-likelihood ratio test statistics [equation (18)] for model selection. The test results show that the general system did not reject any of the four models; however, the log-likelihood for the CBS model has almost identical value as that for the general system, implying the CBS fits the data better than the other three. This result is consistent with the estimates of δ_1 and δ_2 of the general model, i.e., δ_1 has a value close to unity and δ_2 has a value of zero. Accordingly, only results based on CBS are reported and discussed further in this section.

Parameter and Elasticity Estimates

Instead of reporting the AIDS parameters, which may be difficult to interpret directly, marginal budget shares $\theta_{i,s}$ and Slutsky terms $\pi_{ij,s}$ were derived using equation (14) from the AIDS parameter estimates and sample budget share means (see table 3). The estimates of the marginal budget share parameters, $\beta_{i,s}$, for grapefruit and bananas are statistically not different from zero, an indication that these fruits have unitary expenditure elasticities. The positive estimate of β_i for oranges indicates that oranges are luxuries among the fruits studied and the negative estimate of β_i for grapes indicating grapes are necessities among the fruits analyzed. Of the 15 Slutsky term estimates, five cross-price Slutsky estimates statistically the same as zero at $\alpha = 0.05$. All five own-price Slutsky terms except the one for apples are negative and significantly different from zero, ranging from -0.089 for oranges to -0.040 for grapes. Cross-price Slutsky terms are either positive and statistically different from zero or statistically not different from zero, an indication that most fruits are substitutes. Results indicate that grapefruit, bananas, grapes and oranges are substitutes; and bananas, grapefruit, and apples are substitutes. This result is different from the ones found by Thompson et al. that most fresh fruits are complements.

The income elasticity of each commodity group (η_i) and the compensated price elasticities (η_{ij}) are (Barten, 1993)⁶

$$(19) \quad \text{Income Elasticity:} \quad \eta_i = \theta_i/w_i, \quad \text{or} \quad \eta_i = \beta_i/w_i + 1;$$

$$\text{Compensated Price Elasticity:} \quad \eta_{ij} = \pi_{ij}/w_i.$$

Note that in (19) both income and price elasticities are functions of budget shares. Income and price elasticity estimates of the CBS model calculated at sample budget share means and 1967 and 1993 budget shares are presented in table 4. Note that even though oranges and grapefruit are more price elastic than other fruits but their own-price elasticity is still less than unity, which suggests that when retail price decreases, total revenue from the sales of oranges and grapefruit decreases.

Overall, changes in income elasticities were small except that for grapes. Results indicate that oranges, grapefruit, and apples are luxuries and grapes are inferior good among the five fruits examined. Own-price elasticity estimates indicate the demand responses to price changes for oranges, grapefruit, and apples remain about constant over the study period, while the demand for bananas became more sensitive to price and for grapes, which became less price sensitive.

Functional Forms, Income, and Own-Price Elasticities

To demonstrate the impact of functional form on the demand elasticities, income and own-price elasticity estimates of the Rotterdam, AIDS, NBR and the general model are shown for years 1967, 1993, and at sample means in table 5 and can be compared to those of the CBS model reported in table 4. Income elasticity estimates from the Rotterdam and NBR are similar in size and trend while those from the AIDS and CBS are likewise similar. For example, over the sample period the income elasticity estimates for orange demand based on the Rotterdam and

the NBR were between 1.47 and 1.5 while those based on the AIDS and CBS were always greater than 1.5. These differences result from the two different types of marginal shares assumed in the systems -- constant marginal shares in the Rotterdam and NBR but variable ones in the AIDS and CBS -- combined with a decreasing food budget share and increasing total income.

Own-price elasticity estimates based on the Rotterdam and CBS are similar in size and trend while those based on the AIDS and NBR are similar. The elasticities based on Rotterdam-type price coefficients are generally smaller and become more price sensitive (except those for grapes) over the sample period than those based on the AIDS-type price parameters. The own-price elasticity estimates based on the general system are most similar to those of the CBS model for all categories of fruits. Remember that the extra parameter δ_2 , which is used to test the structure of the price terms, is statistically not different from zero, which is the value of δ_2 when the price terms follow those of the Rotterdam model exactly. The point estimate of the general system's extra parameter δ_1 , which tests the structure of the income term, is closer to one than zero, and it is statistically not different from one ($\alpha = 0.05$), based on asymptotic t-tests. This would explain why the income elasticity estimates of the general model are similar to those of the CBS model.

The results shown in Table 3 indicate that most fresh fruits are substitutes which are contradictory to Thompson et al.'s findings, i.e., most fresh fruits are complements. To demonstrate that functional forms dictates the finding of demand relationships, the AIDS cross-price elasticity estimates calculated at sample means are shown in Table 6. Note that while only two CBS cross-price elasticity estimates are negative (statistically not different from zero) six of

the AIDS cross-price elasticity estimates are negative. This result demonstrate that the selection of demand model should be an important part of demand studies.

