IMPORT DEMANDS FOR U.S. FRESH GRAPEFRUIT: EFFECT OF U.S. PROMOTION PROGRAMS AND TRADE POLICIES OF IMPORTING NATIONS

Stephen Fuller, Haruna Bello and Oral Capps, Jr.

Abstract

This study estimated import demands for U.S. fresh grapefruit in Japan, France, Canada, and the Netherlands. Historically, these nations have imported about 90 percent of U.S. grapefruit exports. Four import demand functions were specified and estimated by joint generalized least squares based on the sample period 1969I to 1988IV. Results show that U.S. FOB price, per capita income of importing countries, exchange rates, price of substitutes, U.S. grapefruit promotion programs, and removal of trade restrictions have had an important effect on U.S. fresh grapefruit exports. Analyses suggest that U.S. producers can effectively promote fresh grapefruit in foreign markets, and that trade concessions have an important influence on grapefruit exports.

Key words: grapefruit, import demands, promotion programs

This study examines forces impacting the demand for U.S. fresh grapefruit in Canada, Japan, France, and the Netherlands. Historically, these countries have purchased about 90 percent of U.S. exports of fresh grapefruit. Special attention is focused on the effect of fresh grapefruit promotion programs and trade policy in importing countries. From 1985 to 1989, the value of U.S. citrus exports increased by 40 percent. Grapefruit exports registered the largest growth, increasing from $101.6 million in 1985 to $224 and $259 million in 1988 and 1989, respectively (USDA, *Horticultural Products Review*).

In this paper, attention is initially given to the international fresh grapefruit trade, the major grapefruit importing nations and their import policies, and U.S. promotion programs for fresh grapefruit. The review of literature examines econometric problems associated with the estimation of import demands, and reports on previous studies which specifically examine fresh grapefruit demand. Next, the import demand functions are specified, and the associated variables are defined. The results examine the influence of promotion programs, the liberalization of Japan's and the European Community's (EC) grapefruit trade policy on import demands as well as the effects of price, exchange rates, and income.

INTERNATIONAL FRESH GRAPEFRUIT TRADE

International fresh grapefruit trade increased by about 111 percent during the 1968/69 to 1988/89 period while the share of the international fresh market supplied by the U.S. edged upward from 25 percent to 43 per cent. Much of the gain in market share was at the expense of Israel, historically the principal competitor of the United States in the international fresh market. During the early 1970s, Israel's share of the international market generally exceeded 45 percent, but since 1985/86 their share has averaged about 14 percent.[1] Other major fresh grapefruit exporters include Argentina, Cuba, Cyprus, and South Africa (USDA, *Horticultural Products Review*).

Industrialized western Europe accounts for about two-thirds of world grapefruit imports, while Japan and Canada together comprise about 20 percent. Japan and Canada imported about 54 and 12 percent, respectively, of U.S. fresh grapefruit exports during the 1980s, while much of the remainder was imported by European countries (USDA, *Horticultural Products Review*). Leading European importers of U.S. fresh grapefruit include France and the Netherlands with import shares of 17 and 7 percent, respectively.

Except for Japan, the major grapefruit importers produce no citrus or semi-tropical fruit. Japan im-

[1] In the past decade, Israel has lost an important share of its traditional export market for grapefruit. Israeli fruit is being replaced to a large extent by fresh grapefruit from the U.S. and Cyprus. Smaller grapefruit crops and increased processing are major reasons for the decrease. Low profitability due to difficult economic conditions and unfavorable weather in recent years are major reasons for the decline in Israel's grapefruit production.

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ports over half of the U.S. fresh grapefruit exports despite its own prominence as a citrus producer (Kitagawa and Kawada). Ward and Kilmer observed that the citrus varieties produced in Japan differ considerably from those of most producing nations. The satsuma mandarin (Japanese mandarin orange) accounts for about three-fourths of all citrus production. Small quantities of oranges and lemons and virtually no grapefruit are cultivated in Japan. As incomes in Japan have increased, consumers have moved away from eating those fruits which have been the mainstay of the Japanese diet (satsuma mandarin, apples, and pears), and now Japanese consumers favor less traditional fruit (Australian Bureau of Agricultural and Resource Economics). It is reported that the Japanese view fresh grapefruit as sophisticated and quite different from most of the citrus produced in Japan (USDA, *AgExporter*).

