Journal of Agricultural and Applied Economics, 29,2(December 1997):279–289

Demand and Competition Among Supply Sources: The Indonesian Fruit Import Market

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ABSTRACT

Indonesia is a rapidly growing and competitive market for U.S. fruit. A restricted, source-differentiated, almost ideal demand system is estimated for apples, oranges, grapes, and other fruit in Indonesia. The Marshallian expenditure elasticities for U.S. fruit are estimated to be between 1.01 and 1.21. For grapes and oranges, competition with other fruits appears to be more important than competition with other supply sources. For apples, strong source-differentiated substitution relationships are found.

Key Words: AIDS model, fruit, import demand, Indonesia, source-differentiated demand.

From 1990 to 1993, U.S. exports of high-value food products to Indonesia increased almost 300%, from $11 million to more than $33 million (Humphrey). Imports of U.S. fruits represented an important component of this increase. U.S. fruit characteristics (and sometimes brands) are recognized by most people in Indonesia, particularly in the heavily populated urban areas. Among U.S. exports of high-value food products to Indonesia, fruit exports account for the greatest value—$16 million (U.S. Department of Commerce).

Indonesian fruit importing policies have changed in the past 20 years. Prior to 1981, fruit importing was done by general importers. In 1981, fruit importing was restricted to two licensed state trading companies. From 1981 to 1991, fruit imports decreased dramatically and the cost per unit increased, partially due to government restrictions. Government restrictions on imports during that period were designed to protect and support local industry development, where fruit production is characterized by many relatively small production units and product quality heterogeneity. However, the trade protection did not create the desired supply response, and production continued to fluctuate from year to year. In June 1991, fruit importing was deregulated as part of a general deregulation program. Tariffs of 562 commodities (6% of all imported items) were reduced to 40% or below, pushing the import-weighted average tariff down from 22% in 1985 to 10% in 1991. In agriculture, nontariff barriers have been eliminated on imports of beef, chicken, several fish products, and many fruits (Schwartz). Deregulation in the fruit import market had dramatic effects. Fruit imports increased, prices decreased, and distribution improved.

Fruits are among the most widely distrib-

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Research support for this work was provided by a National Research Initiative grant from the Cooperative State Research, Education, and Extension Service. The authors acknowledge the helpful comments from the reviewers and editors. Any remaining errors are the responsibility of the authors.

Table 1. Indonesian Fruit Imports from Different Countries, 1970–93

Fruit/Country of Origin	Average Share of Total Fruit Imports	Market Shares for Each Country
Oranges:	0.197922	1.00000
United States	0.085685	0.39157
Australia	0.039649	0.24760
China	0.027399	0.12211
ROW	0.045190	0.23871
Apples:	0.439864	1.00000
United States	0.164400	0.44130
Australia	0.098872	0.20006
New Zealand	0.024842	0.06075
ROW	0.151750	0.29789
Grapes:	0.132318	1.00000
United States	0.088467	0.66527
Australia	0.023123	0.15242
Chile	0.002739	0.01665
ROW	0.017989	0.16566
Other Fruits:	0.229896	1.00000

Source: Central Bureau of Statistics, Jakarta, Indonesia.

uted imported products. Traditionally, Indonesians routinely serve fruit after meals. Imported fruits are now available in most large cities in Indonesia and are sold in a growing number of supermarkets, in specialty fruit markets, in traditional open-air "wet" markets, and by street vendors in high-income neighborhoods in major cities.

Among the domestic fruits, bananas rank the highest in production and consumption, and are the most widely available throughout the year. Prices for this fruit are quite low. Bananas are sold to a broader mass market than are imported fruits. Bananas are frequently used in recipes, as ingredients for other products, and are sometimes processed into snack foods. Indonesia also has some commercial plantations. Other domestically produced fruits are available seasonally. Domestic apples are in limited production on Java, but the low volume, quality characteristics, distribution, and seasonal availability limit their competitiveness with imported apples. Citrus is produced in Indonesia, but because of the warm tropical climate, oranges (mostly mandarin varieties) do not gain the uniform orange color of the oranges imported from Australia and the U.S., nor do they have consistent flavor.

Because of the current economic growth in Indonesia, the overall size of the market (200 million people), and growing middle and upper classes, Indonesia is a hotly contested market. U.S. suppliers face strong competition from other countries. Australia, New Zealand, China, and Chile are among the supply sources with significant percentages of the imported orange, apple, and grape markets in Indonesia. Because of the proximity of Australia and New Zealand to Indonesia, their suppliers, particularly of apples and oranges, are among the most significant and aggressive competitors (table 1). U.S. apple suppliers have also become more aggressive by hiring a local representative to manage promotions.

