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Import Demand for U.S. Fresh Grapefruit

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Import Demand for U.S. Fresh Grapefruit

by

Stephen Fuller, Haruna Bello and Oral Capps, Jr.

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Department of Agricultural Economics
Texas Agricultural Experiment Station
Texas A&M University

Abstract

This study estimates import demands for U.S. fresh grapefruit in five major importing nations. Historically, these nations have imported about ninety-five percent of U.S. grapefruit exports. Five import demands are specified and estimated by joint generalized least squares. Results for the sample period 1969I to 1988IV show devaluation of the dollar had an important influence on U.S. exports with elastic exchange elasticities estimated for most buying nations. In recent years, Japan has imported over half of U.S. fresh grapefruit exports and study results show income growth, quota removal and tariff reductions have played important roles in the growth of this market. The Targeted Export Assistance program had a positive effect on fresh grapefruit sales to Japan and Europe.

Key Words: grapefruit, import demands, Targeted Export Assistance Program

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Import Demand for U.S. Fresh Grapefruit

Exports of U.S. horticultural products are increasing and are expected to soon rank third in total value behind grains and oilseeds during the early 1990s (USDA, Agricultural Trade Highlights). 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). Historically, the leading grapefruit producing states have included Florida, California, Texas and Arizona. Given the inherent ability of agricultural exports to generate economic gains for farm economies, research into the effects of various factors influencing fresh grapefruit trade seems justified. This study examines forces impacting the demand for U.S. fresh grapefruit in Canada, Japan, France, Netherlands and West Germany. These five countries have historically purchased about ninety-five percent of the annual U.S. exports of fresh grapefruit.

Attention is initially given to the international fresh grapefruit trade, the major grapefruit importing countries and the U.S. Targeted Export Assistance program 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 the Targeted Export Assistance program and Japan's liberalized grapefruit trade policy on import demand as well as the effects of price, exchange rates, income and other trade policy variables.

International Fresh Grapefruit Trade

International fresh grapefruit trade increased from an average of 440 thousand metric tons in 1968/69-1970/71 to 929 thousand metric tons in

1986/87-1988/89, about an 111 percent increase (Figure 1). Similarly, U.S. fresh grapefruit exports increased from 104 to 429 thousand metric tons during the same period.

The share of the international fresh market supplied by U.S. grapefruit producers edged upward, increasing from a 25 percent share in 1968/69 - 1971/72 to a 43 percent share in 1985/86-1988/89. Much of the gain in the international 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]. In contrast, Cuba's annual share of the international fresh market grew from about one percent in the early 1970s to about 18 percent since 1986/87, while Argentina's share increased from one percent to four percent over the 1969/70-1987/88 period. Exports from Cyprus and South Africa have increased, but their international market share edged downward to about nine and eight percent, respectively, over the past two decades.

Import demand for fresh grapefruit is concentrated in western Europe, Japan and Canada. Industrialized western Europe accounts for roughly two-thirds of world grapefruit imports, while Japan and Canada comprise about 20 percent, respectively. Leading European importers include France, the Netherlands, West Germany and the United Kingdom.

Major Importing Countries

During 1983-1988, Japan and Canada imported about 55 and 12 percent of the fresh grapefruit exports of the United States while France, Netherlands and West Germany imported about 15, 7 and 2 percent, respectively. These five high-income countries import about 45 percent of the fresh fruits and vegetables traded in international commerce (Buckley). Figures 2 through