Canada and many western European countries (except western Mediterranean) are important importers of fresh fruit due to their relatively high standard of living and consumption and less than optimal climatic conditions for production (Buckley). Short seasons restrict their fruit output to apples, berries and other products that can be produced in temperate climates. Therefore, Canada and the European countries import virtually all of their tropical and semi-tropical fruit, primarily bananas, oranges, tangerines, and grapefruit.

Because the leading importers of U.S. grapefruit do not produce a fruit that is a close substitute for the U.S. product, most countries, except Japan, have had modest trade restrictions. Historically, Japan maintained stringent control over citrus imports through the use of quotas. In June, 1971, the Japanese moderated their position on grapefruit by removing the quota and replacing it with a seasonal tariff. In 1970, 2,300 metric tons of grapefruit were imported, but in 1972, imports increased to 91,400 metric tons. Further, the Japanese lowered their peak seasonal tariff on grapefruit from 40 percent to 25 percent of CIF value as a result of the Tokyo Round in 1980, while the EC lowered their *ad valorem* tariff from 4 to 3 percent of CIF value (Buckley).

FRESH GRAPEFRUIT PROMOTION PROGRAMS

The Three Party Program was the principal foreign promotion program for fresh grapefruit until 1986. The Three Party Program was jointly funded by the Florida Department of Citrus, the U.S. government, and the importer. Although the Three Party Program has been in effect since the early 1970s, virtually no resources were expended until the 1976-77 season. Through 1985, Three Party Program expenditures in Japan, France, and the Netherlands were estimated to be $3.11, $2.11, and $.52 million, respectively (Pewonski).

The Targeted Export Assistance (TEA) program was established by the Food Security Act of 1985 to develop export markets for commodities that had suffered as a result of an unfair trade practice and were in adequate supply in the U.S. market (Nichols). During the 1986-1990 period, about $21.5 million of TEA resources were expended on promotion of fresh grapefruit. Promotion expenditures on fresh grapefruit in Japan, France, and the Netherlands comprised about 36, 24, and 5 percent, respectively, of the total outlay on fresh grapefuit (Bouldin). No TEA or Three Party Program expenditures were made in Canada.

REVIEW OF LITERATURE

Thompson as well as Abbott indicated that specification error and simultaneous equation bias may pervade attempts to directly estimate agricultural export demand equations. Specification error involves the omission of relevant variables, resulting in a potential bias in the estimated structural coefficients and in their associated variances. According to Abbott, specification error and excessive aggregation are one problem and are of special concern when estimating a single aggregated export demand function. Thursby and Thursby observed that the Durbin-Watson test statistic can be used to identify a misspecification problem but noted a tendency among trade economists to correct for first-order autocorrelated disturbances rather than search for a more appropriate specification.

Simultaneity bias occurs when ordinary least squares (OLS) is used to estimate parameters in a simultaneous system of equations. Binkley (1981) showed that it is proper to specify import demand as a single equation and estimate it with least squares when the supply price faced by the importing nation is exogenous. This occurs when the importer is virtually a price taker and hence faces a highly elastic supply function.

An important specification issue in agricultural trade research is the treatment of exchange rates in trade equations. The potential effect of exchange rates on trade was outlined by Schuh. Fletcher, Just, and Schmitz argued that a change in the U.S. exchange rate affects a change in the foreign price of most U.S. commodities that are internationally traded, while a change in the price of a U.S. agricultural product implies only a change in its price in the foreign market. Thus, a 1 percent decrease in the price of grapefruit would affect import demand for grapefruit while a 1 percent depreciation of the dollar

would affect demand for all U.S. exports (Ruppel). Depreciation yields not only a price effect for grapefruit but also an income effect for countries that are large buyers of U.S. products. Chambers and Just argued for the inclusion of exchange rate as a separate regressor to assess its direct impact on exports while holding constant the impacts of other variables. Further, Chambers and Just noted that empirical studies that simply use own-price, adjusted by the exchange rate, may have a downward bias on estimates of exchange rate impacts as well as an associated upward bias on own-price elasticity estimates and income estimates.

