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# IMPORT DEMAND FOR CANNED PEACHES, PEARS AND TOMATO PRODUCTS

by

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and



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## Abstract

Changes in EC processor subsidies and proposed change in import duties will alter U.S. import prices for processed peaches, pears and tomato products. This article reports the results of estimating import demand functions for these products. The price elasticity of import demand with respect to import price ranges from -2.94 to -3.53 for these products indicating that import levels will be sensitive to changes in tariffs and subsidies.

# Import Demand for Canned Peaches, Pears and Tomato Products

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November 1990

In 1989, the European Community changed the way in which subsidies to fruit and vegetable processors were calculated. The result was a net increase in the finished cost of canned peaches, pears, and tomato products. Concurrently, negotiations under the General Agreement on Tariffs and Trade (GATT) were aimed at reducing tariffs on most agricultural products. Both of these changes are likely to affect U.S. import prices for canned fruits and vegetables. Little analysis has been done that would permit an estimate of the changes in import level that might result for such price changes. This paper reports the findings of an analysis of U.S. import demand for canned peaches, pears and tomato products. The purpose of the analysis was to estimate the price elasticity of import demand for those products so that estimates could be made of changes in import demand resulting from tariff and subsidy changes.

The estimation of changes in import demand are made in a separate paper, *Effects of the U.S. GATT Proposal on U.S. Imports of Canned Peaches and Pears, Tomato Paste and Wine*[1]. The balance of this paper examines the model and the estimation results derived from it.

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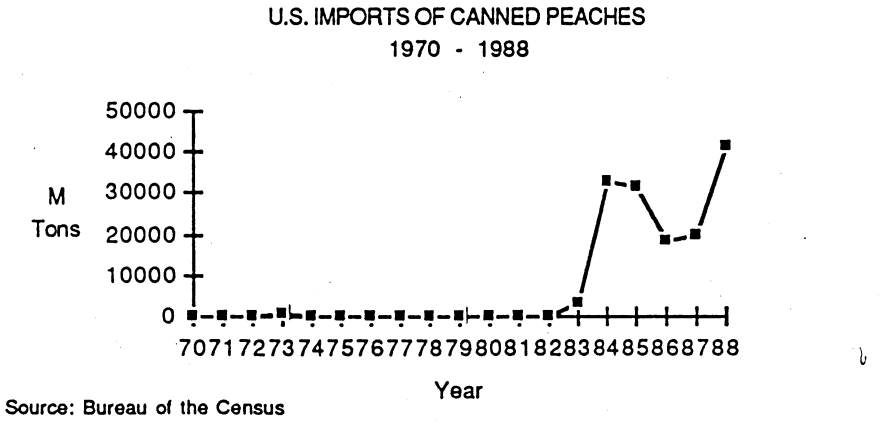
[1]Moulton, Kirby S. "Effects of the U.S. GATT Proposal on U.S. Imports of Canned Peaches and Pears, Tomato Paste and Wine". Department of Agricultural and Resource Economics, University of California, Berkeley, October 1990, 15p.

# Canned Peach Import Demand

## 1. Data Description

The data used were obtained from annual issues of the Almanac of the Canning, Freezing and Preserving Industries, covering the period 1970-1988. These data were supplemented by price and other data provided by the California Canning Peach Association, the Food Institute News, and USDA Foreign Agricultural Service. The data used in the model were the domestic and import price per ton of canned peaches, deflated by the CPI and converted to a per case basis. Deflated per capita income and the world supply of peaches for processing were also used. A dummy variable with a value of one or zero was used to account for the sudden and sharp rise in imports occurring in 1983-86. A time trend variable was also introduced to the model.