Fig. 1. Total Fresh Grapefruit Exports of the World and the U.S. 1971-1989

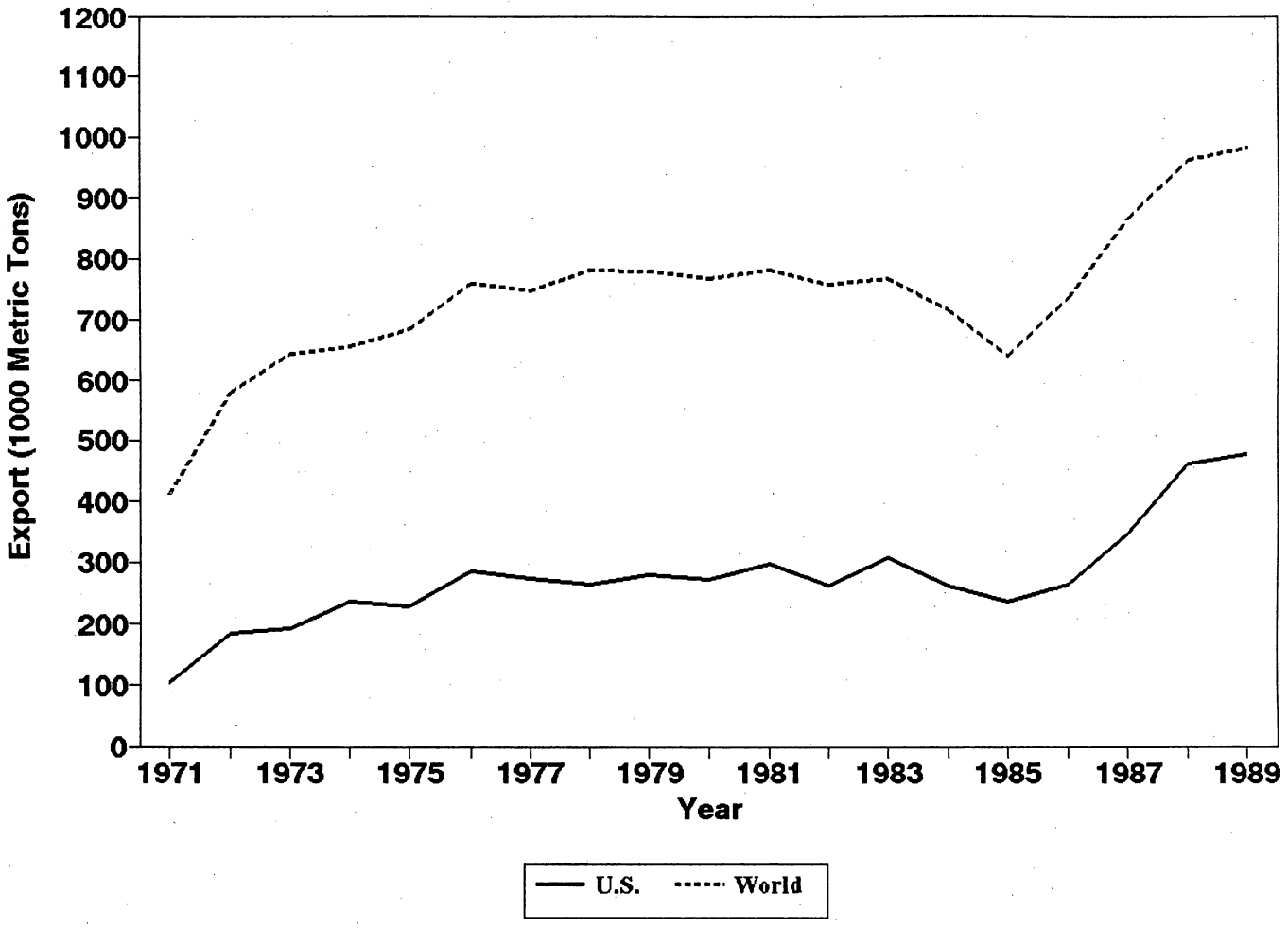


Fig 2. Imports of U.S. Fresh Grapefruit by Japan, Metric tons/1000 population

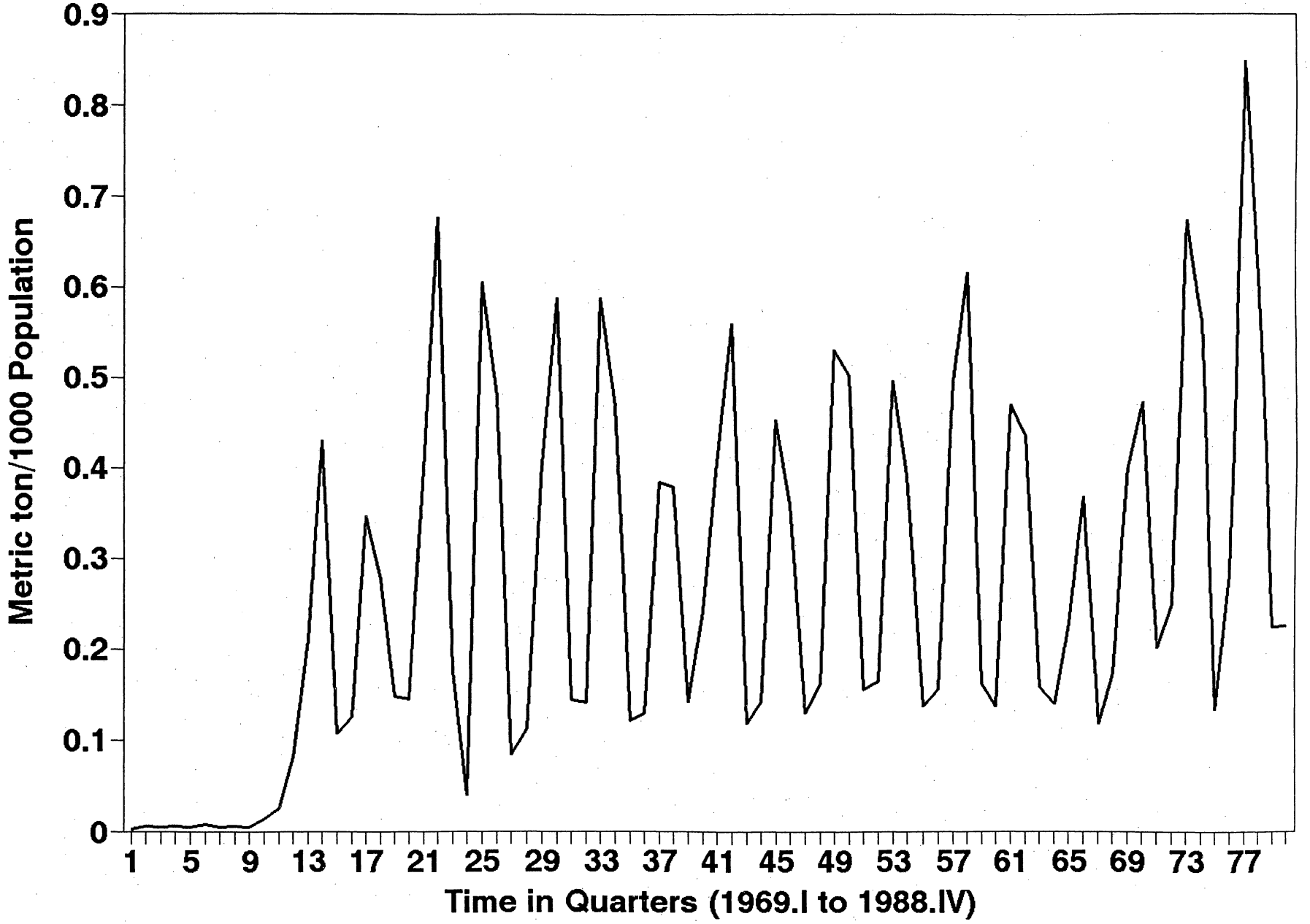