A 1978 study by Ward and Tang estimated demands for U.S. fresh grape fruit in Canada, Japan, and the aggregate of the European Economic Community (EEC). Their model included imports of U.S. fresh grapefruit per quarter as the dependent variable, and FOB price in the United States, per capita GNP of the importing country, seasonal dummies, and time trend as exogenous variables. In the EEC equation, Israeli grapefruit price was included as an exogenous variable because historically Israel maintained a strong presence in the European market, and Israeli grapefruit was viewed as a substitute for the U.S. product. Estimated own-price elasticities for the Canadian, Japanese, and European demands were -1.25, -3.57, and -0.34, respectively, while the income elasticities for these respective regions were estimated to be 5.24, 9.39, and -4.34 (Table 1). Neither the own-price nor cross-price variable was statistically significant in the EEC equation; however, income and Israeli grapefruit price were significant, with a 1 percent increase in Israeli fruit price increasing U.S. exports by 4.55 percent.

Because fixed exchange rates were generally in effect before 1974, Ward and Tang did not include this variable in their analysis. To examine the influence of exchange rates on import demands for U.S. grapefruit, Lee and Fairchild contrasted import demand equations that include the U.S. FOB price in U.S. dollars with estimates that include the U.S. FOB price in the currency of the importing country. They showed that the associated price elasticities differ substantially, and they argued the need to incorporate the influence of exchange rates on import demands (Table 1).

More recently, Aviphant, Lee, and Seale examined U.S. citrus demands in Japan by using the absolute version of the Rotterdam model. They found that a 1 percent increase in the fresh grapefruit import price (Japanese currency) would decrease imports of all fresh grapefruit 1.42 percent. Further, bananas and pineapples were found to substitute for fresh U.S. grapefruit. Finally, Japan's expenditure elasticity for fresh grapefruit was estimated to be 0.85.

MODEL DEVELOPMENT

Binkley (1981) showed that simultaneity bias is not a likely problem when estimating import demand by OLS or joint generalized least squares (seemingly-unrelated-regression (SUR)) if the supply price faced by importers is exogenous, i.e., the importer is a price-taker. It was assumed in this study

Table 1. Elasticities Associated with Estimated Import Demands for U.S. Fresh Grapefruit

Study Authors	Study Period	Import Demand Region	Elasticities				
					Cross-Price		
			Own-Price	Income	Other Grapefruit	Banana	Pineapple
Ward and Tang[a]	1971-1975 (quarters)	Canada	-1.25	5.24			
		Japan	-3.57	9.39			
		Europe	-0.34	-4.34	4.55		
Lee and Fairchild[a]	1972-1986 (annual)	Canada[b]	-0.28				
		Japan[b]	-0.47				
		Europe[b]	-1.01				
		Canada[c]	-0.46				
		Japan[c]	-0.56				
		Europe[c]	-0.35				
Aviphant, Lee and Seale[d]	1973-1987 (annual)	Japan	-1.42	0.84[e]		0.50	0.35

[a]Estimated by seemingly-unrelated-regression (SUR).

[b]U.S. FOB price adjusted by exchange rate of importing region.

[c]U.S. FOB price.

[d]Rotterdam model used.

[e]Expenditure elasticity.

that the fresh grapefruit price faced by importers of U.S. fruit is exogenous because the principal price-determining forces are associated with the domestic grapefruit market in the United States and not with the export market. Historically, the domestic market has taken about 90 percent of U.S. grapefruit production. Therefore, it seems realistic to assume that a particular importing nation is "almost" a price-taker and hence, faces a very elastic grapefruit supply function. Thus, it seems appropriate to specify single-equation import demand models. Further, credence for specifying single-equation models when estimating import demands for U.S. grapefruit is suggested by the research of Ward et al., Lee et al., and Aviphant, et al.

Per capita demand for U.S. fresh grapefruit in the importing country was assumed to be a function of the FOB price for fresh grapefruit in the United States, exchange rates, substitute prices, population, and selected trade policy variables of the importing country. Following the suggestion of Chambers and Just, the real exchange rate was specified as a separate variable in order to segregate the total price component into exchange rate and own-price effects. Further, import demands were specified for each major importing country in western Europe to reduce potential problems of excessive aggregation.