Source: Bureau of the Census

## 2. Model Specification and Implications

An ordinary least squares (OLS) model was specified to explain changes in the level of U.S. imports of canned peaches as a function of changes in domestic prices, import prices, a dummy variable, and a time trend variable.A two stage least squares (2SLS) model was also specified to investigate problems of identification raised by the OLS specification. In the two stage model, the quantity of

imports are explained by import price, the U.S. domestic price, per capita income, and time trend and a dummy variable to account for the surge in imports between 1983 and 1988. Import price was expressed as a function of the world supply of canned peaches and the lagged value of import prices.Prices and income were deflated using the CPI deflator. The functional form that was most appropriate was log-linear since the estimated elasticities remain constant over the range of the model. Other functional forms, for example, linear and non-linear in certain variables, were investigated also but did not match the log-linear form in fitting the data to the model.

The OLS model specified was of the following form:

$$\ln Q_{im} = a_o + a_1 \ln P_d + a_2 \ln P_{im} + a_3 D + a_4 T + \xi$$

The 2SLS model was of the following form:

$$\ln Q_{im} = \beta_o + \beta_1 \ln P_d + \beta_2 \ln P_{im} + \beta_3 \ln Y + \beta_4 D + \beta_5 T + \xi$$

$$\ln P_{im} = \sigma_0 + \sigma_1 \ln S + \sigma_2 \ln P_{im-1} + \xi$$

where:

$Q_{im}$ = quantity of canned peaches imported, in cases
$P_d$ = deflated price for U.S. canned peaches
$P_{im}$ = deflated price for imported canned peaches
$P_{im-1}$ = import price lagged one period
Y = deflated per capita disposable income, U.S.
T = time trend, 1970 = 1, 1971 = 2, etc.
D = dummy variable, years 1983 - 1988 = 1.
$\xi$ = error term

If the model is specified correctly the error term, $\xi$, should be randomly variable. If not, then the term might show serial correlation or indicate heteroskedasticity.

The ordinary least squares (OLS) procedure was employed in the estimation. Then the residual structure (the error term, $\xi$) was examined for serial correlation and heteroskedasticity to determine if an alternative estimation procedure was required. The results of the OLS estimation are as follows:

$$\ln Q_{im} = 8.57 + 4.44 \ln P_d - 2.91 \ln P_{im} + 4.77D - 0.22T$$
$$\quad (1.90) \quad (1.41) \quad (-3.13) \quad (7.28) \quad (-3.06)$$

$$\bar{R}^2 = 0.895; \quad DW = 1.81$$

The figures in parentheses are t-values indicating the significance of the coefficients at the 95 percent confidence level. The elasticity of import demand with respect to import price, $\varepsilon_{im}$, is -2.91, and with respect to domestic price, $\varepsilon_d$, is 4.44. The $\bar{R}^2$ of the equation is 0.895 and shows that 90 percent of the fluctuation in import levels has been explained by this econometric model. The unexplained remainder is treated as the error term of the model. That term appears to be random. The Durbin Watson statistic, DW = 1.81, is close to a value of 2 and provides little evidence of auto regressive disturbances (serial correlation). The pattern of residuals in relation to trended variables was examined graphically, but not through a formal test, and did not suggest a significant level of heteroskedasticity.

The use of the OLS procedure in demand analysis raises the question of whether the demand curve has actually been identified or whether some other type of relationship has been estimated. To test this, the model was re-estimated using the instrumental variable approach employing a two-stage least squares procedure (2SLS) that included import price as a variable dependent on the world supply of canned

peaches, excluding the United States, and import prices lagged one period.

The results of the 2sls estimation are:

$$\ln Q_{im} = 9.11 + 3.80\ln P_d - 2.94\ln P_{im} + 8.12\ln Y + 4.81D - 0.37T$$
$$(2.21) \quad (0.88) \quad (-1.38) \quad (0.81) \quad (8.33) \quad (-1.35)$$

$$\bar{R}^2 = 0.8913; \quad DW = 1.72$$

The explanatory power of the 2SLS equation is the same as the OLS model, the signs are consistent with prior expectations and the coefficients for the common variables are quite similar.The significance of the explanatory price and time trend variables is lower in the 2SLS estimation. Other specifications of a 2SLS import demand model in which one or the other of the income, time trend or dummy variables were dropped resulted in import price coefficients greater than 2.25, and t-values ranging between 1.03 and 1.84.