Concluding Remarks

The Rotterdam and AIDS models have been popular demand systems in empirical work. However, the functional forms of their income and price terms differ which cause the basic demand responses for these models to differ in important ways. It is possible to develop hybrid systems of these two models which incorporate the income terms of one and price terms of the other. Choosing among the competing models can be accomplished by higher-order comparisons with a general demand system that nest the other four. Further, elasticity behaviors and other economic criteria can be used to evaluate the systems.

In our study of U.S. fresh fruit consumption data, the higher-order comparisons with the general model selected the CBS model over the other systems. This result suggests that AIDS-type income and Rotterdam-type price responses better explain U.S. fresh fruit consumption behavior than do the other models. This result is similar to what Barten (1993) found with Dutch data. In addition to a demand system selection tool, the general system which combines the features of all four systems -- the AIDS, CBS, NBR, and Rotterdam -- can be used as a demand system in its own right with the cost of only two additional parameters.

For this particular data, the use of a AIDS-type income parameter gives the questionable result that grapes are inferior good among the five fresh fruits studied.

Footnote

¹The AIDS and Rotterdam, for example, are not directly tested against each other, but against the more general demand system within which both are nested..

²The models are named after the Netherlands Central Bureau of Statistics and the National Bureau of Research, where Keller and van Driel and Neves worked when the respective models were developed.

³When one uses the Divisia price index for $d \log P$, equations (13) and (13a) are close approximations of the differential AIDS.

⁴The naive AIDS model is $w_{it} d \log q_{it} = b_i d \log Q_t + e_{it}$. This model also satisfies the adding-up condition, $\sum b_i = 1$, by construction.

⁵The autocorrelation coefficient estimate ρ ($= 0.008$ with an asymptotic standard error of 0.002) for the AIDS was statistically different from zero at the $\alpha = 0.01$ level.

⁶For alternative formulas, see Green and Alston (1990 and 1991).

Table 1. Taiwanese budget shares and price indices for seven categories of goods, 1970 through 1989.

Year	Oranges	Grapefruit	Apples	Bananas	Grapes
Budget Share					
1967	0.1604	0.0660	0.3871	0.3150	0.0716
Average	0.1502	0.0715	0.3748	0.2637	0.1399
1993	0.1581	0.0667	0.3283	0.2381	0.2088
Price Index (1979-80 Average = 100)					
1967	30.69	32.01	56.87	60.31	31.27
Average	89.18	103.66	103.89	89.57	85.82
1993	138.11	167.67	144.17	111.70	144.05

Table 2. Test results for the Rotterdam model, CBS, AIDS, NBR, and general model with first-order autocorrelation imposed.

Model	Log Likelihoods	$-2(L(\theta^*)-L(\theta))^a$
General Model ^b	334.80	
Rotterdam	333.73	2.14
CBS	334.74	0.12
AIDS	333.35	2.90
NBR	331.87	5.86

^aThe table value for $\chi_{(2)}^2 = 5.99$ at $\alpha = 0.05$ level.

^bThe estimates for δ_1 and δ_2 in (14) are 1.1253 and 0.1616 with standard errors 0.6209 and 0.4754, respectively.

Table 3. Implied marginal shares and Slutsky coefficients based on parameter estimates of the CBS model, homogeneity and symmetry imposed.

Commodity Group	Expenditure Coefficient (β_i) ^a	Slutsky Coefficient (π_{ij})				
		Oranges	Grapefruit	Apples	Bananas	Grapes
Oranges	0.0884** (0.0526)	-0.0888** (0.0172)	0.0212** (0.0092)	0.0073 (0.0149)	0.0265** (0.0138)	0.0338** (0.0120)
Grapefruit	0.0087 (0.0285)		-0.0489** (0.0110)	-0.0041 (0.0096)	0.0311** (0.0112)	0.0007 (0.0092)
Apples	0.1305** (0.0689)			-0.0256 (0.0248)	0.0208* (0.0154)	0.0016 (0.0152)
Bananas	-0.0075 (0.0454)				-0.0820** (0.0209)	0.0035 (0.0136)
Grapes	-0.2201** (0.0444)					-0.0396** (0.0161)

^aEstimated at sample mean budget shares.^bNumbers in parentheses are asymptotic standard errors.*Statistically different from zero at $\alpha = 0.10$ level.**Statistically different from zero at $\alpha = 0.05$ level.