Fig 3. Imports of U.S. Fresh Grapefruit by France, Metric tons/1000 population

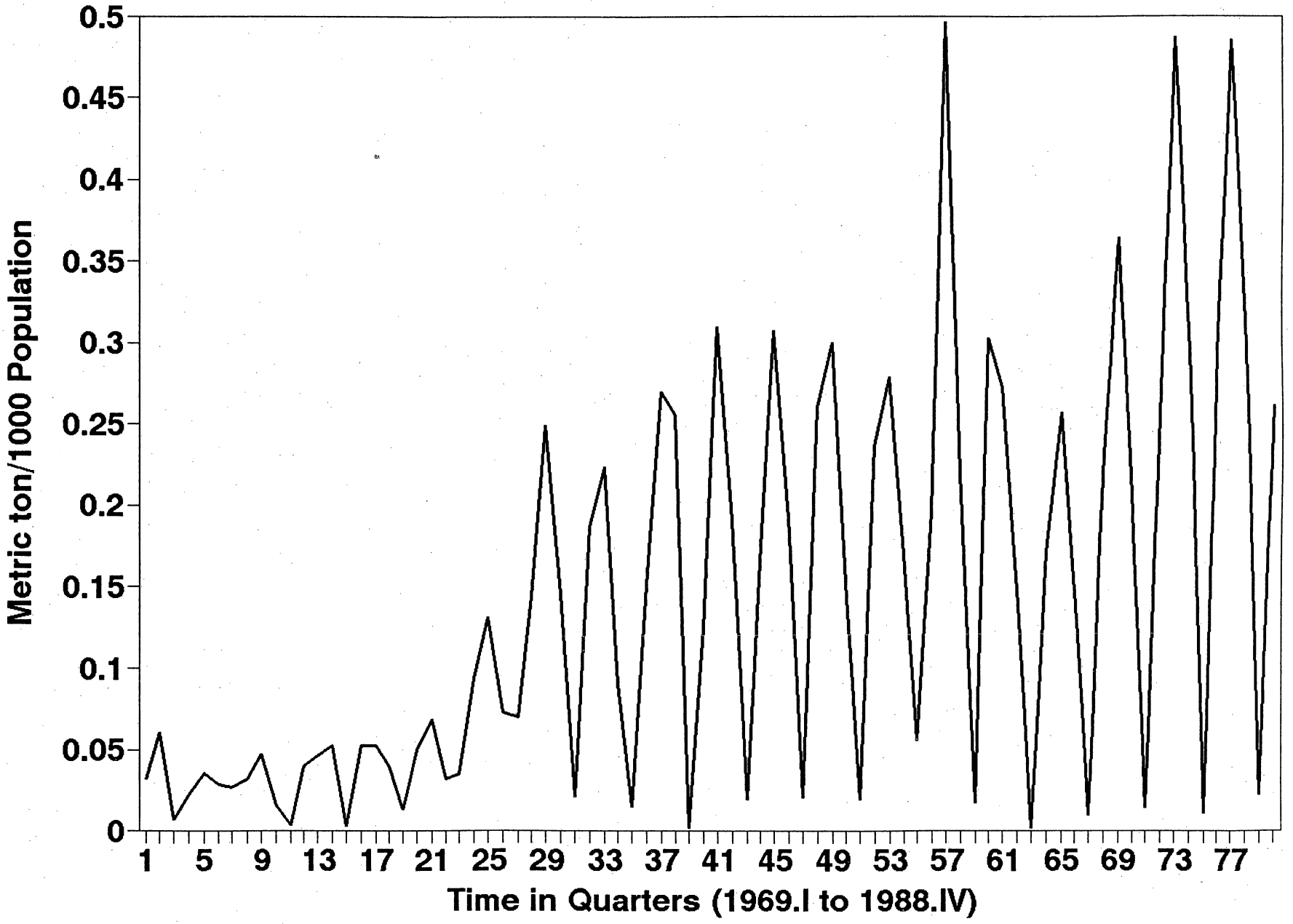


Fig 4. Imports of U.S. Fresh Grapefruit by Canada, Metric tons/1000 population

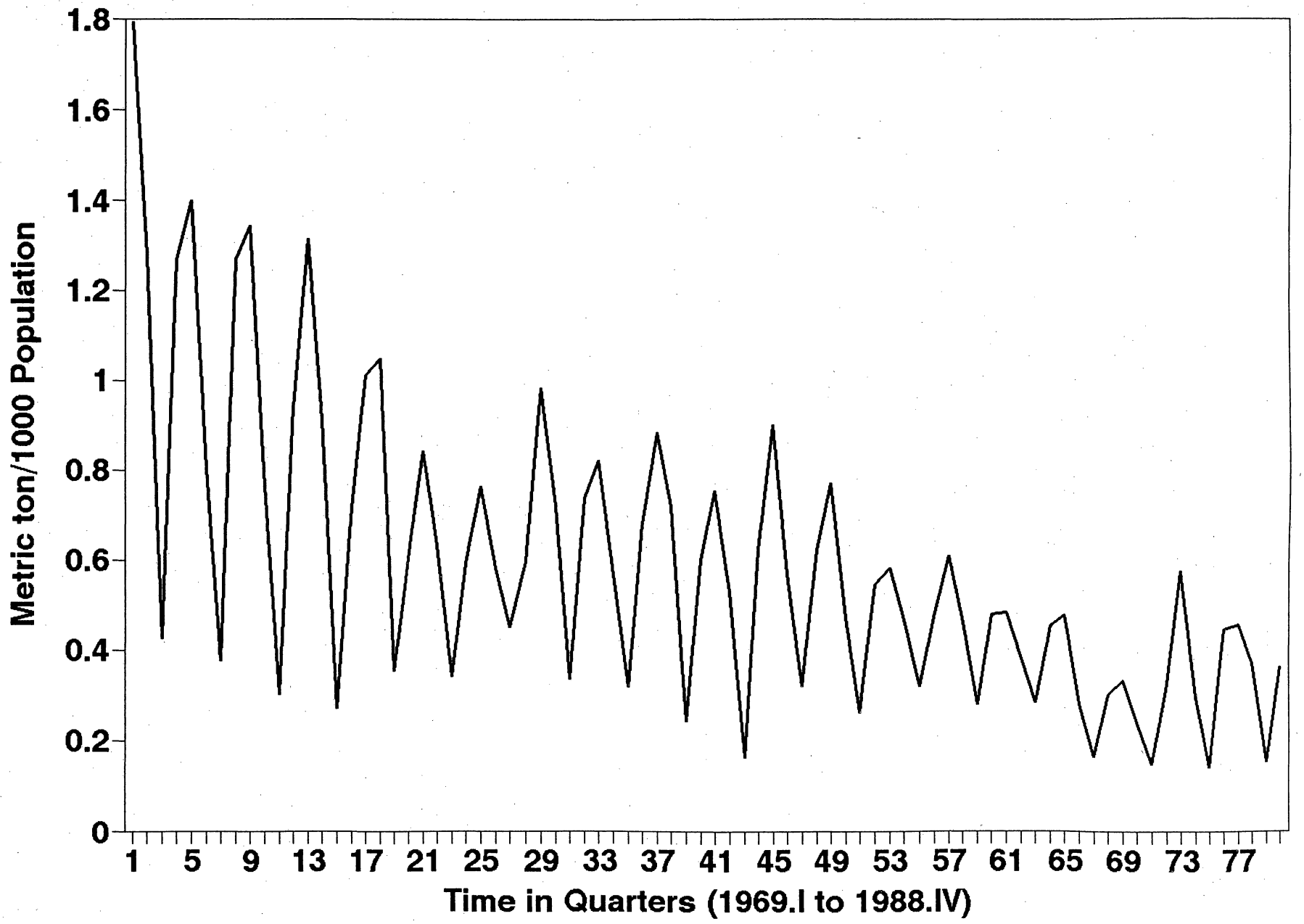


Fig 5. Imports of U.S. Fresh Grapefruit by N/lands, Metric tons/1000 population