Import demand was analyzed in order to obtain an estimate of the price elasticity of demand with respect to import prices. The similarity of the estimates obtained through the OLS and 2SLS procedures suggests that the supply of canned peaches is more volatile than demand, and therefore the observed equilibrium values for prices and quantity trace the import demand schedule.The test of the residual values derived in the OLS procedure confirms that the error term is acceptable. The comparison of OLS and 2SLS estimations indicates that there is little or no problem in identifying the demand schedule. The price elasticity estimate, -2.94, derived in the 2SLS procedure, is used to analyze the potential impact on U.S. imports of changes in import prices for canned peaches.

## 3. Economic Implications

The signs of the explanatory variables are consistent with theoretical expectations. Specifically, the sign associated with domestic prices is positive and that associated with import prices is negative. An increase in the domestic price of canned peaches will induce a positive increase in canned peach imports, other things being equal. This indicates that imported and domestic canned peaches are substitutes and compete with one another in the U.S. market. The elasticity of import demand with respect to domestic price, $\varepsilon_d$, is 3.80 (4.41 in the OLS model) and implies that a one percent increase in domestic prices will lead to a 3.8 percent increase in imports, if other factors do not intervene. The t-values for this coefficient in the OLS and 2SLS models are low, but in every specification estimated, the coefficients ranged between 3.2 and 16.4, supporting the existence of a rather strong positive correlation between domestic prices and import quantities.

The coefficient of import price has a negative sign, as expected, indicating that imports will fall as import prices rise and other factors remain the same. The import price elasticity, $\varepsilon_{im}$, is -2.94 (2.91 in the OLS model), indicating that a one percent increase of the import price will result in a 2.9 percent decrease in import volume. By comparing $\varepsilon_{im}$ and $\varepsilon_d$ it can be seen that import demand is more sensitive to the change of domestic price than change in import prices. A change in the ratio between the two prices has an important affect on import volume.

The coefficient of the income variable is positive, as suggested by theory, but not significant in the 2SLS model. It was also not significant in other 2SLS and OLS specifications. A likely explanation is that canned peaches are imported almost exclusively (in excess of 70 percent) for institutional users that are almost entirely influenced by relative prices, and other institutional parameters, and relatively little by changes in consumer income.

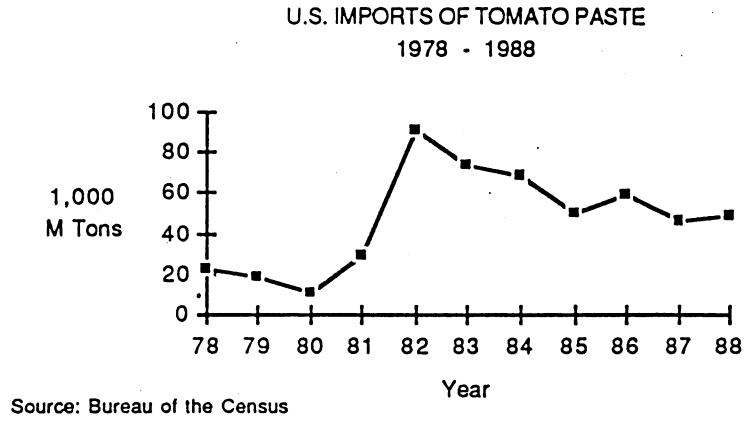
The binary (or dummy) variable, D, was introduced to account for some unknown structural change or shock that caused the abrupt rise in imports during the period 1983-88. Price movements and supply conditions during this period did not explain the magnitude of import changes. The use of D significantly improved the fit of the model.The cause of this structural change needs more investigation since it was not evident in the data examined for this analysis. A time trend, T, was used to account for trends in consumption or other usage patterns. The estimation resulted in a negative sign for the time variable with a relatively low coefficient, 0.37. Based on this result, imports would have decreased slowly over the estimation period if price and structural changes had not intervened.