Because of the high level of competition faced by U.S. suppliers, market growth, and potential size, Indonesia is an ideal choice for examining the nature of U.S. fruit export potential in a rapidly developing country. The overall objective of this study is to provide information that will enhance our understanding of high-value fruit product market potentials in developing countries. The specific objectives are to: (*a*) explain variation in U.S. apple, orange, and grape imports to Indonesia; (*b*) estimate the nature of the price competition between U.S. fruits and fruits from other suppliers; and (*c*) appraise the likely prospects for U.S. fruit suppliers in the Indonesian market.

To meet these objectives, import demand models for fruit in Indonesia are estimated. Most previous studies have focused on demand in developed economies; relatively little is known about demand in rapidly developing economies. Based on our review of published literature, this study is the first to examine the Indonesian fruit market and to estimate all fruit import demand functions together using a source-differentiated model. Therefore, this research contributes to the needed understanding of U.S. fruit import demand in Pacific Rim countries (Mathews; McCracken et al.). Import demand studies of other markets are reviewed in the following section.

Literature Review

Import allocation models have been used to investigate import demand for U.S. fresh fruit products. Lee, Seale, and Jierwiriyapant found that U.S. fresh grapefruit exports to Japan would have to compete against banana and pineapple imports in Japan and that U.S. citrus juice exports would have to compete against the juices from Brazil and Israel. Sparks, Seale, and Buxton found that the U.S. will increase its apple exports to Canada, Hong Kong, Singapore, and the United Kingdom as the import demand of the countries increases. Their results also show that the growth of Chile as a major world supplier of apples has not changed the U.S. competitive position in each of the major markets.

A restricted, source-differentiated, almost ideal demand system (RSDAIDS) is used in this study. The almost ideal demand system (AIDS), Rotterdam, linear and quadratic expenditure system, translog, and hybrid models with less restrictive assumptions than the Armington model were considered as alternative models (Winters; Alston et al.). The Rotterdam and AIDS models are most frequently used (Alston et al.; Sparks, Seale, and Buxton; Lee, Seale, and Jierwiriyapant; Eales and Unnevehr). Recently, Lee, Brown, and Seale (following Barten) employed nonnested tests to choose the model that would best represent their data. However, to analyze the import demand for products differentiated by sources, this method may lead to a different model for each product, while the RSDAIDS model results in a similar model for each product. For products that are similar and competing in the same market, we prefer the RSDAIDS approach.

Empirical applications of the AIDS model to import demand have frequently assumed either product aggregation or block separability (Yang and Koo). Under the product aggregation assumption, products are not differentiated by sources and are perceived as the same (Hayes, Wahl, and Williams). Moreover, the block separability assumption among goods allows estimation of share equations for goods from different origins (e.g., Alston et al.). The Armington model is derived by assuming block separability. Product aggregation (perfect substitutability among sources) and block separability are very strong assumptions. The RSDAIDS model is a more general model and does not impose perfect substitutability or the block separability assumptions.

Restricted SDAIDS Models

The AIDS model is obtained from a specific parameterization of the price-independent generalized logarithmic (PIGLOG) cost function (Deaton and Muellbauer). The PIGLOG cost function is written as

$$(1) \qquad \ln[C(p, u)] = (1 - u) \times \ln[A(p)] + u \times \ln[B(p)],$$

where $A(p)$ is a price aggregation function of the type

$$(2) \qquad \ln[A(p)] = \alpha_0 + \sum_i \sum_h \ln(p_{ih}) + \frac{1}{2} \sum_i \sum_j \sum_h \sum_k \gamma^*_{ihjk} \ln(p_{ih}) \ln(p_{jk});$$

$B(p)$ is written as

$$(3) \qquad \ln[B(p)] = \ln[A(p)] + \beta_0 \prod_i \prod_h p_{ih}^{\beta_{ih}};$$

and α, β, and γ^* are parameters. The subscripts i and j are goods ($i, j = 1, \ldots, N$)—in this case, oranges, apples, grapes, and other fruits; and h and k denote sources. For each good, the number of sources is not necessarily the same. Good i may be imported from m different sources, while good j may have n import sources. If $i \neq j$, then $h = 1, \ldots, m$, and $k = 1, \ldots, n$. By taking the derivative of (1) with respect to the price, a system of demand equations can be written in share form as

$$(4) \qquad w_{ih} = \alpha_{ih} \sum_j \sum_k \gamma_{ihjk} \ln(p_{jk}) + \beta_{ih} u \beta_0 \prod_i \prod_h p_{ih}^{\beta_{ih}},$$