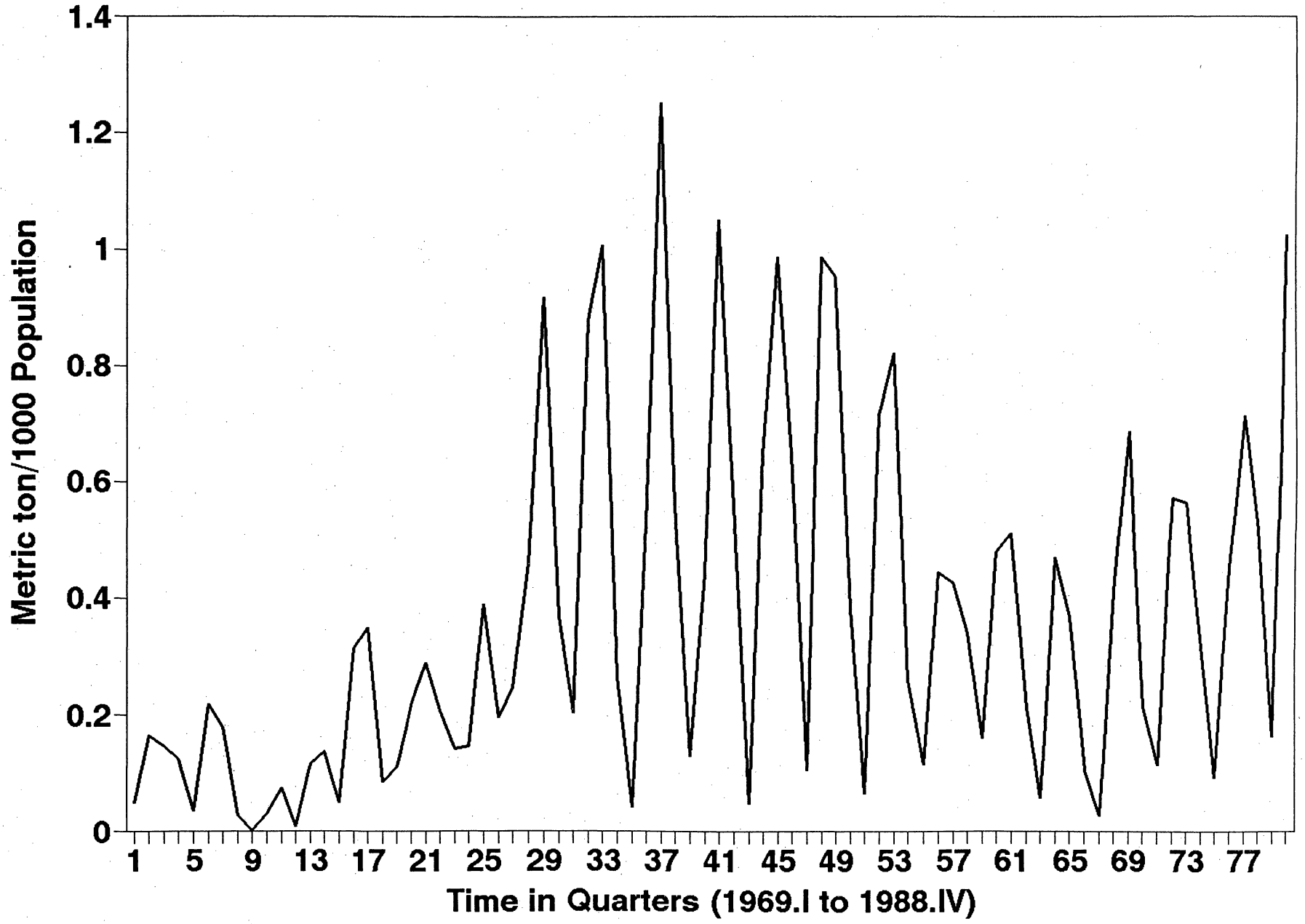
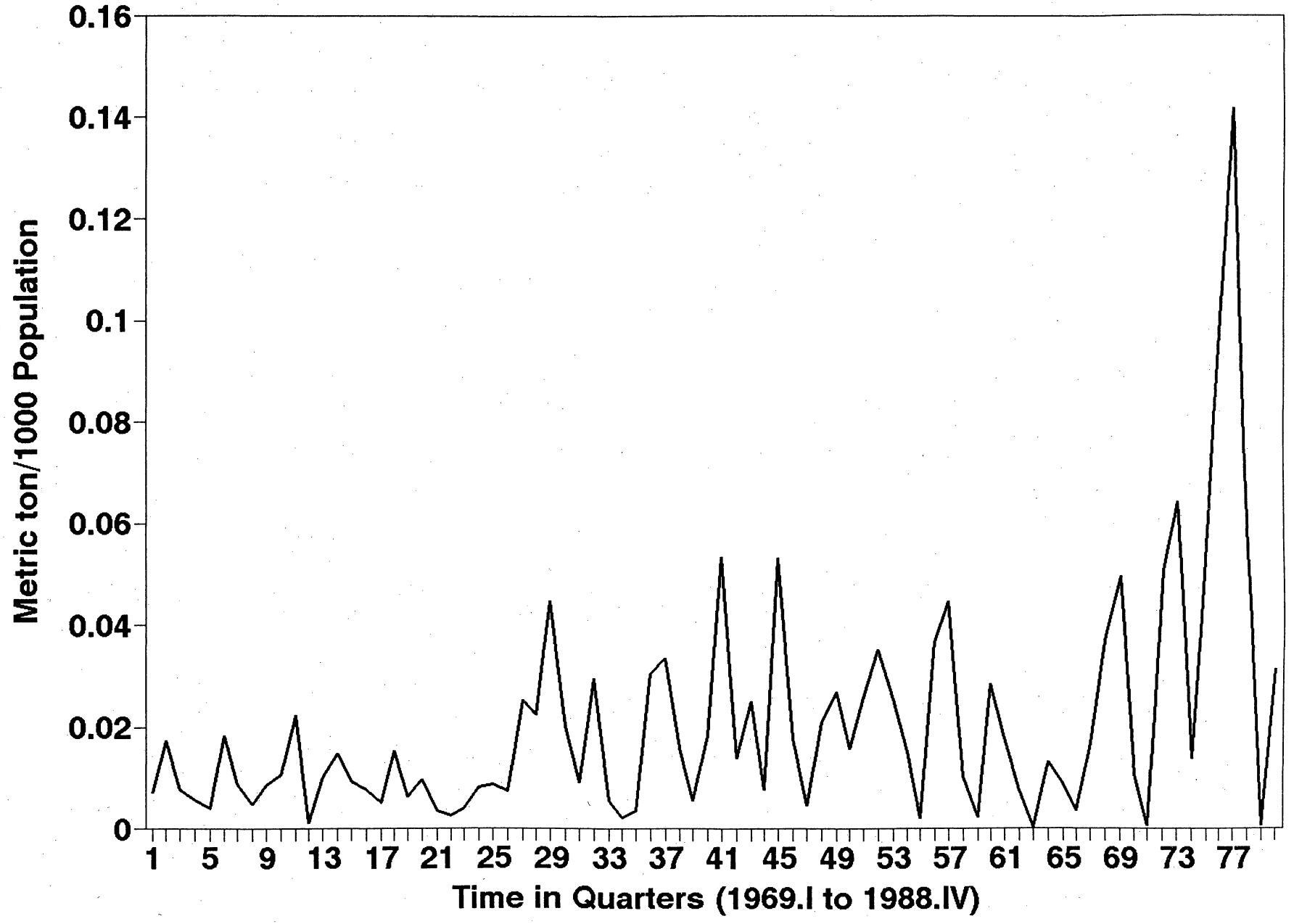


Fig 6. Imports of U.S. Fresh Grapefruit by Germany, Metric tons/1000 population



6 illustrate quarterly imports of U.S. fresh grapefruit by major importers over 1968-1988.