In early stages of model specification and estimation, the domestic supply of peaches for processing was included in the model. This variable turned out to be insignificant, as measured by the t test. An explanation of this result is that domestic prices already accounted for raw product supply changes. The 2SLS model used the world supply of peaches for processing (excluding the U.S.) as an explanatory variable for import price, but a statistical evaluation of that relationship was not provided by the regression program used.

## Tomato Paste Import Demand

### 1. Data Description

The data used were obtained from annual issues of the Almanac of the Canning, Freezing and Preserving Industries, covering the period 1970 - 1988. These data were supplemented by price and other data from the Food Institute News, the California Tomato Growers Association and USDA Foreign Agricultural Service.




Source: Bureau of the Census

### 2. Model Specification and Estimation Procedures

The economic model postulated the level of imports to be a function of the price for domestic tomato paste, the price of imported paste, per capita income, world supply of tomato paste and a dummy variable to account for unexplained structural changes.

The model was estimated in the log- linear functional form because it gave the best estimates among several functional forms investigated (i.e. linear, semi-log and quadratic). Given the technological similarities among the various canned fruit and vegetable industries, it is not surprising that such a form proved useful in analyzing import demand for canned peaches, pears, tomatoes and tomato paste.Others have found this functional form appropriate for the estimation of demand and supply relationships. For

example, Adams and Behrman estimated 16 supply and demand equations for eight globally traded agricultural commodities and found that the log-linear functional form yielded the best results in each case[2].

The reduced form economic model is as follows:

$$\ln Q_{im} = a_0 + a_1 \ln P_d + a_2 \ln P_{im} + a_3 Y + a_4 D + \xi$$
$$\ln P_d = ßo + ß_1 \ln S + ß_2 D_1 + \xi$$

where:

$Q_{im}$ = quantity of tomato paste imported, in tons
$P_d$ = real price for U.S. tomato paste, f.o.b. plant
$P_{im}$ = real price for imported tomato paste, c.i.f. entry
$Y$ = deflated per capita disposable income, U.S.
$D$ = dummy variable to account for unexplained import jumps in 1971-73 and 1981-83
$D_1$ = dummy variable to account for sudden increase in world tomato capacity, 1984-88
$\xi$ = error term

The reduced form model was estimated using the 2SLS procedure. The program used for the estimation, Shazam, derived coefficients for the independent variables but not the instrumental variables. The results were as follows.

$$\ln Q_{im} = -10.30 + 2.34 \ln P_d - 3.53 \ln P_{im} + 0.52D$$
$$(-1.59) \quad (2.54) \quad (-3.98) \quad (3.42)$$
$$\bar{R}^2 = 0.728; \quad DW = 1.83$$

As with the peach equations, the figures in parentheses are t-values indicating the significance of the coefficients. The coefficients are significant at the 0.05 level, although the constant is not. The elasticity of demand for imports

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[2]Adams, F. G. and J.R. Behrman. *Econometric Models of World Agricultural Commodity Markets*. Cambridge, Mass. Ballinger Publishing Co., 1976.

with respect to import price, $\varepsilon_{im}$, is -3.53, similar to the elasticity measured for canned peaches,-2.94, canned pears, -3.53, and canned tomatoes, -3.17. The elasticity with respect to domestic prices is 2.34, considerably lower than that for canned peaches, 3.80, but above the values for pears and canned tomatoes. The Durbin Watson value of 1.83 provides relatively little evidence of the presence of serial correlation in the error term.