The import demand for U.S. fresh grapefruit in the ith country was specified as,

$$(1)\quad Q_{ij} = B_o + B_1P_{ij} + B_2EX_{ij} + B_3I_{ij} + B_4PS_{ij} + B_5PRO_{ij} + B_6TAR_{ij} + B_7QTA_{1j} + B_8S_2 + B_9S_3 + B_{10}S_4 + B_{11}P_{ij}S_2 + B_{12}P_{ij}S_3 + B_{13}P_{ij}S_4 + B_{14}T_j + U_{ij},$$

where Q_{ij} corresponds to per capita imports (pounds per capita) of U.S. fresh grapefruit by country i (i = 1...,4; 1 = Japan, 2 = France, 3 = Canada, 4 = Netherlands) in the jth quarter (j = 1, ...,80 quarters) (1969-1988); P_{ij} denotes the real FOB price of U.S. fresh grapefruit imported by country i in the jth quarter ($/metric ton) in 1980 dollars; EX_{ij} denotes the real exchange rate between currency of the ith importing country and one U.S. dollar in the jth quarter (base year 1980); I_{ij} corresponds to real per capita gross domestic product (GDP) of the ith importing country in the jth quarter in the currency of the importer (base year 1980); PS_{ij} denotes the real price of commodities that may substitute for U.S. fresh grapefruit in importing country i in the jth quarter in the currency of the importer (base year 1980); PRO_{ij} represents promotion program expenditures on fresh grapefruit in the ith importing country in the jth quarter; TAR_{ij} identifies the *ad valorem* tariff rate in the ith importing country in the jth quarter; QTA_{1j} is a 0-1 variable that corresponds to removal of a quota by country 1 (Japan); S_k is a quarterly 0-1 variable that controls for seasonality of U.S. fresh grapefruit imports in quarter k (k = 1, ...,4), where k = 1 is the base and winter quarter, 2 = spring, 3 = summer, 4 = fall; $P_{ij}S_k$ corresponds to an interaction or a slope shifter that attempts to examine differences in the effect of real price on imports by quarter; T_j, a time trend variable, is designed to measure changes in tastes and preferences for U.S. fresh grapefruit over the study period; and U_{ij} is the error term.

The effect of own-price on import demand was hypothesized to be negative, while the influences of income and price of substitutes on import demands were hypothesized to be positive. The sign on the exchange rate variable was expected to be negative because it represents foreign currency per U.S. dollar.

Because grapefruit production in Japan is not viewed as a substitute for U.S. grapefruit, and because Japan and Canada import up to 95 percent of their grapefruit from the United States, other grapefruit were not included as a substitute in either country's import demand equation.[2] Israeli grapefruit prices were collected for purposes of measuring the effect of Israel's price on U.S. fresh grapefruit exports to western Europe even though their position had diminished in the European market.[3]

Because other citrus may substitute for fresh grapefruit, the price of fresh oranges was included in the specified import demand equations. Because fresh bananas are produced year-round and are traded internationally in substantial volume, they were also specified as possible substitutes for grapefruit (Food and Agricultural Organization). For all of the major grapefruit importers except the Netherlands, bananas rank as the first or secondmost valuable fresh fruit import, while oranges rank second or

[2]The Japanese government has encouraged citrus growing as a substitute for rice production. Citrus has been used by Japanese policy makers as a basic element of the adjustment process for the rice industry. Thus, much of the Japanese unwillingness to moderate their trade protection on citrus was not concern for the competitive threat of citrus imports, but rather the disruption of an existing rice policy (Australian Bureau of Agricultural and Resource Economics).

[3]Professor Hovav Talpaz, Department of Statistics, The Volcani Center, BetDagan, Israel, indicated that fresh grapefruit price information was confounded by shipping in various container sizes. Therefore, historical information on Israel's FOB grapefruit price was not viewed as reliable.

third (Buckley). Unfortunately, when the Israeli grapefruit price and orange and banana prices were included in the import equations for France and the Netherlands, a collinearity problem developed. Consequently, banana prices were selected as a proxy for these substitutes. For purposes of the analysis, banana price, BP_{ij} was defined as the price of bananas for the ith importing country in the jth quarter. Banana prices were represented in the currency of the importing nation. Aviphant et al. found fresh pineapple to substitute for fresh grapefruit in the diet of the Japanese; accordingly, the price of fresh pineapple imports (PP_{ij}) in yen was included in that country's demand equation.