where $\{\gamma_{i_h j_k} = \frac{1}{2}(\gamma^*_{i_h j_k} + \gamma^*_{j_k i_h}), w_{i_h}\}$ is the share of good i from country h. Furthermore, taking the first derivative of the cost function with respect to u and substituting the results into equation (4) gives the source-differentiated AIDS (SDAIDS) in expenditure share form:

$$(5) \qquad w_{i_h} = \alpha_{i_h} \sum_j \sum_k \gamma_{i_h j_k} \ln(p_{j_k}) + \beta_{i_h} \ln(E/P^*),$$

where

$$(6) \qquad \ln(P^*) = \alpha_0 + \sum_i \sum_h \alpha_{i_h} \ln(p_{i_h}) + \frac{1}{2} \sum_i \sum_h \sum_j \sum_k \gamma^*_{i_h j_k} \ln(p_{i_h}) \ln(p_{j_k}).$$

Since P^* is not linear, several alternative representations of the index have been evaluated. Moschini proposed the regular price indices, the Tornquist index, the "corrected" Stone index, and the geometrically weighted average of prices. The Tornquist index is used in this study because it retains some features of the Stone index, which is the log-linear analog of the Paasche price index, and also it retains some features of the log-linear analog of the Laspeyres price index (Moschini). The Tornquist index, P^T, viewed as a discrete approximation to the Divisia index, is

$$(7) \qquad \log(P^T_t) = \frac{1}{2} \sum_i \sum_h (w_{i_h t} + w^0_{ih}) \log(p_{i_h t}/p^0_{ih}),$$

where the zero superscript denotes base period values. Instead of base period values, mean values are used as a base for time t.

Using the SDAIDS model in equation (5), the import demand of different goods from different sources can be estimated if a sufficient number of observations are available. However, the SDAIDS model contains all product prices of different goods from different sources in each equation to be estimated. For example, to estimate three products (e.g., apples, oranges, and grapes), each of which has four sources, there will be 14 parameters (3 × four prices + intercept + expenditure) to be estimated in each equation. Yang and Koo assumed that

$$(8) \qquad \gamma_{i_h j_k} = \gamma_{i_h j} \quad \forall\, k \in j \neq i.$$

This means that the cross-price effects are not source differentiated between products, while the cross-price effects are source differentiated within a product. For example, the Indonesian demand for U.S. apples will have a source-differentiated cross-price effect for apples from other sources, but the cross-price responses to grapes and oranges are not source differentiated. If Yang and Koo's assumption is used, the SDAIDS model [equation (5)] becomes the restricted SDAIDS (RSDAIDS) model:

$$(9) \qquad w_{i_h} = \alpha_{i_h} + \sum_k \gamma_{i_h k} \ln(p_{i_k}) + \sum_{j \neq i} \gamma_{i_h j} \ln(p_j) + \beta_{i_h} \ln(E/P^T),$$

where $\{\ln(p_j) = \Sigma_k(w_{j_k} + w^0_j) \times \ln(p_{jk}/p^0_j), \gamma_{i_h k}\}$ denotes the price coefficients of good i from different source h; $\gamma_{i_h j}$ is the cross-price coefficient between good i and good j where $i \neq j$; and w^0_j and p^0_j are mean values. For three products, each of which has four sources, each equation of the RSDAIDS model has a price coefficient for each source, two coefficients for the other two products, an intercept, and an expenditure coefficient—or eight total coefficients (compared with 14 in the SDAIDS model). The Marshallian price elasticities can be calculated from the RSDAIDS coefficients. These elasticities are derived by assuming $\partial \ln P^*/\partial \ln P_j = w_j$ (Chalfant). Since this model is highly disaggregated and expenditure shares are small, the compensated elasticities are approximately equal to uncompensated elasticities (Green and Alston).

The general demand conditions for import behavior—adding-up, symmetry, and homogeneity—also can be imposed or tested in the RSDAIDS model. Block substitutability and symmetry conditions among goods are not applicable. Symmetry is applied only within each good.

Data, Estimation Procedure, and Results

Data

Annual data from 1970 through 1993 are used for this study. Indonesia's fruit imports are

Table 2. RSDAIDS Model Coefficient Estimates for Indonesian Fruit Demand, 1970–93