A single equation model was estimated to ascertain if coefficients changed significantly. The estimates derived by using the OLS procedure were:

$$\ln Q_{im} = -6.89 + 2.18 \ln P_d - 3.34 \ln P_{im} + 0.46D$$
$$(-1.38) \quad (3.06) \quad (-5.22) \quad (3.18)$$
$$\bar{R}^2 = 0.726; \quad DW = 1.75$$

The income variable was dropped from the model since its t-value was -0.09. In this respect, the model is similar to that used for canned peaches. The estimated elasticities of import demand with respect to import price and domestic price are close to the estimates derived from the reduced form model. The t-values remained significant at the .05 level of confidence, except for the constant term. The $\bar{R}^2$ and Durbin Watson statistic are similar, as well. A visual examination of the pattern of residuals did not disclose evidence of heteroskedasticity.

These results suggest that the OLS procedure had little or no problem in identifying the demand schedule and might have been used in lieu of the 2SLS procedure to obtain an acceptable import demand elasticity estimate.

## 3. Economic Implications

The signs of the explanatory variables are consistent with theoretical expectations. The elasticity of import demand with respect to import prices indicate that, other things held constant, import volume will increase by 3.5 percent for every one percent decrease in import prices.A one

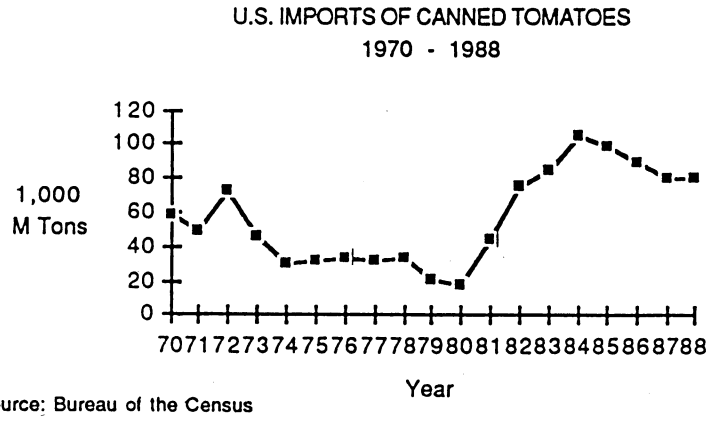
percent increase in domestic prices would stimulate a 2.3 percent increase in import volume if other factors don't change. This confirms the substitutability between domestic and imported tomato paste, although the effect is not as great as in canned peaches. The elasticity of import demand with respect to income is 1.18 and reflects the income driven demand for fast foods such as hamburgers or pizzas that use tomato paste products.The dummy variable raised the explanatory power of the equation substantially. As in the peach equation, it apparently captures the effects of important but unexplained structural changes occurring in the early seventies and again in 1983-87 that resulted in very large increases in import quantities.

The reduced form model explains about 73 percent of the fluctuation in import levels. The unexplained portion of these changes appears to be random. A potential reason for this is that the industry has been changing rapidly (e.g. the emergence of Greece and Mexico as important suppliers, the incidence of high subsidies in the European Community, the strengthening of international marketing links and a decline in the number of U.S. processors) and this has subjected the pricing system to a series of unrelated shocks. Some of these shock has been picked up in the dummy variables, but others apparently have not.

## Canned Tomato Import Demand

### 1. Data Description

The data for canned tomato imports and import prices were obtained from the Almanac of the Canning, Freezing and Preserving Industries. Data on domestic prices were obtained from Food Industry News. Real per capita income figures were from USDA Economic Research Service. Comparable data were not available for the same period as for tomato paste and so estimations were made for the period 1974-1988. Import data was converted from metric tons to equivalent standard cases of canned tomatoes to correspond with domestic data.




Source: Bureau of the Census

### 2. Model Specification and Estimation Procedures

A reduced form model was specified similar to that for canned peaches and tomato paste. That is, changes in import volumes are a function of import and domestic prices, per capita income, world supply of canned tomatoes, a dummy variable reflecting unexplained structural changes in the mid-1980s, and a time trend variable. The first statement of this model was as follows:

$$\ln Q_{im} = a_o + a_1 \ln P_d + a_2 \ln P_{im} + a_3 Y + a_4 T + a_5 D_1 + \xi$$

$$\ln P_{im} = ßo + ß_1 \ln S + ß_2 D + \xi$$

where:

$Q_{im}$ = quantity of canned tomatoes imported, in tons
$P_d$ = real price for U.S. canned tomatoes, f.o.b.
$P_{im}$ = real price for imported canned tomatoes
Y = deflated per capita income, U.S.
S = world supply of canned tomatoes, except U.S.
T = time trend, 1974 = 1, 1971 = 2, etc.
D = dummy variable, years 1979, 1980 = 1.
$D_1$ = dummy variable, years 1984 - 1988 = 1.
$\xi$ = error term

The 2SLS procedure was used to estimate these equations, with disappointing results. The coefficient of the income term was -11.6 which as unreasonably high as an estimate of income elasticity and had the wrong sign. The income variable was dropped and the dummy variable used only as an instrumental variable. The results of the second estimation are as follows.

$$\ln Q_{im} = 19.47 + 1.54 \ln P_d - 3.17 \ln P_{im} + .023T$$
$$(1.81) \quad (1.11) \quad (-2.29) \quad (0.33)$$
$$\bar{R}^2 = 0.513; \quad DW = 0.91$$

The signs remained the same as in the first estimation. The explanatory power remained the same, but the Durbin Watson statistic declined. The t-value for the elasticity of import demand with respect to import price is significant at the 0.05 level. The low $\bar{R}^2$ value indicates that the equation can only explain about one-half of the changes in import volumes. The Durbin Watson statistic suggests that autocorrelation exists and lag relationships have not been properly specified in the model.

## 3. Economic Implications

The implications of this model need to be drawn with care because of potential misspecification, the relatively low $R^2$ value, and the low t-values for the domestic price elasticity. However, the signs are correct and the t-value for the elasticity of import price is significant. Based on the econometric analysis of import demand for canned peaches, canned pears and tomato paste, and the similarity of market structures between these products and canned tomatoes, the import price elasticity estimated for canned tomatoes appears reasonable. The values for peaches, pears and tomato paste are -2.9, -3.5 and -3.5, respectively, and that for canned tomatoes is -3.2.

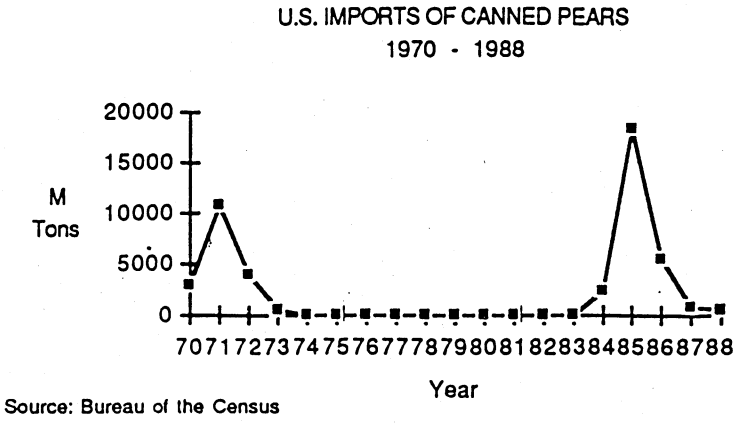
The elasticity results suggest that a one percent increase in import prices would stimulate a reduction of 3.2 percent in the quantity of canned tomato imports, if other factors remain the same. However, the unexplained factors that have influenced canned tomato imports in the past could easily overcome the effects of import price changes.

## Canned Pear Import Demand

### 1. Data Description

Data on import volumes and prices and domestic prices were drawn from the Almanac of the Canning, Freezing and Preserving Industries and the Food Institute News covering the years 1970-1987. The quality of the price data was poor. It was found that the correlation between the U.S. domestic price for canned pears with the U.S. export price was only 0.39. Since the product mix of exports is similar to that of domestic shipments, it was expected that export and domestic prices for canned pears would move together.Consequently, both price series were used to determine which provided the best fit.

Examination of the import data showed a sharp peak in 1971 and again 1n 1985 and a very low volume relative to domestic market movement between 1973 and 1983.