To evaluate the influence of promotion programs on import demands PRO was included. The PRO variable equals the estimated promotion expenditure in the ith importing country in the kth quarter. It was assumed that promotion expenditures were proportional to historic import levels. The sign on the PRO variable was expected to be positive.

Removal of an import quota by the Japanese in June, 1971 was included as a binary variable (QTA = 0 when $j \leq 10$ and QTA = 1 when $j > 10$). A positive sign was expected on the QTA variable. To measure the influence of Japan's seasonal tariff on its import of U.S. fresh grapefruit, a tariff variable (TAR) was included in Japan's import demand function. TAR = 0 when $j \leq 10$ and, in subsequent quarters, TAR equals the appropriate *ad valorem* tariff rate. In particular, TAR equals 40 percent in the winter and spring quarters ($k = 1$ and $k = 2$) and 20 percent in the summer and fall quarters ($k = 3$ and $k = 4$) for $j > 10$ through $j \leq 44$. TAR equals 25 percent in the winter and spring quarters ($k = 1$ and $k = 2$) and 12 percent in the summer and fall quarters ($k = 3$ and $k = 4$) for $j > 44$ through $j = 80$. The decline in the *ad valorem* tariff (4 percent to 3 percent) imposed by the EC on grapefruit imports was similarly included in the specified import demands of France and the Netherlands. A negative sign was expected on the TAR variables.

DATA

Quarterly observations from 1969-1988 for U.S. fresh grapefruit exports and associated FOB values were obtained from U.S. Customs for sales to Japan, France, and the Netherlands.[4] Similar data for U.S. exports to Canada were procured from Statistics Canada. Quarterly data on currency exchange rates were taken from *International Financial Statistics* (International Monetary Fund). Import prices for fresh pineapple in Japan were obtained from the *Statistical Yearbook* of the Ministry of Agriculture, Forestry, and Fisheries. Annual expenditures for promotion of fresh grapefruit in Japan, France, and the Netherlands were obtained from the Florida Department of Citrus, and information on tariff levels was taken from Buckley. Table 2 gives a description of the selected continuous variables.

The disturbance terms in the four import demand equations would likely be related. Therefore, the seemingly-unrelated-regression (SUR) technique was used to estimate equation parameters. Estimation by SUR of two or more equations having correlated errors yields more efficient estimates than does OLS applied to separate equations (Binkley 1982).

RESULTS

The estimated import demand equation for each country is shown in Table 3. The goodness-of-fit measure varied from a high ($R^2 = .91$) for Canada to a low ($R^2 = .69$) for the Netherlands. The Durbin-Watson statistics were inconclusive or showed no serial correlation (Table 3). The significance level chosen for this study was the .10 level (one-tailed t-test). The general lack of serial correlation implied that import demands were correctly specified (Thursby and Thursby).

The estimated equation for Japan, the principal importer of U.S. grapefruit (54 percent share), explained 87 percent of the variation in per capita imports with estimated parameters on the own-price, exchange rate, income, banana price, pineapple price, quota, tariff, third quarter, and trend variables statistically significant (Table 3). The estimated equation representing France (17 percent share) had a goodness-of-fit statistic of .87 and showed the own-price, exchange rate, banana price, promotion, third quarter dummy and second quarter slope variables to be significant. The Canadian (12 percent share) demand equation had a good fit ($R^2 = .91$) with significant own-price, income, exchange rate, third quarter, fourth quarter, third quarter slope, and trend variables.

The goodness-of-fit measure for the Netherlands (7 percent share) import demand was .69, with significant exchange rate, income, banana price, and promotion variables. The comparatively modest ex-

[4] It is estimated that U.S. Customs data overstate exports to the Netherlands by about 11 percent and understate exports to France by about 8 percent. Much of the fruit imported into Europe enters via Rotterdam, Netherlands, and because accurate information on final destination is not known on some fruit when exported from the United States, there is a tendency to overstate exports to the Netherlands.

