RESEARCH PAPER: 1990-4

THE SYSTEM-WIDE APPROACH TO IMPORT ALLOCATION: THE CASES OF JAPANESE IMPORT DEMAND FOR CITRUS JUICES AND UNITED KINGDOM IMPORT DEMAND FOR FRESH APPLES

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The System-Wide Approach to Import Allocation: The Cases of Japanese Import Demand for Citrus Juices and United Kingdom Import Demand for Fresh Apples

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Abstract: The system-wide approach is used to develop an import allocation model based on blockwise dependence. The import demand system is parameterized using the absolute version of the Rotterdam model. Two empirical examples are given to illustrate the approach.

Subject Areas: International Agricultural Economics

*Paper presented at Southern Agricultural Economics Annual Meeting, Fort Worth, Texas, February 4-6, 1991. The authors are associate professor, adjunct professor, and former graduate research assistant, respectively, Food and Resource Economics, University of Florida, Gainesville, FL 32611.

THE SYSTEM-WIDE APPROACH TO IMPORT ALLOCATION: THE CASES OF JAPANESE IMPORT DEMAND FOR CITRUS JUICES AND UNITED KINGDOM IMPORT DEMAND FOR FRESH APPLES

Introduction

The system-wide approach to import demand is based on a system of equations rather than single equation estimation. This approach has been used frequently in the past decade for consumer demand and for the input demand of a firm, but less frequently for import allocation models. For examples of this approach applied to import allocation, see Barten, (1971), Barten et al. (1976), Armington (1969), Clements (1977), Hickman and Lau (1973), Clements and Theil (1978), Marwah (1976), Theil and Clements (1978), and more recently Winters (1984).

Typically, in import allocation models one imposes separability between domestic and imported goods. Allocation decisions are assumed to follow a hierarchal fashion, and conditional import demand systems are estimated. This strategy is used to restrict the number of estimated parameters. Separability is often used in consumer demand analysis (eg., Theil and Clements 1987 and Theil et al. 1989). Winters (1984) has recently argued that domestic and imported goods are not separable. However, his suggestions for incorporating domestic goods price into the import allocation problem were in his own words unsuccessful. In what follows, an import allocation model based on blockwise dependence is developed. In this framework, domestic and imported goods prices interact at a higher level in the hierarchal scheme. Accordingly, this allows one to estimate conditional demand systems at lower hierarchal stages without them explicitly entering domestic goods prices.

The paper is organized as follows. First, several different methods of the system-wide approach are briefly mentioned. The differential approach to demand analysis is used to derive an import demand system. Several ways of treating preferences are discussed and two-(or more) stage budgeting under blockwise dependence is used to derive a conditional import demand model where the effect of domestic price on import allocation enters at a higher decision level. Finally, two examples--the import demands for citrus juices in Japan and fresh apples in the United Kingdom--are presented based on the conditional demand system developed. Finally, implications are discussed.

The System-Wide Approach

A popular way of proceeding to estimate a demand system is the direct estimation of demand equations without any reference to the utility function. One of the most used functional forms of this approach is the double-log model. This model is attractive for its simplicity of estimation but has a major weakness in that it violates the adding-up constraint, $E = \Sigma_i\, p_i\, q_i$ where E is total expenditure on all goods, q_i is the quantity demanded of good i and p_i is its price.

Another approach is the algebraic specification of some functional form for the utility function as the first step in generating a system of demand equations. Popular examples of this are the linear expenditure (Stone 1954) and the quadratic expenditure systems (Polak and Wales 1978). Additionally, one can specify some algebraic form for the indirect utility function (eg., the translog model (Christensen et al. 1975)) or the cost (or expenditure) function (eg., the almost ideal demand system (AIDS) (Deaton and Muellbauer 1980)). A third approach is the differential approach which derives demand equations from a general (and algebra free) utility function, and parameterization is the last step prior to estimation. This approach is discussed more fully below.

The Differential Approach to Import Allocation

Let $p_1, \ldots, p_n$ be the prices of n imported goods and E be expenditures on total imports. The country is treated as an individual consumer (or household), and its problem is to select the import quantities $q_1, \ldots, q_n$ which maximize a utility function u(q) subject to the budget constraint $p'q = E$. Typically, we assume separability between domestic and imported goods, but we shall see later this is not necessary. The result is a system of import demand equations each describing some q_i as a function of n + 1 predetermined variables (i.e. $E, p_1, \ldots, p_n$).