Except for Japan, the major grapefruit importers produce no citrus or semi-tropical fruit. Japan imports over half of U.S. fresh grapefruit exports in spite of its prominence as a citrus producer: typically, Japan ranks as the third or fourth largest producer of citrus in the world (Kitagawa and Kawada). Ward and Kilmer observe 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. Historically, about 90 percent of the satsuma mandarin production was directed to the fresh market, but oversupply and lower prices have directed about one-third of the crop to processing (Kitagawa and Kawanda). It is estimated that per capita consumption of the satsuma mandarin declined about 50 percent between 1975 and 1985 (Kitagawa and Kawada). 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 the fresh grapefruit as sophisticated and quite different than most of the citrus production in Japan (USDA, AgExporter).

Canada and the western European countries 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). Per capita fresh fruit consumption in Canada, France, Germany and the Netherlands is estimated to be 60, 71, 107 and 149 kilograms, respectively. In contrast, Japan's per capita consumption of fresh fruit is 37 kilograms (Buckley). Short production seasons in Canada and western Europe restrict their fruit

output to apples, berries and other products which may be produced in temperate climates. As such, these countries import virtually all of their tropical and semi-tropical fruit, primarily bananas, oranges, tangerines and grapefruit.

Because the five leading importers of U.S. grapefruit do not produce a fruit which 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 European Community lowered their ad valorem tariff from 4 to 3 percent of CIF value (Buckley).

TEA Program

The Targeted Export Assistance (TEA) program was established by the Food Security Act of 1985 and subsequently repealed by the 1990 Farm Bill. Recently, however, the Food, Agriculture, Conservation and Trade Act of 1990 has authorized the Market Promotion Program (MPP), a program which is similar to the TEA program. The purpose of the TEA program was to develop export markets for commodities which could be shown to have suffered as a result of unfair trade practice and which are in adequate supply to meet domestic needs (Nichols). About 75 percent of the TEA monies are spent on consumer-related promotion, i.e., consumer advertising on television, newspapers and magazines. Horticultural products have received about 45 percent of the program funding with about two-thirds of all funding concentrated in western Europe and

Japanese markets (Borris). 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, West Germany and Netherlands comprised about 36, 24, 12 and 5 percent, respectively, of the total outlay on fresh grapefruit (Bouldin). No TEA expenditures were made in Canada.

Review of Literature

Thompson and Abbott indicate specification error and simultaneous equation bias may pervade attempts to directly estimate agricultural export demand equations. Specification error involves the omission of relevant variables from the model. Such omission results in a potential bias, not only in the estimated structural coefficients, but also in their associated variances. According to Abbott, specification error and excessive aggregation are one in the same problem and are of special concern when estimating a single aggregated export demand function. Thursby and Thursby observe 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 an appropriate specification.

Simultaneity bias occurs when ordinary least squares (OLS) is used to estimate parameters in a simultaneous system of equations. Leamer and Stern indicate that OLS may be appropriate to estimate excess demand when shifts in the excess supply are large relative to those of the excess demand schedule or when supply is elastic. Binkley (1981) argues that the reasoning by Leamer and Stern may not result in serious estimation error, but it is misleading. In Binkley's view, considering bias in the context of changing elasticity is not meaningful without giving attention to exogenous variation. In a hypothetical case, Binkley shows how an elastic supply may lead to severe least squares bias when estimating import demand, and subsequently suggests that researchers be concerned with exogeneity and not elasticity. To illustrate,

Binkley considers the problem of estimating the import demand of a small buyer that is virtually a price-taker and hence faces a highly elastic supply curve. The elastic supply faced by the small buyer is the result of the dominant role played by other buyers in determining price. In which case, the supply price faced by the small importer is essentially exogenous. Consequently, Binkley argues it is exogeneity and not elasticity which allows a researcher to use least squares to estimate import demand without creating serious estimation problems.

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. Chambers and Just observe that most agricultural trade models either exclude exchange rates or use them to adjust import prices. They argue the need to include a separate exchange rate variable in the regression equation and note that empirical studies using this approach have often found exchange rates to be important determinants of agricultural trade flows. Further, Chambers and Just note that the empirical studies which 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 (WT) estimated demands for U.S. fresh grapefruit 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 independent variable since historically Israel maintained a strong presence in the European market, and the Israeli grapefruit was viewed as a substi-

tute 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 price variable nor the income variable was statistically significant in the EEC equation; however, Israeli grapefruit price was significant with a one percent increase in Israeli fruit price increasing U.S. exports to the EEC by 4.55 percent.

Because fixed exchange rates were generally in effect before 1974, Ward and Tang (WT) 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 contrast import demand equations which 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 show the associated price elasticities differ substantially, and they argue 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 a one 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) shows 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 is assumed in this study that the fresh grapefruit price faced by importers of U.S. fruit is exogenous since the principal price-determining forces are associated with the domestic grapefruit

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

Study Authors	Study Period	Import Demand Region	Elasticities: Own-Price	Elasticities: Income	Elasticities: Cross-Price: Other Grapefruit	Elasticities: Cross-Price: Banana	Elasticities: Cross-Price: 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.

market in the United States and not the export market. Historically, the domestic market has taken 90 percent of U.S. grapefruit production. As such, it seems realistic to assume 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 this approach when estimating import demands for U.S. grapefruit is suggested by the research of Ward, et al; Lee, et al; and Aviphant, et al.

Separate import demand equations are specified for five countries (Canada, Japan, France, Netherlands and West Germany) which have historically imported about 95 percent of U.S. fresh grapefruit exports. Per capita demand for U.S. fresh grapefruit in the importing country is assumed to be a function of the FOB price for fresh grapefruit in the United States, exchange rates, substitutes, population, and selected policy-related variables relevant to the United States and the particular importing country. Following the suggestion of Chambers and Just, the real exchange rate is specified as a separate variable in each equation. As such, the total price component can be segregated into exchange rate and own-price effects. Further, in contrast to earlier studies, import demands are specified for each major importing country in western Europe. This specification reduces potential problems of excessive aggregation which may have been associated with prior studies which estimated a single aggregated import demand for Europe.