Table 2. Selected Variable Identification Description, and Mean Values

Variable Identification	Description	Means			
		Japan	France	Canada	Netherlands
Q_{ij}[a]	Imports of U.S. fresh grapefruit by ith country in jth quarter (lbs./capita) (i=1....,5) (j=1...,80)	.2693	.1398	.5940	.3609
P_{ij}[b]	Real FOB price paid for U.S. gapefruit by ith country in jth quarter ($/MT) (1980=100)	386.48	356.94	324.62	357.58
EX_{ij}[c]	Real excahnge rate in currency of ith country per $1 in jth quarter (1980=100)	262.32 (yen)	5.49 (franc)	1.10 ($can)	2.62 (gilder)
I_{ij}[d]	Real per capita GDP in currency of ith country in jth quarter, (1980=100)	1,997,000 (yen)	49637 (franc)	11685 ($can)	21279 (gilder)
PB_{ij}[e]	Real price of fresh bananas in currency of ith country in jth quarter, per metric ton (1980=100)	3740 (yen)	773.25 (franc)	155.72 ($can)	369.53 (gilder)

Source:
[a]U.S. Customs and Statistics Canada.
[b]U.S. Customs and Statistics Canada.
[c]International Monetary, *International Financial Statistics,* various issues, 1970-1988.
[d]International Monetary, *International Financial Statistics,* various issues, 1970-1988.
[e]International Monetary, *International Financial Statistics,* various issues, 1970-1988.

planation of the Netherlands equation may be due to the tendency of U.S. Customs data to overstate exports to that country.[5]

Except for the Canadian equation, statistically significant variables had the anticipated sign on estimated coefficients. In the Canadian equation, the income and exchange rate variables were significant but had a negative and a positive sign, respectively. Per capita consumption of fresh grapefruit in Canada has edged downward about 40 percent since the early 1970s, providing a possible explanation for the negative sign on the income variable.[6]

EFFECT OF IMPORTING NATION'S TRADE POLICIES AND U.S. PROMOTION PROGRAM

Removal of Japan's import quota on U.S. fresh grapefruit in June 1971 had a statistically significant and large impact on per capita imports. In particular, quota removal increased per capita imports an estimated 0.296 pounds per quarter. Simultaneous with the removal of the quota, the Japanese implemented a tariff that was subsequently lowered in 1980 as a result of the Tokyo Round. The tariff variable (TAR) was significant in the Japanese equation (one-tailed t-test) and showed that a 1 percent reduction in tariff increased imports of U.S. fresh grapefruit 0.19 percent (Table 4). In particular, reducing the *ad valorem* tariff from 40 to 25 percent of the CIF variable in quarters 1 and 2 increased per capita imports of U.S. grapefruit by about 7 percent, whereas lowering the rate from 25 to 12 percent in quarters 3 and 4 increased per capita imports by about 9 percent. The modest reduction in tariff by the EC as a result of the Tokyo Round was not statistically significant in the French or Netherlands equations.

Promotion expenditures had a statistically significant and positive influence on fresh grapefruit exports. In particular, when all other variables are held constant, each additional $1,000 of promotion expenditure increased per capita imports of U.S. grapefruit 0.00026, 0.00060, and 0.0034 pounds per quarter in Japan, France, and the Netherlands, respectively. Based on 1988 population figures, this expenditure would have increased exports about 14.4, 15.2, and 22.7 metric tons in these respective

[5]See n.4, above.

[6]The positive sign on the exchange rate variable in the Canadian equation was unexpected. It implies some complementarity between Canadian goods and imports of U.S. fresh grapefruit, so that as the Canadian dollar depreciates, the increased use of domestic goods warrants an increase in grapefruit imports. Or, as the Canadian dollar increases relative to the U.S. dollar, internal changes in relative domestic prices yield changes in consumption patterns that discourage U.S. grapefruit imports.

Table 3. Estimated Import Demand Equations for Major Importers of U.S. Fresh Grapefruit.