Equations/ Variables[a]	Block Separable AIDS Models	
	U.S. Equation	ROW Equation
Oranges:		
PO_{US}	−0.08980 (0.029693)	−0.05935 (0.022385)
PO_{ROW}	−0.05935 (0.021934)	−0.01521 (0.031762)
P_{Grapes}	−0.00574 (0.068608)	−0.01490 (0.070965)
P_{Apples}	0.14387 (0.028311)	0.09222 (0.031322)
P_{Ofruit}	0.01102 (0.064891)	−0.00277 (0.067965)
Y	0.00106 (0.004683)	−0.00259 (0.004899)
Grapes:		
PG_{US}	−0.01614 (0.014505)	0.01067 (0.013317)
PG_{ROW}	0.01067 (0.013415)	0.03469 (0.032373)
$P_{Oranges}$	−0.05371 (0.040622)	−0.04425 (0.040864)
P_{Apples}	0.04448 (0.021072)	−0.02403 (0.037443)
P_{Ofruit}	0.01469 (0.039508)	0.02292 (0.040867)
Y	0.00882 (0.003558)	0.00158 (0.003764)
Apples:		
PA_{US}	−0.03923 (0.058827)	0.17452 (0.059559)
PA_{ROW}	0.17452 (0.041419)	−0.51330 (0.052184)
$P_{Oranges}$	0.02682 (0.14937)	−0.11842 (0.21488)
P_{Grapes}	−0.08607 (0.17758)	0.40735 (0.25693)
P_{Ofruit}	−0.07605 (0.076738)	0.049846 (0.10977)
Y	0.03216 (0.005831)	−0.061312 (0.00826)
$R^2 = 0.9850$		

Note: Numbers in parentheses are standard deviations.
[a] Definitions of variables are as follows: PO_{US} = price of oranges from United States, PO_{ROW} = price of oranges from rest of the world, PG_{US} = price of grapes from United States, PG_{ROW} = price of grapes from rest of the world, PA_{US} = price of apples from United States, PA_{ROW} = price of apples from rest of the world, $P_{Oranges}$ = price of oranges (unit value of import for oranges is used as a proxy), P_{Grapes} = price of grapes (unit value of import for grapes is used as a proxy), P_{Apples} = price of apples (unit value of import for apples is used as a proxy), P_{Ofruit} = price of other fruit (unit value of import for other fruit is used as a proxy), and Y = expenditures on fruits.

grouped into four goods: apples, oranges, grapes, and other fruits. Two origins, the U.S. and the rest of the world, are used. Table 1 shows the average share of the U.S. and its competitors for each fruit. Apples, oranges, and grapes account for 70% of imported fruits. The U.S. has the largest average share of these three import fruits, and Australia has the second largest share. For oranges, the U.S. export average share is 39%, for apples 44%, and for grapes 67%. The import price used is the unit value of imports.

The RSDAIDS model is used to conserve degrees of freedom. The full model has a U.S. and rest-of-the-world (ROW) equation for oranges, grapes, apples, and other imported fruits. In each of the equations, there is one source-differentiated own-price coefficient, one source-differentiated cross-price coefficient, three nonsource-differentiated cross-price coefficients (one for each of the other fruits), an expenditure coefficient, and an intercept. Because the adding-up condition across goods creates a singularity problem, the equations for other fruits were dropped.

Estimation Procedure

The following steps are used in the estimation procedure:

STEP 1. A nonsource-differentiated (aggregate) AIDS model is estimated where perfect substitutability is assumed.

STEP 2. Equation (9), the RSDAIDS model, is estimated by seemingly unrelated regression (SUR) with homogeneity and symmetry conditions imposed using the SHAZAM computer program (table 2).

STEP 3. Equation (9) is then tested for symmetry and homogeneity of the coefficients as follows:

$$\gamma_{i_h j_k} = \gamma_{j_k i_h} \quad \text{(symmetry)},$$

$$\sum_k \gamma_{i_h k} + \sum_{j \neq i} \gamma_{i_h j} = 0 \quad \text{(homogeneity)}.$$

Because of block substitutability, symmetry conditions among goods are not applicable. Symmetry is applied only within each good. Homogeneity and symmetry tests were conducted using likelihood ratio tests.

STEP 4. Following Hayes, Wahl, and Williams, block separability among goods and product aggregation are tested. The following constraints on the RSDAIDS model [equation (9)] are tested:[1]

$$(10) \qquad \gamma_{i_h j} = w_{i_h} w_{j_k} \gamma_{ij} \quad \forall j \neq i$$

(block separability),

$$(11) \qquad \begin{bmatrix} \alpha_{i_h} = \alpha_i & \forall h \in i, \\ \gamma_{i_h j_k} = \gamma_{ij} & \forall h, k \in i, j, \\ \beta_{i_h} = \beta_i & \forall h \in i \end{bmatrix}$$

(product aggregation),

where γ_{ij} is the cross-price parameter between groups i and j. The γ_{ij} are estimated from a nonsource-differentiated (aggregate), three-goods AIDS model where perfect substitutability is assumed (as performed in Step 1). To test the source-differentiation assumption that apples from the U.S. and from the rest of the world are perfect substitutes, the price and expenditure coefficients in the U.S. equation and the ROW equation in the apple model were restricted to be equal [equation (11)]. The tests are conducted by imposing the restrictions in (10) and (11) on the RSDAIDS model.