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

$$(1)\ Q_{ij} = B_o + B_1P_{ij} + B_2EX_{ij} + B_3I_{ij} + B_4PS_{ij} + B_5TEA_{ij} + B_6TAR_{ij} + B_7QTA_1 + B_8S_{i2} + B_9S_{i3} + B_{10}S_{i4} + B_{11}P_{ij}S_{i2} + B_{12}P_{ij}S_{i3} + B_{13}P_{ij}S_{i4} + B_{14}T_{ij} + U_{ij}$$

where Q_{ij} corresponds to per capita imports (pounds per capita) of U.S. fresh grapefruit by country i (i = 1...,5; 1 = Japan, 2 = France, 3 = Canada, 4 =

Germany, 5 = Netherlands) in the jth quarter (j = 1, ...,80) (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 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 real price of commodities which may substitute for U.S. fresh grapefruit in importing country i in the jth quarter in currency of the importer (base year 1980); TEA represents Targeted Export Assistance program expenditures on fresh grapefruit promotion 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 is a 0-1 variable which corresponds to removal of a quota by country 1 (Japan); S_{ik} is a quarterly dummy which controls for seasonality of U.S. fresh grapefruit imports by country i in quarter k (k = 1, ...,4, where k = 1 is the base quarter), $P_{ij}S_{ik}$ corresponds to an interaction or a slope shifter that attempts to examine differences in the effect of real price on imports by quarter; T_{ij}, 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 is hypothesized to be negative while the influence of income and price of substitutes on import demands are hypothesized to be positive. The sign on the exchange rate variable is expected to be negative since it represents foreign currency per one U.S. dollar.

The United States supplies about 90 to 95 percent of the fresh grapefruit imported by Japan and Canada. As such, it was not necessary to account for competing fresh grapefruit substitutes in their estimated import demand functions. Further, because grapefruit production in Japan is very small and

the Japanese view other domestic citrus production differently than grapefruit, the influence of domestic citrus production was not included in the equation for Japan[2].

The market for fresh grapefruit in Europe is shared by Mediterranean Basin countries, Argentina, United States and South Africa. Israel was a major supplier to Europe in the 1970s, but during the 1980s their position diminished. Regardless, Israeli fresh grapefruit prices were collected for purposes of measuring the effect of Israel's price on fresh grapefruit exports from the United States to western Europe[3].

It was reasoned that other citrus may substitute for fresh grapefruit, as such, the price of fresh oranges were 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 (Foreign Agricultural Organization). With the exception of the Netherlands, bananas rank as the first- or second-most valuable fresh fruit import of the major grapefruit importers, while oranges rank second or third (Buckley). Unfortunately, when Israeli grapefruit price and orange and banana prices were included in the import equations for France, Germany 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} is defined as the price of bananas for the ith importing country in the jth quarter. Banana prices are 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_{1j}) in yen is included in that country's demand equation.

To evaluate the influence of the Targeted Export Assistance program on

import demands a TEA variable is included. TEA = 0 for j = 1 through j = 68 and in remaining quarters TEA equals the estimated promotion expenditure in the ith importing country. It was assumed TEA expenditures in the kth quarter were proportional to historic import levels in the kth quarter and there was no carryover effect in subsequent quarters. The sign on the TEA variable is expected to be positive.

Removal of an import quota by the Japanese in June, 1971 was accompanied by the simultaneous adoption of a tariff which was subsequently lowered during the study period. The quota (QTA) and its removal is included as a binary variable (QTA = 0 when $j < 10$ and 1 when $j > 10$). Japan's removal of its quota on imports is thought to have increased the import of U.S. fruit, consequently, the expectation of a positive sign on the QTA variable. To measure the influence of Japan's seasonal tariff on its imports of U.S. fresh grapefruit, a tariff variable (TAR) is included in Japan's import demand function. TAR = 0 when $j < 10$ and, in subsequent quarters, TAR equals the appropriate ad valorem tariff rate. In particular, TAR equals 40 percent in quarter k = 1 and k = 2 and 20 percent in quarters k = 3 and k = 4 for $j > 10$ through $j < 44$. TAR equals 25 percent in quarters k = 1 and k = 2 and 12 percent in quarters k = 3 and k = 4 for $j > 44$ through j = 80. The ad valorem tariff imposed by the EEC on grapefruit imports is similarly included in the specified import demands of France, Netherlands and Germany. A negative sign is 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, Netherlands and West Germany. 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 Mone-

tary Fund). Import prices for fresh pineapple in Japan were obtained from Statistical Yearbook of the Ministry of Agriculture, Forestry and Fisheries. Annual expenditure of the TEA monies for fresh grapefruit promotion in Japan, France, Netherlands and Germany were obtained from the Florida Department of Citrus and information on tariff levels were taken from Buckley (See Table 2 for a description of the selected continuous variables).

It is likely the disturbance terms in the five import demand equations are related. Therefore, the seemingly-unrelated-regression (SUR) technique is used to estimate equation parameters. Estimation of two or more equations having correlated errors by SUR yields more efficient estimates than 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 varies from a high (R^2 = .91) for Canada to a low (R^2 = .67) for the Netherlands. The Durbin-Watson statistics are inconclusive or show no serial correlation (Table 3). The significance level chosen for this study is the .10 level. The general lack of serial correlation implies import demands were correctly specified (Thursby and Thursby).

The estimated equation for Japan, the principal importer of U.S. grapefruit (55 percent share), explains 86 percent of the variation in per capita imports, with estimated parameters on the own-price, exchange rate, income, banana price, pineapple price, Targeted Export Assistance, quota, and third quarter variables statistically significant and of the correct sign (Table 3).

The estimated equation representing France (15.5 percent share) has a goodness-of-fit statistic of .83 and shows the own-price, exchange rate, banana price, Targeted Export Assistance, tariff, third quarter, fourth quarter, second quarter slope and third quarter slope to be significant.