Source: Bureau of the Census

## 2. Model Specification and Estimation Procedures

There was a question about how well an econometric model could explain the abrupt peaks occurring in an otherwise stable pattern of imports. While not satisfying this question fully, it was decided that a model similar to those of canned peach and tomato paste imports would be defensible on economic grounds.

A two-stage model was specified in a log-linear form with the import volume of canned pears as a function of import prices, the U.S. carryin inventory of canned pears, deflated per capita income, and a time trend variable to account for changes in buyer preferences. Import price was specified as a function of the instrumental variables, identified as the world supply of canned pears, except the United States, U.S. export prices for canned pears and a dummy variable to account for the large import changes in 1971, 1986 and 1987. The original model specified U.S. domestic prices of canned pears as an independent variable in the import demand equation. However, estimation results were so poor that price was dropped and domestic carryin of canned peaches was retained.The form of the pear model is similar to

the reduced form models used for other products in this study.

$$\ln Q_{im} = a_o + a_1 \ln P_{im} + a_2 \ln C + a_3 T + a_4 D + \xi$$

$$\ln P_{im} = \beta o + \beta_1 \ln P_e + \beta_2 \ln S + \beta_3 \ln Y + \xi$$

where:

$Q_{im}$ = quantity of canned pears imported, in tons

$P_e$ = unit value of U.S. canned pears exports

$P_{im}$ = price for imported canned pears, c.i.f.

C = carryin of U.S. canned pears, 1,000 std. cases

S = world supply of canned pears ex. U.S.

Y = deflated per capita disposable income, U.S.

T = time trend, 1974 = 1, 1971 = 2, etc.

D = dummy variable, years 1971, 1986,87 = 1.

$\xi$ = error term

The regression program used for this analysis, Shazam, did not evaluate the coefficients associated with the instrumental variables in the 2SLS procedure. This was acceptable because the objective of the analysis was to obtain estimates for the elasticity of import demand for canned pears.The results of the estimation were as follows, with t-values shown in parentheses.

$$\ln Q_{im} = \underset{(4.06)}{26.71} - \underset{(-1.43)}{1.12 \ln C} - \underset{(-7.73)}{3.53 \ln P_{im}} - \underset{(-.40)}{6.0 \ln Y} + \underset{(0.21)}{.06 T}$$

$$\bar{R}^2 = 0.825; \quad DW = 1.66$$

Similar results, with higher t-values for the coefficients of carryin and time trend, were obtained when income was designated as one of the instrumental variables.

A single equation model of import demand was also estimated using the OLS procedure. The premise for this approach is that the import demand for canned pears, like that for canned peaches, is stable relative to import supply and, therefore, the equilibrium price-quantity points will approximate a demand curve. During the estimation it was found that the dummy and time trend variables were not significant. The loss of the dummy variable was surprising given the peaks in the data set. The results, using domestic f.o.b. prices, are as follows:

$$\ln Q_{im} = 15.38 + 1.13 \ln P_d - 3.89 \ln P_{im}$$
$$(2.46) \quad (0.35) \quad (-9.15)$$
$$\bar{R}^2 = 0.830; \quad DW = 1.58$$

Similar results were obtained when U.S. export prices for canned pears were substituted for the domestic f.o.b. price.

Much of the explanatory power in the reduced form equation system lies in the import price variable with a relatively large and significant coefficient. This is also true in the single equation model in which the coefficient is larger (-3.89 vs. -3.53) and the significance level is higher (t-value of -9.15 vs. -7.73). The domestic price coefficient was not significant in either model.. The $\bar{R}^2$ values of 0.83 for both models indicates that the equations explain over 80 percent of past variations in import levels. This is a very high degree of explanation given the pattern of imports between 1970 and 1987. The Durbin Watson statistics of 1.66 for the 2SLS estimation is above the upper bound for serial autocorrelation and that is unlikely to be a problem. The value for the OLS estimation raises the possibility of some autoregressive tendency and misspecification of the model. Visual inspection of the pattern of residuals did not show evidence of heteroskedasticity.