STEP 5. Since the Tornquist index is used to deflate expenditures and is constructed using the budget share (the left-hand side in the RSDAIDS model), an endogeneity problem may arise (LaFrance). A Wu-Hausman endogeneity test (Hausman) is performed to determine whether expenditures may be endogenous. If endogenous expenditures are correlated with the error terms, estimates will be biased and inconsistent. Let the expenditure variable, $\ln(E/P^*)$, in the SDAIDS model be approximated by equation (12):

$$(12) \qquad \ln(E/P^*) = \alpha_{i_h} + \sum_j \sum_k f_{i_h j_k} \ln(p_{j_k t}) + g_{i_h} \ln(GNP_t) + h_{i_h} \ln(ER_t) + i_{i_h} \ln(p_o) + V_{i_h},$$

where t is time, GNP is per capita gross national product, ER is real effective exchange rate for imports, p_o is the price vector of all other goods, and V_{i_h} is the random error term. The random error term is partitioned as

$$(13) \qquad V_{i_h} = \xi_{i_h} V^*_{i_h} + e_{i_h},$$

where ξ_{i_h} is the correlation parameter such that $E(V^*_{i_h}, e_{i_h}) = 0$, and e_{i_h} are independent of $V^*_{i_h}$. To test the endogeneity of the expenditure variable, the residual $V^*_{i_h}$ is included in the RSDAIDS equation and the Wald chi-square test is performed.

Results

The results of the source differentiation and separability tests are shown in table 3. The Wald chi-square test statistic for the null hypothesis that oranges are separable from all other fruits (i.e., apples, grapes, and other fruits) is 69.63. Moreover, the statistics for the separability tests for apples and grapes and the joint test for all three equations are 17.27, 148.88, and 235.78, respectively. The null hypotheses that the fruit import demand can be estimated separately for each good are all rejected at less than the 5% level of significance. The Wald chi-square test statis-

[1] Two fruit groups, i and j, may be considered separable if the compensated cross-price effects between the share of import fruit from source h in fruit group i and the price of import fruit from source k in fruit group j ($i \neq j$) satisfy the restriction in (12). However, because fruit group j is specified as a single commodity, the weight for that group is 1. This causes the separability restriction to be respecified as follows: $\gamma_{i_h j_k} = w_{i_h} \times \gamma_{ij}$.

Table 3. Results of Block Separability, Source Differentiation, and Endogeneity Tests for the RSDAIDS Model

Type of Test	Test Results
Block Separability	H_0: Oranges are separable from all other fruits. Wald $\chi^2 = 69.63^{**}$ DF = 6
	H_0: Grapes are separable from all other fruits. Wald $\chi^2 = 17.27^{*}$ DF = 6
	H_0: Apples are separable from all other fruits. Wald $\chi^2 = 148.88^{**}$ DF = 6
	H_0: All of the above. Wald $\chi^2 = 235.78^{**}$ DF = 18
Source Differentiation	H_0: Orange sources are not differentiated. Wald $\chi^2 = 15.36^{*}$ DF = 4
	H_0: Grape sources are not differentiated. Wald $\chi^2 = 108.35^{**}$ DF = 4
	H_0: Apple sources are not differentiated. Wald $\chi^2 = 196.67^{**}$ DF = 4
	H_0: All of the above. Wald $\chi^2 = 320.38^{**}$ DF = 12
Auxiliary Regression of Total Expenditures to Test for Endogeneity	$\ln(E/P^T) = \underset{(17.01)^*}{37.16} - \underset{(0.89)^{**}}{3.16}LP_{Oranges} - \underset{(0.84)}{1.14}LP_{Grapes} + \underset{(3.03)}{1.88}LP_{Apples}$ $- \underset{(1.27)^*}{2.42}LP_{Ofruit} + \underset{(2.48)}{2.22}CPI + \underset{(2.22)}{1.43}GNP - \underset{(1.83)^*}{1.30}ER$ $R^2 = 0.8578$, DW = 1.77

Note: Single and double asterisks (*) denote significance at the 5% and 1% level, respectively.

tics for the aggregation over sources for orange, grape, apple, and fruit imports as a whole are 15.36, 108.35, 196.67, and 320.38, respectively; thus, the null hypotheses are rejected. The data support the RSDAIDS model.