Table 2. Selected Variable Identification, Description and Mean Values

Variable Identification	Description	Means				
		Japan	France	Canada	Germany	Netherlands
Q_{ij} [a/]	Imports of U.S. fresh grapefruit by the ith country in jth quarter (lbs./capita) (i=1,...,5) (j=1...,80)	.2693	.1398	.5940	.0188	.3609
P_{ij} [b/]	Real FOB price paid for U.S. grapefruit by ith country in jth quarter ($/MT) (1980=100)	386.48	356.94	324.62	313.16	357.58
EX_{ij} [c/]	Real exchange rate in currency of ith country per $1 in jth quarter (1980=100)	262.32 (yen)	5.49 (franc)	1.10 ($can)	2.30 (mark)	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 ($can)	22618 (mark)	21279 (gilder)
PB_{ij} [e/]	Real price of fresh bananas in currency of ith country in jth quarter, per metric ton (1980=100)	3740 (yen)	773.25 (franc)	155.72 ($can)	324.71 (mark)	369.53 (gilder)

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

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})	Pine-apple Price (PP_{1j})	TEA_{ij}	Tariff or (TAR_{ij})	Trend (T_{ij})	Quarter 2 (S_{i2})	Quarter 3 (S_{i3})	Quarter 4 (S_{i4})	Quarter 2 Slope ($P_{ij}S_{i2}$)
Japan	-0.64758	-0.00036*	0.00000055*	-0.00160*	0.0000072*	0.0000025*	0.000184*	-0.00317*	-0.4438*	0.1143[b/]	-0.2388*[b/]	-0.1451[b/]	-0.000075[b/]
	(1.634)	(1.824)	(3.164)	(4.197)	(2.771)	(1.560)	(2.821)	(1.290)	(2.555)	(.598)	(6.345)	(1.224)	(.222)
France	0.5077*	-0.000541*	0.0000024	-0.0396*	0.000207*	NA	0.000352*	-0.0609*	0.0790	-0.0693[b/]	-0.4375*[b/]	-0.2442*[b/]	0.000718*[b/]
	(2.332)	(2.545)	(.486)	(3.282)	(2.845)		(4.238)	(1.701)	(.564)	(1.083)	(5.252)	(2.201)	(3.122)
Canada	2.3738*	-0.00421*	-0.000046*	0.4132*	-0.000158	NA	NA	NA	-0.4553*	-0.3765[b/]	-1.059*[b/]	-0.5191*[b/]	-.000883[b/]
	(5.366)	(6.403)	(1.665)	(1.477)	(.225)				(2.375)	(1.403)	(3.804)	(1.778)	(.994)
W. Germany	0.08313	0.0000249	-0.00000061	-0.0114*	0.0000273	NA	0.000224*	-0.0104*	-0.00421	-0.0076	0.00521	-0.0049	-0.000055*[b/]
	(1.408)	(1.300)	(.266)	(2.11)	(.733)		(11.798)	(1.605)	(.179)	(.977)	(.892)	(.189)	(3.590)
Nether-lands	-0.0955	0.000117	0.0000722*	-0.339*	0.001632*	NA	0.001597*	-0.1045	-0.3993	-0.2178	-0.4171	0.2108	0.0000379
	(.095)	(.230)	(1.778)	(3.592)	(3.163)		(1.424)	(1.001)	(.968)	(1.143)	(1.463)	(.648)	(.049)

*Significant at .10 level, one-tailed test used where appropriate.

[a/] t-values are in parentheses

[b/] F-test shows quarter or slope dummies added significantly to explanation.

Table 3. Estimated Important Demand Equations for Major Importers of U.S. Fresh Grapefruit, (continued)

Country	Quarter 3 slope ($P_{ij}S_{i3}$)	Quarter 4 slope ($P_{ij}S_{i4}$)	Quota (JQTA)	R^2	DW
Japan	-0.00032[b/]	-0.000230[b/]	0.2900*	.865	1.836
	(.979)	(.375)	(3.699)		
France	0000579*[b/]	-0.000062[b/]	NA	.825	1.939
	(1.856)	(.362)			
Canada	0.00248*[b/]	0.001344[b/]	NA	.912	1.636
	(2.945)	(1.358)			
W. Germany	0.000013[b/]	-0.00001[b/]	NA	.763	1.844
	(.156)	(.520)			
Nether-lands	-0.00075	-0.000257	NA	.674	1.814
	(.819)	(.503)			

*Significant at .10 level, one-tailed test used where appropriate.

[a/] t-values are in parentheses

[b/] F-test shows quarter or slope dummies added significantly to explanation.

The Canadian (12 percent share) demand equation has a good fit (R^2 = .91) with significant own-price, income, exchange rate, third quarter, fourth quarter, and third quarter slope variables.

The goodness-of-fit measures for the West Germany (2 percent share) and the Netherlands (7 percent share) import demands are .76 and .67, respectively, with significant exchange rate, income, banana price, Targeted Export Assistance, tariff and second quarter slope variables in the West Germany equation. Exchange rate, banana price and Targeted Export Assistance variables are significant in the Netherlands equation.

In all except the Canadian equation, statistically significant variables (one-tailed t-test) have the anticipated sign on estimated coefficients. In the Canadian equation, the income and exchange rate variables are marginally significant and have a negative and positive sign, respectively. Per capita consumption of fresh grapefruit in Canada has edged downward about 40 percent since the early 1970s, hence the possible explanation for the negative sign on the income variable. Further, the positive sign on the exchange rate variable in the Canadian equation is 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 which discourage U.S. grapefruit imports.

Effect of Government Trade Policy and TEA Program

Removal of Japan's import quota on U.S. fresh grapefruit in June 1971 was found to have a statistically significant and large impact on per capita imports. In particular, the 0-1 variable shows quota removal increased per capita imports an estimated .290 pounds per quarter. Simultaneous with the removal of the quota, the Japanese implemented a tariff which was subsequently

lowered in 1980 as a result of the Tokyo Round. The tariff variable (TAR) is significant in the Japanese equation (one-tailed t-test) and shows a 1 percent reduction in tariff increases imports of U.S. fresh grapefruit .18 percent (Table 4). In particular, reducing the ad valorem tariff from 40 to 25 percent of the CIF value in quarters 1 and 2 increased per capita imports of U.S. grapefruit about 7 percent, whereas lowering the rate from 25 to 12 percent in quarters 3 and 4 increased per capita imports about 9 percent. Similarly, the modest reduction in tariff by the EEC as a result of the Tokyo Round negotiations was statistically significant in the French and German equations. The associated tariff elasticities for these respective countries are -1.54 and -1.81 (Table 4).

Results show promotion expenditures (Targeted Export Assistance program) to have a statistically significant and positive influence on fresh grapefruit exports to Japan, France, Germany and the Netherlands. In particular, when all other variables are held constant, each additional $1,000 of promotion expenditure increases per capita imports of U.S. grapefruit .00018, .00035, .00022, and .0016 pounds per quarter in Japan, France, Germany and the Netherlands. As such, TEA expenditures increased per capita exports to Japan, France, Germany and the Netherlands by an average of .091, .075, .034 and .105 pounds per quarter. The associated promotion elasticities for these respective countries are estimated to be .05, .08, .26, and .04 (Table 4).