## 3. Economic Implications

The low correlation between domestic f.o.b. prices reported by the Food Institute News and the U.S. export prices reported by the U.S. Department of Commerce has not been satisfactorily explained. A hypothesis is that export prices more nearly reflect transaction prices than do the prices reported by processing firms to the Food Institute News (FIN). The latter prices are closer to list prices. The successful use of FIN prices in explaining peach and processed tomato imports may be due to the large scale of those markets and consequent stability relative to the market for canned pears.

The coefficient for canned pear domestic prices estimated by the OLS procedure was insignificant, and those estimated by the 2SLS procedure had wrong signs and were insignificant as well.These results may stem from the poor quality of data or an important difference in the mix and value of products imported and exported. They may not be a valid indication that domestic prices are unimportant to importing decisions. The estimated elasticity of canned pear import demand with respect to import prices, derived from the reduced form model, is -3.53. This is similar to the value of -3.89 estimated through the OLS procedure and to the estimated elasticities for peaches, tomato paste and canned tomatoes of -2.94, -3.53, and -3.17, respectively.

Pear imports are sensitive to changes in import prices. The model indicates that a one percent decrease in import prices will stimulate a 3.5 percent increase in import volume, if other factors remain constant. Imports appear not to respond to changes in domestic prices as reported by the Food Institute News since the estimated coefficients were insignificant. This result is similar to that obtained for canned tomatoes.The sign for the coefficient estimated by the OLS procedure was positive as indicated by theory.

Imports are negatively correlated with the U.S. carryin of canned pears at the beginning of the marketing year. This is consistent with expectations that a large domestic supply, other things being equal, would depress domestic prices and import demand.The sign associated with income was negative and that for the time trend was positive, although in both cases the coefficients were not sufficiently significant to be of value. The negative sign associated with income reflects the changes in consumer preferences away from canned fruits as income increases. The positive time trend probably represents the structural changes in the institutional sector that increased the need for institutional size packs.

## APPENDIX I

### The Identification of Simultaneous Equations

Structural or behavioral equations may be used to describe the structure of an economic system (a commodity system, for example) or the behavior of a consumer or producer or other economic agent. A problem in interpreting these equations is that they may not represent what they purport to represent.An equation representing the demand for imported peaches, for example, may not, in fact describe the structure of demand but some mixture of supply and demand structures. In such a case, the coefficients of demand shifters such as income or substitute product prices, will be in error because they are estimated from an improperly identified equation. An equation can be identified if the coefficients of the structural equation can be obtained from the estimated reduced-form coefficients.

A reduced-form equation is one in which an endogenous variable is explained solely in terms of predetermined (given) exogenous variables. For example, an equation that specifies the volume of imports as dependent on the price of imports, the price of substitute products, consumer income and an error term is attempting to explain the level of one endogenous variable, import volume, partly on the basis of another endogenous variable, import price. To be properly identified, import price needs to be solved in terms of other exogenous variables, such as world supply and opportunity costs. If this cannot be done, the equation under consideration is unidentified or under-identified.

Generally speaking there is no way of identifying the analysis of price (P) and quantity( Q) data as estimating either the supply function or the demand function. A given $P_t$ and $Q_t$ represent simply the point of intersection of the appropriate demand and supply curves because of the equilibrium conditions that supply equal demand.

To solve the identification problem in estimating supply or demand curves, a procedure called the instrumental variable method is extensively used in empirical analysis. This method may employ two or three stage least squares estimation procedures to solve an instrumental variable (for example, import price) in terms of exogenous variables which are then introduced into the demand equation and their coefficients estimated in the second stage. This procedure results in the estimation of a coefficient for the instrumental variable which can then be used for further analysis. For example, price elasticity of demand with respect to import price (the instrumental variable) may be calculated even though that variable had been expressed in term of exogenous variables.