The Wu-Hausman endogeneity test for the null hypothesis of no correlation between group expenditures and the error term is conducted. The error terms from the auxiliary equation shown in table 3 are included in the demand equations and tested for significance—where $LP_{Oranges}$, LP_{Grapes}, LP_{Apples}, and LP_{Ofruit} are price vectors of products in the group; *CPI* is a proxy of the price vector of all other goods; *GNP* is GNP per capita; and *ER* is the real effective exchange rate for imports. The inclusion of the exchange rate measures the effect of omitted price variables in the model. A consumer price index is used as a proxy for the price of all other goods, and per capita GNP is used as a proxy for total expenditure. The Wu-Hausman endogeneity test indicates that simultaneity is not a problem. The null hypothesis of no correlation between group expenditures and the error terms is not rejected at the 5% level of significance. The Wald chi-square statistic for this test is 4.04.

Homogeneity and Slutsky symmetry are tested and are supported by the data. The likelihood ratio test statistics are 7.63 for homogeneity and 4.32 for Slutsky symmetry.

Interpretation

In general, it appears that the demand system provides an excellent explanation of the variation in apple, grape, and orange imports [objective (*a*)]. Most of the coefficients have the expected signs and the system R^2 of the model is 0.9850 (table 2).

Tables 4 and 5 present the Marshallian and Hicksian price elasticities, respectively, of In-

Table 4. Marshallian Elasticities for Indonesian Fruit Import Demand, 1970–93

Products/ Variables	U.S. Equation	ROW Equation
Oranges:		
PO_{US}	−1.8237**	−0.1298
	(0.4333)	(0.1433)
PO_{ROW}	−0.1738	−0.7220*
	(0.2761)	(0.1850)
P_{Grapes}	−0.7181	−1.2744**
	(0.5450)	(0.2420)
P_{Apples}	1.2300**	0.4177*
	(0.3361)	(0.1720)
P_{Ofruit}	0.4242	0.6807*
	(0.2750)	(0.1271)
Y	1.0617**	1.0278**
	(0.0547)	(0.0276)
Grapes:		
PG_{US}	−1.2060**	0.2051
	(0.1533)	(0.2758)
PG_{ROW}	0.0998	−0.3412
	(0.1420)	(0.6523)
$P_{Oranges}$	−0.7976**	−1.0631*
	(0.2389)	(0.4609)
P_{Apples}	0.5279*	−0.2910
	(0.2215)	(0.7550)
P_{Ofruit}	0.2885*	0.4840
	(0.1260)	(0.2470)
Y	1.0873**	1.0062**
	(0.0388)	(0.0801)
Apples:		
PA_{US}	−1.8582**	0.9073*
	(0.3665)	(0.2470)
PA_{ROW}	1.3713**	−2.9354**
	(0.2674)	(0.2092)
$P_{Oranges}$	1.7068	−1.0056
	(0.9330)	(0.8467)
P_{Grapes}	−2.9561*	2.5611*
	(0.9862)	(0.9021)
P_{Ofruit}	0.5041*	−0.3360*
	(0.1429)	(0.1319)
Y	1.2136**	1.0373**
	(0.0332)	(0.0050)
$R^2 = 0.9850$		

Notes: Numbers in parentheses are standard errors. Single and double asterisks (*) denote significance at the 5% and 1% level, respectively. Variables are as defined in table 2 footnote. Marshallian elasticities are calculated using the following formulae for own-price, cross-price among fruits and sources, and expenditure elasticities:

$$\epsilon_{i_h i_h} = -1 + \frac{\gamma_{i_h h}}{W_{i_h}} - \beta_{i_h}, \quad \epsilon_{i_h i_k} = \frac{\gamma_{i_h k}}{W_{i_h}} - \beta_{i_h}\left(\frac{W_{i_k}}{W_{i_h}}\right),$$

$$\epsilon_{i_h J} = \frac{\gamma_{i_h J}}{W_{i_h}} - \beta_{i_h}\left(\frac{W_J}{W_{i_h}}\right), \quad \eta_{i_h} = 1 + \frac{\beta_{i_h}}{W_{i_h}}.$$

donesian fruit import demand for the 1970–93 data period. As shown in table 4, for oranges, the Marshallian own-price elasticities for the U.S. and the rest of the world indicate that U.S. orange imports are more price responsive than the ROW imports (−1.824 and −0.722, respectively). The source-differentiated Marshallian cross-price elasticities between oranges from the U.S. and oranges from the rest of the world are negative but not significant. Competition among sources of oranges does not appear to be occurring, perhaps because the U.S. and its competitors have Northern and Southern Hemisphere production and marketing cycles which overlap only during a few months of the year. The Marshallian cross-price elasticities among oranges and other fruits (not source differentiated) are negative for grapes and positive for apples and other fruits. The results suggest that oranges from both the U.S. and other sources face more market competition from apples and other fruits than they face from oranges from the other sources [objective (*b*)].