Country	Constant	FOB Grapefruit Price (P_{ij})	Per Capita GDP (I_{ij})	Exchange Rate (EX_{ij})	Banana Price (PB_{ij})	Pineapple Price (PP_{ij})	Promotion (PRO_{ij})	Tariff (TAR_{ij})	Trend (T_j)	Quarter 2 (S_2)	Quarter 3 (S_3)	Quarter 4 (S_4)	Quarter 2 Slope ($P_{ij}S_2$)
Japan	-0.5940	-0.00036*	0.00000054*	-0.00156*	0.0000068*	0.0000024*	0.00026*	-0.00336*	-0.4895*	0.1009[a]	-0.2219*[a]	-0.1235[a]	-0.000054
	(1.525)	(1.921)	(3.135)	(4.218)	(2.713)	(1.524)	(3.493)	(1.361)	(2.893)	(0.540)	(5.878)	(1.063)	(0.160)
France	0.3620*	-0.000532*	0.0000012	-0.0409*	0.000218*	NA	0.000609*	-0.0180	0.0948	-0.0835[a]	-0.3914*[a]	-0.1363[a]	0.000692*[a]
	(2.684)	(2.527)	(0.264)	(3.700)	(3.415)		(4.328)	(0.553)	(0.731)	(1.287)	(4.562)	(1.219)	(3.982)
Canada	2.2955*	-0.00427*	-0.00004*	0.4643*	-0.00020	NA	NA	NA	-0.5012*	-0.3900[a]	-1.013*[a]	-0.5476*[a]	-.000934[a]
	(5.150)	(6.451)	(1.441)	(1.647)	(0.286)				(2.597)	(1.443)	(3.615)	(1.864)	(1.045)
Netherlands	-0.3551	-0.000026	0.0000698*	-0.336*	0.00173*	NA	0.00344*	-0.0538	-0.4254	-0.1975	-0.3242	0.336	0.0000639
	(0.095)	(0.052)	(1.986)	(3.878)	(3.460)		(2.808)	(0.526)	(1.188)	(1.684)	(1.114)	(1.044)	(0.083)

* Significant at .10 level, one-tailed test used where appropriate.
t-values are in parentheses.

[a] F-test showed quarter or slope dummies added significantly to explanation.

Table 4. Estimated Own-Price, Exchange Rate, Income, Tariff, Promotion Programs, and Cross-Price Elasticities for Major Importers of U.S. Fresh Grapefruit

Country	Own-Price (Qtr 1, base)	Own-Price (Qtr 2)	Own-Price (Qtr 3)	Own-Price (Qtr 4)	Exchange Rate	Income	Tariff	Banana	Pineapple	Promotion
Japan	-0.522*	-0.541	-0.641	-0.589	-1.526*	4.001*	-0.189*	0.950*	0.777*	0.109*
France	-1.358*	-0.873*	-1.158	-1.344	-1.605*	0.443	-.457	1.207*	NA	0.234*
Canada	-2.336*	-2.212	-1.935*	-2.153	0.859*	-0.794*	NA	-0.053	NA	NA
Netherlands	-0.026	-0.042	-0.285	-0.083	-2.439*	4.115*	-0.528	1.767*	NA	0.153*

*Significant at 10 percent level, one-tailed test used where appropriate.
Elasticities calculated at the means.

countries. The estimated promotion elasticities for Japan, France, and the Netherlands were 0.11, 0.23, and 0.15, respectively (Table 4).[7]

EFFECT OF PRICE, EXCHANGE RATE, INCOME, AND TREND

French and Canadian per capita imports of fresh grapefruit were sensitive to the FOB price in the United States with respective own-price elasticities of -1.36 and -2.34, in the base period (quarter 1). However, in the second quarter, France's own-price elasticity became -0.87 and in the third quarter, Canada's own-price elasticity became -1.94 (Table 4). Per capita exports of U.S. fresh grapefruit to Japan were less sensitive to U.S. FOB price, i.e., a 1 percent increase in U.S. FOB price reduced exports to Japan by 0.52 percent. Price was not a statistically significant variable in the Netherlands equation. During the 20-year study period, the real FOB price for U.S. grapefruit trended modestly downward, and because of the elastic demands in France and Canada, revenues from U.S. grapefruit exports would have been favorably affected.

The exchange rate variable (EX_{ij}) was significant in all equations and results suggested that the effect of FOB price and exchange rate on U.S. exports were quite different (Table 3). The estimated exchange rate elasticities for Japan, France, Canada, and the Netherlands were -1.53, -1.61, 0.86, and -2.44, respectively (Table 4). During the study period, the U.S. dollar declined relative to the yen and gilder, and *ceteris paribus*, if the weakening were to continue, per capita annual imports in Japan and the Netherlands would increase by about 5 and 1.3 percent, respectively.