Table 4. CBS demand elasticity estimates for five fresh fruits, 1967 to 1993

Commodity	Income Elasticity	Compensated Price Elasticity				
		Oranges	Grapefruit	Apples	Bananas	Grapes
		1967				
Oranges	1.5513	-0.5537	0.1322	0.0454	0.1654	0.2107
Grapefruit	1.1321	0.3212	-0.7409	-0.0621	0.4711	0.0107
Apples	1.3371	0.0188	-0.0106	-0.0662	0.0539	0.0041
Bananas	0.9763	0.0842	0.0987	0.0662	-0.2603	0.0112
Grapes	-2.0750	0.4720	0.0099	0.0221	0.0491	-0.5531
		Sample Mean				
Oranges	1.5887	-0.5913	0.1412	0.0485	0.1766	0.2250
Grapefruit	1.1219	0.2964	-0.6836	-0.0573	0.4347	0.0099
Apples	1.3481	0.0194	-0.0109	-0.0683	0.0556	0.0042
Bananas	0.9717	0.1006	0.1180	0.0791	-0.3110	0.0133
Grapes	-0.5741	0.2416	0.0050	0.0113	0.0252	-0.2831
		1993				
Oranges	1.5591	-0.5615	0.1341	0.0460	0.1677	0.2137
Grapefruit	1.1308	0.3178	-0.7332	-0.0615	0.4662	0.0106
Apples	1.3974	0.0222	-0.0125	-0.0780	0.0635	0.0048
Bananas	0.9687	0.1114	0.1306	0.0876	-0.3444	0.0148
Grapes	-0.0545	0.1619	0.0034	0.0076	0.0169	-0.1897

Table 5. Fresh fruit income and own-price elasticity estimates of four demand system calculated at sample means and two selected years.

Commodity Group	Income Elasticity			Own-Price Elasticity		
	1967	Mean	1993	1967	Mean	1993
Rotterdam						
Oranges	1.4799	1.5802	1.5007	-0.5592	-0.5971	-0.5671
Grapefruit	1.2394	1.1436	1.2265	-0.7472	-0.6894	-0.7394
Apples	1.2931	1.3356	1.5244	-0.0767	-0.0792	-0.0904
Bananas	0.4484	0.5356	0.5932	-0.2513	-0.3003	-0.3326
Grapes	0.5465	0.2798	0.1874	-0.5507	-0.2819	-0.1889
AIDS						
Oranges	1.5412	1.5779	1.5488	-0.5866	-0.5796	-0.5853
Grapefruit	1.1379	1.1272	1.1365	-0.7016	-0.7140	-0.7033
Apples	1.3102	1.3204	1.3657	-0.0741	-0.0687	-0.0364
Bananas	0.9852	0.9823	0.9804	-0.5432	-0.5669	-0.5743
Grapes	-3.7026	-1.4072	-0.6127	1.1864	0.2224	-0.0660
NBR						
Oranges	1.4701	1.5698	1.4908	-0.5915	-0.5849	-0.5903
Grapefruit	1.2437	1.1476	1.2308	-0.7067	-0.7188	-0.7084
Apples	1.2667	1.3083	1.4933	-0.0851	-0.0801	-0.0495
Bananas	0.4574	0.5464	0.6051	-0.5332	-0.5549	-0.5610
Grapes	0.6676	0.3418	0.2290	1.1891	0.2238	-0.0651
General						
Oranges	1.5588	1.5881	1.5649	-0.5583	-0.5886	-0.5646
Grapefruit	1.1194	1.1198	1.1194	-0.7336	-0.6877	-0.7274
Apples	1.3382	1.3452	1.3762	-0.0661	-0.0670	-0.0697
Bananas	1.0441	1.0283	1.0178	-0.3072	-0.3537	-0.3831
Grapes	-2.3839	-0.6710	-0.0781	-0.2722	-0.2015	-0.1697

Table 6. AIDS parameter estimates and price elasticity estimates

	Oranges	Grapefruit	Apples	Bananas	Grapes
AIDS Price Parameters (e_{ij})					
Oranges	0.0406	0.0102	-0.0481	-0.0032	0.0006
Grapefruit	0.0102	0.0153	-0.0283	0.0226	-0.0198
Apples	-0.0481	-0.0283	0.2086	-0.0320	-0.1002
Bananas	-0.0032	0.0226	-0.0320	0.0447	-0.0320
Grapes	0.0006	-0.0198	-0.1002	-0.0320	0.1514
Price Elasticity Estimates (at Sample Means)					
Oranges	-0.5796	0.1393	0.0543	0.2421	0.1439
Grapefruit	0.2924	-0.7140	-0.0203	0.5792	-0.1374
Apples	0.0218	-0.0039	-0.0687	0.1782	-0.1274
Bananas	0.1379	0.1572	0.2533	-0.5669	0.0185
Grapes	0.1647	-0.0703	-0.4526	0.0348	0.2224

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