In the grape equation, the own-price Marshallian elasticity of the U.S. (−1.206) is negative, significant, and elastic (table 4). The ROW own-price elasticity is not significant. The source-differentiated Marshallian and Hicksian cross-price elasticities between the U.S. and other world suppliers are positive but not significant. The cross-price elasticities between grapes and oranges are both unexpectedly negative, suggesting that substitution does not occur between grapes and oranges. However, U.S. grapes were found to have positive and significant substitution relationships with apples and other fruit imports. Again,

Table 5. Hicksian or Compensated Price Elasticities for Indonesian Fruit Import Demand, 1970–93

Products/ Variables	U.S. Equation	ROW Equation
Oranges:		
PO_{US}	−1.7327**	−0.04173
	(0.4355)	(0.1440)
PO_{ROW}	−0.0546	−0.60664**
	(0.2781)	(0.1864)
P_{Grapes}	−0.5080*	−1.0710*
	(0.5401)	(0.2397)
P_{Apples}	1.3239	0.6211**
	(0.3283)	(0.1684)
P_{Ofruit}	0.4715	0.88412**
	(0.2817)	(0.1301)
Grapes:		
PG_{US}	−1.1098**	0.2941
	(0.1549)	(0.2782)
PG_{ROW}	0.1482	−0.2963
	(0.1423)	(0.6537)
$P_{Oranges}$	−0.6537*	−0.9299*
	(0.2354)	(0.4549)
P_{Apples}	0.6718**	−0.1578
	(0.2198)	(0.7429)
P_{Ofruit}	0.4324**	0.6171*
	(0.1268)	(0.2491)
Apples:		
PA_{US}	−1.6601**	1.0766**
	(0.3655)	(0.2476)
PA_{ROW}	1.7070**	−2.6484**
	(0.2675)	(0.2099)
$P_{Oranges}$	2.2406*	−0.5493
	(0.9348)	(0.8489)
P_{Grapes}	−2.4223*	3.0173**
	(0.9789)	(0.8994)
P_{Ofruit}	1.0379**	0.1203
	(0.1446)	(0.1319)

Notes: Numbers in parentheses are standard errors. Single and double asterisks (*) denote significance at the 5% and 1% level, respectively. Variables are as defined in table 2 footnote.

these results suggest that for grapes, Southern Hemisphere suppliers do not provide as much competition as do apples and other fruits that may be marketed at the same time as U.S. grapes are marketed in Indonesia. No significant substitution relationships were found in the grape equation for the rest of the world.

For apples, U.S. demand is own-price elastic and significant, but less own-price elastic than the highly elastic ROW apple demand. In contrast with oranges and grapes, important Marshallian and Hicksian cross-price substitution effects are demonstrated by the source-differentiated cross-price elasticities, which are large and significant in both the U.S. and ROW equations. We suggest that this reflects the controlled atmosphere storage conditions of apples that cause Northern and Southern Hemisphere sources to compete throughout the year. The nonsource-differentiated cross-price relationships are less clear for apples than for oranges and grapes.

The Marshallian expenditure elasticities (table 4) for all three fruits and the two sources are all positive and significant at the 1% level, and the value estimates are between 1.01 and 1.21. This implies that if expenditures on fruit imports in Indonesia continue to grow, imports of the fruits in these models will grow at a rate slightly above the expenditure growth rate. Given continued economic growth and development in Indonesia, we would expect that the Indonesian fruit market will continue to grow [objective (*c*)].

Summary and Conclusions

The RSDAIDS model is found to provide an excellent explanation of variation in Indonesian fruit imports from the U.S. and other sources [objective (*a*)]. In particular, the RSDAIDS system captures the essential nature of price effects and competition [objective (*b*)]. Own-price Marshallian elasticities for fruits imported from the U.S. and rest of the world all exhibit the expected negative sign and are significant except for grapes in the ROW equation. Oranges and grapes imported from the U.S. are much more Marshallian own-price elastic than are imports from the rest of the world. For apples, the reverse is true.

The results identified competition among fruits as well as competition between sources of the same fruit [objective (*b*)]. For oranges and grapes, the substitution relationships with other fruits are more important than the source-differentiated substitution relationships between sources of the same fruit (tables 4 and 5). Apples have a significant and positive substitution relationship with both U.S. oranges and U.S. grapes that is more important than the cross-price effects of competing suppliers of oranges and grapes. Apples compete with other fruits throughout the year and account for 44% of the weight of Indonesian fruit imports during the data period. Grapes and oranges from Southern and Northern Hemisphere suppliers are frequently not competing for market share during the same months. For U.S. apples, the source-differentiated substitution relationships are important.