Increasing per capita gross domestic product (I_{ij}) in Japan and the Netherlands, with respective income elasticities of 4.00 and 4.12, had a positive influence on U.S. exports of fresh grapefruits. If the per capita income growth of these countries were to continue at the historical rate, per capita annual imports would increase 9 and 8 percent in Japan and the Netherlands, respectively. The income variable in the Canadian equation was negative, implying that grapefruit may be an inferior product. Income was not statistically significant in the import demand relationship for France.

The influence of substitutes on per capita imports of U.S. fresh grapefruit was significant in Japan, France, and the Netherlands. In Japan, 1 percent increase in banana price (BP_{ij}) and in fresh pineapple price (PP_{ij}) led, respectively, to a 0.95 percent and a 0.78 percent increase in the quantity of U.S. grapefruit imported. In France and the Netherlands, the estimated cross-price elasticities with respect to banana price were 1.21 and 1.77, respectively. Finally, the trend variable (T_j) was significant in the Canadian and Japanese equations reflecting diminishing taste for U.S. fresh grapefruit after accounting for other influences over the 20-year sample period.

Comparing the results of this study with those of Ward et al., Lee et al., and Aviphant et al. is difficult. The study by Ward et al. included 18 quarters in the early 1970s, whereas this study focused on 80 quarters extending from 1969-1988. Further, the studies by Lee et al. and Aviphant et al. specified Japan's import price in yen while this study attempted to segregate the influence of price and exchange rate by specifying FOB price and exchange rate as separate variables. Aviphant et al. calculated Japan's expenditure elasticity rather than a comparable income elasticity. However, both studies found bananas and fresh pineapples to be substitutes for U.S. grapefruit. Aviphant et al. estimated the cross-price elasticity of fresh grapefruit with respect to banana price and pineapple price at 0.50 and 0.35, respectively, while

[7] An attempt was made to determine the effect of promotion expenditures beyond one time period by including lags and a cumulative expenditure variable. Neither outcome gave a theoretically expected result and, in most cases, they were not statistically significant.

this study estimated these respective elasticities to be 0.95 and 0.78.

SUMMARY AND CONCLUSIONS

Import demand functions were estimated for Japan, France, Canada, and the Netherlands, which have historically imported about 54, 17, 12, and 7 percent of U.S. fresh grapefruit exports, respectively. Special attention was focused on the effect of U.S. promotion expenditures and trade policies of importing nations. A seemingly-unrelated-regression (SUR) procedure was used to estimate each country's import demand based on a 1969I to 1988IV sample period.

Growth in U.S. exports of fresh grapefruit to Japan can be attributed, in large part, to removal of Japan's import quota in 1971, the increase in Japan's per capita income, devaluation of the dollar relative to the yen, and U.S. expenditures on fresh grapefruit promotion. *Ceteris paribus*, Japan's removal of its quota in 1971 increased per capita imports about 0.296 pounds per quarter and the 1980 tariff reduction (Tokyo Round) increased imports about 0.045 pounds per quarter. Promotion of U.S. grapefruit in Japan has also had an important effect on import demand. For example, in 1988 each $1,000 of promotion expenditure increased U.S. grapefruit revenues by about $5,018. In other major importing countries, own-price or FOB price (France, Canada), income (Netherlands, Canada), exchange rates (France, Canada, Netherlands), promotion programs (France, Netherlands), and substitutes (France, Netherlands) had statistically significant influences on per capita imports of U.S. fresh grapefruit.

In conclusion, fresh grapefruit producers in the United States have varying control over forces that affect their economic well-being in foreign markets. Producers have virtually no ability to affect exchange rates, the price of substitutes, income growth in importing countries, or U.S. FOB prices. Conversely, several forces over which producers exercise varying control can affect their economic welfare. In particular, promotion expenditures were found to have an important and positive influence on import demand as was relaxation of trade restrictions by importing nations. This study shows that each dollar of promotion expenditure in Japan, France, and the Netherlands increased U.S. grapefruit sales to these countries about $5.02, $4.13, and $6.65, respectively, in 1988. Finally, trade policy of importing nations had a significant impact on U.S. fresh grapefruit exports. Most notable examples were the removal of Japan's import quota in 1971 and the subsequent reduction in tariff in 1980 (Tokyo Round). This finding suggests that producer groups will find it profitable to influence the position of U.S. negotiators regarding selected countries' import restrictions on fresh grapefruit.

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