The approach begins by total differentiation of demand with respect to prices and income variations. Additionally, it involves the use of Divisia (1925) price and volume indexes, obtained by totally differentiating the budget constraint $E = p_1q_1 + \ldots + p_nq_n$ with respect to all n prices and n quantities:

(1) $$dE = \Sigma_i\, q_i dp_i + \Sigma_i p_i dq_i.$$

By dividing both sides by E and using the budget shares $w_i = p_i q_i/E$,

we obtain

(2) $$d(\log E) = \Sigma_i w_i d(\log p_i) + \Sigma_i w_i d(\log q_i).$$

By defining d(log P) and d(log Q) as the Divisia price and volume indexes, respectively,

$$d(\log P) = \Sigma_i w_i d(\log p_i)$$

$$d(\log Q) = \Sigma_i w_i d(\log q_i),$$

we obtain

(3) $$d(\log E) = d(\log P) + d(\log Q).$$

Next consider the total differential of the budget share $w_i = p_i q_i/E$,

$$dw_i = (q_i/E)dp_i + (p_i/E)dq_i - (p_i q_i/E^2)dE.$$

This can be written more conveniently as

(4) $$dw_i = w_i d(\log p_i) + w_i d(\log q_i) - w_i d(\log E).$$

Thus the change in the budget share is the sum of price, quantity and expenditure components. The quantity component is equal to the contribution of good i to the Divisia volume index and is the dependent variable of the differential demand system,

(5) $$w_i d(\log q_i) = \theta_i d(\log Q) + \phi\, \Sigma_j \theta_{ij} d\, (\log(p_j/P')).$$

This demand equation is derived in Theil (1976).

The first term on the right, $\theta_i d(\log Q)$, is the real-expenditure term of import demand, with θ_i representing the marginal share of good i. Real income is thus measured by the Divisia volume index and results from two sources. The first is the change in money expenditures on imports, E, and the second is the expenditure effect of the price changes. The latter is equal to θ_i times the Divisia price index d(log P). Accordingly, this effect transforms the change in money expenditure into a real-expenditure change.

The second term on the right in (5) is the substitution term and represents the total substitution effect of the price changes. Note that the price of import good j is deflated by the Frisch price index,

$$d(\log P^*) = \Sigma_i \theta_i d(\log p_i).$$

Unlike the Divisia price index which uses the budget shares (or average shares) as weights, the Frisch price index uses the marginal shares as weights.

Similarly to the real-expenditure term, the substitution term results from two sources: the specific substitution term

$$\phi \Sigma_j \theta_{ij} d(\log p_j)$$

which is undeflated and the general substitution effect of the price changes represented by the Frisch price index.

The θ_{ij} in the substitution term of (5) is equal to

(6) $$\theta_{ij} = (\mu/\phi E)\ p_i\ u^{ij}\ p_j,$$

where μ represents the marginal utility of income, ϕ is the income flexibility or the reciprocal of the income elasticity of the marginal utility of income,

$$(1/\phi) = (d\mu/dE)\ (E/\mu)$$

and u^{ij} is the (i,j)th element of U^{-1}, the inverse of the Hessian matrix for the utility function (See Theil et al., 1989, Appendix B.) The matrix $[\theta_{ij}]$ is n x n and symmetric positive definite. The sum over j of θ_{ij} gives the ith marginal share:

(7) $$\Sigma_j\ \theta_{ij} = \theta_i,\ \Sigma_i\ \theta_i = 1, \text{ and } \Sigma_i \Sigma_j \theta_{ij} = 1.$$

The differential demand system in (5) can be simplified to present the total substitution effect directly without separating it into its two parts. This is done by combining p_j and its Frisch deflator. The result is

(8) $$w_i d(\log q_i) = \theta_i d(\log Q) + \Sigma_i\ \pi_{ij} d(\log p_j)$$

where $\pi_{ij} = \phi(\theta_{ij} - \theta_i \theta_j)$ and π_{ij} is the (i,j)th Slutsky coefficient such that $\pi_{ij} = \pi_{ji}$ (the symmetry condition) and $\Sigma_j \pi_{ij} = 0$ (the homogeneity condition).

The coefficients of the differential approach need not be constant. Indeed, Theil et al. (1989) developed a differential demand system in which θ_i varied with w_i, the budget share for good i. However, by assuming that θ_i and the π_{ij}'s are constant, one obtains the Rotterdam model in absolute prices. A finite change version, thus, of (8) under constant θ_i and π_{ij}'s is

(9) $$\bar{w}_{it}\, Dq_{it} = \theta_i DQ_t + \Sigma_j \pi_{ij}\, dp_{jt} + \epsilon_{it}$$

where $\bar{w}_{it} = (w_{i,t-1} + w_{it})/2$, $Dx_t = \log x_t - \log x_{t-1}$, ϵ_{it} is a random error term and $DQ_t = \Sigma_i \bar{w}_{it} Dq_{it}$ (a finite-change version of the Divisia volume index). This model originated with Barten (1964) and Theil (1965).

Block Independence and Conditional Demand Equations

One of the short-comings of the system-wide approach (including the differential approach) is the large number of parameters that are generated (and must be estimated) when n (= number of goods) is large. However, by making restrictive assumptions concerning the utility function (preferences) one can limit the number of parameters to be estimated.

The most restrictive assumption is to assume preference independence (an additive utility function u(q) = $\Sigma_i u(q_i)$). This assumption reduces the price parameters in the model to one, ϕ. Examples of this type of model are the relative price version of the Rotterdam model under preference independence and the Working-P.I. model (Theil et al. 1989).