Prospects for future demand appear to be quite positive. All of the expenditure elasticities are positive, significant, and between 1.01 and 1.21 in value. Should expenditure growth match the growth in real GNP, 8–10% growth per year at constant real prices could easily be achieved [objective (*c*)]. The markets for U.S. fruits were found to be own-price elastic. A 1% decrease in price would be expected to generate 1.8%, 1.2%, and 1.8% increases in the volume of oranges, grapes, and apples, respectively. The results suggest that competition among fruits is as important, or in some cases more important, as competition among sources of the same fruit. For example, prices of apples from all sources are an important determinant of the quantity of oranges imported from both the U.S. and other sources. This means that if apple prices are low, the U.S. orange market shares will be negatively impacted, and if orange prices are low, the U.S. apple market shares will be negatively impacted.

We find the RSDAIDS model useful in this analysis. Further applications of this approach appear to have merit because of the insights provided about the nature of the competition in an import market. Because of the rapid growth in the market, it is important to recognize that this study will need to be updated in order to remain useful. In particular, future updates of the model may want to consider testing for structural change following the period of trade deregulation in Indonesia. Sufficient observations were not available to perform that test in this research.

References

Alston, J.M., C.A. Carter, R. Green, and D. Pick. "Whither Armington Trade Models?" *Amer. J. Agr. Econ.* 72(1990):455–67.

Barten, A.P. "Consumer Allocation Models: Choice of Functional Form." *Empirical Econ.* 18(1993):129–58.

Central Bureau of Statistics, Jakarta, Indonesia. Various unpublished statistical reports, 1970–93.

Chalfant, J.A. "A Globally Flexible, Almost Ideal Demand System." *J. Bus. and Econ. Statis.* 5(1987):233–42.

Deaton, A., and J. Muellbauer. "An Almost Ideal Demand System." *Amer. Econ. Rev.* 70(1980): 312–26.

Eales, J.S., and L. Unnevehr. "Demand for Beef and Chicken Products: Separability and Structural Change." *Amer. J. Agr. Econ.* 70(1988): 521–32.

Green, R., and J.M. Alston. "Elasticities in AIDS Models." *Amer. J. Agr. Econ.* 72(1990):442–45.

Hausman, J.A. "Specification Test in Econometrics." *Econometrica* 46(1978):1251–71.

Hayes, D., T. Wahl, and G. Williams. "Testing Restrictions on a Model of Japanese Meat Demand." *Amer. J. Agr. Econ.* 72(1990):556–66.

Humphrey, M. "Indonesia: Vast Island Chain Offers New Vistas for U.S. Exporters." *Ag-Exporter* 5,9(1993):4–9. Foreign Agricultural Service.

LaFrance, J.T. "When Is Expenditure 'Exogenous' in Separable Demand Models?" *West. J. Agr. Econ.* 16(1991):49–62.

Lee, J.-Y., M.G. Brown, and J.L. Seale, Jr. "Model Choice in Consumer Analysis: Taiwan, 1970–89." *Amer. J. Agr. Econ.* 80(1994):504–12.

Lee, J.-Y., J.L. Seale, Jr., and J.L. Jierwiriyapant. "Do Trade Agreements Help U.S. Exports? A Study of the Japanese Citrus Industry." *Agribus.: An Internat. J.* 6(1990):505–14.

Mathews, J.R. "An Illustration of the Need for an International Marketing Profile Database: The Case of Exported U.S. Apples." *J. Food Distribution Res.* 23,1(1992):127–36.

McCracken, V., P. Tansuhaj, D. O'Rourke, and K. Walter. "Strategies for U.S. Apple Exporting Firms." *J. Food Distribution Res.* 22,2(1991): 63–75.

Moschini, G. "Units of Measurement and the Stone Index in Demand System Estimation." *Amer. J. Agr. Econ.* 77(1995):63–68.

Schwartz, A. "Indonesian Tariff Reforms: Lowering the Barricades." *Far Eastern Econ. Rev.* 149(1993):73–74.

Sparks, A.L., J.L. Seale, Jr., and B.M. Buxton. "Apple Import Demand: Four Markets for U.S. Fresh Apples." Agr. Econ. Rep. No. 641, USDA/Economic Research Service, Washington DC, 1990.

U.S. Department of Commerce. "U.S. Exports of Agricultural, Fish, and Forestry Products to Indonesia, CY 1987–1993." USDC/Bureau of the Census, Washington DC, 1993.

Winters, L.A. "Separability and the Specification of Foreign Trade Function." *J. Internat. Econ.* 17(1984):239–63.

Yang, S.-R., and W.W. Koo. "Japanese Meat Import Demand Estimation with the Source Differentiated AIDS Model." *J. Agr. and Resour. Econ.* 19(1994):396–408.