Price, Exchange Rate and Income Elasticities

French and Canadian per capita imports of fresh grapefruit are sensitive to the FOB price in the United States with estimated own-price elasticities of -1.38 and -2.30, respectively in the base period (quarter 1). Results show elasticity to change by quarter. For example, in the third

Table 4. Estimated Own-Price, Exchange Rate, Income, Tariff, Targeted Export Assistance (TEA), 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	TEA
Japan	-0.507*	-0.533	-0.621	-0.581	-1.561*	4.136*	-0.178*	1.00*	.816*	0.052*
France	-1.387*	-0.883*	-1.02*	-1.427	-1.561*	0.865	-1.547*	1.145*	NA	0.082*
Canada	-2.302*	-2.185	-1.886*	-2.131	0.765*	-0.912*	NA	-0.042	NA	NA
W. Germany	0.404	0.215*	0.453	0.359	-1.30*	-0.674	-1.812*	0.435	NA	0.256*
Netherlands	-0.116	-0.108	-0.298	-0.179	-2.466*	4.248*	-1.028	1.672*	NA	0.044*

*Significant at 10 percent level, one-tailed test used where appropriate.

quarter, France's own-price elasticity becomes -1.02 and Canada's own-price elasticity becomes -1.88 (Table 4). Per capita exports of U.S. fresh grapefruit to Japan is less sensitive to U.S. FOB price, i.e., a one percent increase in U.S. FOB price reduces exports to Japan .50 percent. Price was not a statistically significant variable in the equations for the Netherlands and Germany. 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, U.S. sales would have been favorably affected.

The exchange rate variable (EX_{ij}) is significant in all equations and results suggest the effect of FOB price and exchange rate on U.S. exports are quite different, thus the merit in segregating the two components of total price (Table 3). The estimated exchange rate elasticities for Japan, France, West Germany, Canada and the Netherlands are -1.56, -1.56, -1.30, 0.76, and -2.46, respectively (Table 4).[4] During the study period, the U.S. dollar declined about 58, 28 and 33 percent relative to the yen, mark and gilder, respectively. Ceteris paribus, the weakening in the dollar during the study period would have increased per capita imports of U.S. grapefruit in Japan, West Germany and the Netherlands about 90, 36, and 81 percent, respectively.

Increasing gross domestic product (I_{ij}) per capita in Japan and the Netherlands has a positive and important influence on U.S. exports of fresh grapefruit. Estimated income elasticities for these respective countries are 4.13 and 4.25. Assuming all other variables constant, and given the increase in real per capita GDP over the 20 year study period, it is estimated per capita imports would have increased 246 and 193 percent in Japan and the Netherlands. In Canada the income variable was negative, thus the possibility that grapefruit may be viewed as an inferior product. Income was not statistically significant in the import demand relationships for France and West Germany.

The influence of substitutes on per capita imports of U.S. fresh grapefruit are significant in Japan, France and the Netherlands. In Japan, a one percent increase in banana price (BP_{1j}) or fresh pineapple price (PP_{1j}) leads to a respective 1.03 percent and a .82 percent increase in the import of U.S. grapefruit. In France and the Netherlands the estimated cross-price elasticities with respect to banana price are 1.145 and 1.67, respectively. Finally, the trend variable (T_{ij}) is negative and significant in the Japanese and Canadian equations and reflects a diminishing taste for U.S. fresh grapefruit after accounting for other influences over the 20 year sample period.

Comparing 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. includes 18 quarters in the early 1970s, whereas this study focuses on 80 quarters extending from 1969-1988. Further, the study by Lee, et al. and Aviphant, et al. specifies Japan's import price in yen while this study attempts to segregate the influence of price and exchange rate by specifying FOB price and exchange rate as separate variables. Aviphant, et al. calculates Japan's expenditure elasticity rather than a comparable income elasticity. However, both studies find bananas and fresh pineapples to be substitutes for U.S. grapefruit. Aviphant, et al. estimates the cross-price elasticity of fresh grapefruit with respect to banana price and pineapple price at .50 and .35, respectively, while this study estimates these respective elasticities to be 1.03 and .82.

Summary and Conclusions

Fresh grapefruit are an increasingly important export of the United States with sales reaching $259 million in 1989. This study focuses on the effect of price, exchange rate, income, Targeted Export Assistance program and trade policy on imports of U.S. fresh grapefruit by Japan, France, Canada, Netherlands and West Germany. In recent years, these respective countries have im-

ported an average 55, 15, 12, 7 and 2 percent of U.S. fresh grapefruit exports. A seemingly-unrelated-regression (SUR) procedure is used to estimate each country's import demand for U.S. fresh grapefruit. The sample period extends from 1969-1988 and includes quarterly observations.

Growth in the U.S. exports of fresh grapefruit to Japan (55 percent market share) can be attributed, in large part, to removal of its import quota in 1971, the increase in Japan's per capita income, and devaluation of the dollar. Recent expenditures on promotion (Targeted Export Assistance program) have effectively increased Japan's imports of U.S. grapefruit since 1986. The recent TEA promotion effort is estimated to have increased quarterly imports nearly .091 pounds/capita. Ceteris paribus, quota removal increased per capita imports about .290 pounds/quarter, and the tariff reduction (Tokyo Round) about .045 pounds/quarter. The quota removal and tariff reduction would have impacted all subsequent quarters, whereas, during the 20 year study period, income growth and devaluation of the dollar increased per capita imports about .51 and .37 pounds/quarter. In the remaining countries, own-price (France, Canada), income (Netherlands, Canada), exchange rates (France, Germany, Canada, Netherlands), tariff reduction (France, Germany), and the TEA program (France, Germany Netherlands) had statistically significant influences on per capita imports of U.S. fresh grapefruit.

In summary, these results show trade negotiations and associated concessions have extremely important effects on U.S. exports as do income and exchange rates. Further, analysis suggests promotion efforts (TEA) have been successful in expanding foreign demand for U.S. fresh grapefruit. In only two of these high-income countries (Canada, France) were per capita exports statistically sensitive to price. This finding is consistent with the notion that consumers in high-income countries are quality conscious buyers rather than price-sensitive buyers.

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Footnotes

[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 drop in Israel's grapefruit production.

[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, Bet-Dagan, Israel, informed that in an effort to thwart an embargo on Israeli fresh grapefruit, price information was confounded by shipping in various container sizes. As such, historical information on Israel's FOB fresh grapefruit price was not viewed as reliable.