Additionally, one can allow for allocation decisions to be made in budgeting stages. For example, in our case of import allocation, the nation makes allocation decisions in the first stage among groups of related goods. Then, conditional on the demand for the group, it further allocates expenditure on each group among goods within the group. Further, conditional on the expenditure of a good, the nation can allocate the expenditure on that good among the export suppliers.

One way to proceed along the lines of two (or multi-) stage budgeting is to assume that the utility function is additive in **groups** of goods rather than individual goods, $u(q_i) = \Sigma_g u_g(q_g^*)$ where q_g^* is a vector of the q_i's in the group S_g, g = 1,...,n. Utilizing this assumption, one can derive the demand equations for the group of goods. Then, one can derive the conditional demand for a good within a group.

In practice, almost all empiricists have used block independence in order to make the demand for imports separable from the demand for domestic goods (eg., Armington (1969), Barten (1971), Hickman and Lau (1973), Deppler and Ripley (1981), Ranuzzi (1981), Clements and Theil (1978), and Theil and Clements (1978)). Recently, Winters (1984) has questioned this assumption as being too restrictive. Using an almost ideal demand system (AIDS) model, he estimated United Kingdom (UK) import demand for manufactured goods from 10 export supplying countries, using annual data for 28 years. His test statistics rejected separability between domestic and imported goods, although Laitenen (1978) and Meisner (1979) have shown that such tests generally over reject. More convincing than Winter's analysis and statistical tests is his intuitive argument that the domestic price should enter into the allocation decision for imports (that domestic goods and imports are not truly separable). Winters proposes two solutions. One is to add the price (index) of domestic goods to the AIDS model for the 10 imported goods. He admits this is unsatisfactory since the AIDS model with the additional domestic price term is not a proper demand system. Secondly, Winters suggests adding an eleventh good (domestic goods) to the 10 good import model. This is unsatisfactory for several reasons (Winters gives five), the strongest two in the author's opinion are the adding of 10 additional parameters to an already over-parameterized model and the fact that UK's share of manufactured goods (including imports) ranged from 96 percent in 1954 to 75 percent in 1979, while the largest share (Germany's) of any importing country over the data period was only 5.7 percent.

Blockwise Dependence

In this section, a theoretically sound import demand system is developed which includes the effect of domestic goods price on the demand for imported goods. As with block independence, we begin with the demand for a group of goods, but we no longer assume the utility function to be additive for groups of goods. Instead, we assume that the utility function is some increasing function of the group utilities,

$$u(q) = f(u_1(q_1^*),...,u_G(q_G^*)) ,$$

where q_g^* is a vector of q_i's in group S_g. This type of preference is known as blockwise dependence. Under blockwise dependence, the marginal utility of good i depends on the consumption of good j even when j is in a different group than is i.

Let $i \in S_g$, $j \in S_h$, and $g \neq h$. Further, let

$$W_g = \Sigma_{i \in S_g} w_i, \text{ and } \Theta_g = \Sigma_{i \in S_g} \theta_i$$

representing the budget and marginal shares for S_g ($g = 1,..., G$), respectively. Next, define the group Divisia volume and Frisch price indexes as follows.

$$d(\log Q_g) = \Sigma_{i \in S_g} (w_i/W_g)\, d(\log q_i)$$

$$d(\log P_g^*) = \Sigma_{i \in S_g}\, \theta_i/\Theta_g)\, d(\log p_i)$$

Note that

$$d(\log Q) = \Sigma_g W_g d(\log Q_g)$$

$$d(\log P^*) = \Sigma_g \Theta_g d(\log P_g^*)$$

where again d(log Q) and d(log P^*) are the overall Divisia volume and Frisch price indexes, respectively.

Using this notation, it can be shown that the demand equation of the group S_g under blockwise dependence is

$$W_g d(\log Q_g) = \Theta_g d(\log Q) + \phi \sum_{h=1}^{G} \Theta_{gh}\, d\,(\log P_h^*/P^*) \tag{10}$$

where $\Theta_{gh} = \Sigma_{i \in S_g} \Sigma_{j \in S_h} \theta_{ij}$ and $\Sigma_h \Theta_{gh} = \Theta_g$ (g, h = 1,..., G.

Comparing (10) to (5), we see that the demand equation of the group S_g under blockwise dependence is the uppercase version of the general demand equation for the differential approach. By dividing both sides of (10) by W_g, we find that the income elasticity of demand for S_g is Θ_g/W_g and the Frisch own-price elasticity is

$$\phi_{gg} = \phi\Theta_{gg}/W_g. \tag{11}$$

Unlike with preference independence or block independence, a group may be inferior (a negative marginal share) under blockwise dependence.

In essence, the demand for S_g depends on the relative prices of other groups. Thus, in our case, a nation's first-stage budget allocation for groups of goods (including domestic and imported goods) depends on the relative price indexes of all groups. To see this, let g = 1, 2 where 1 represents domestic goods (aggregated) and 2 represents imported goods. In the first stage, the demand for imported goods is a function of total real expenditures (real-income) and the relative price indexes of domestic and imported goods. Thus, by using block dependence preferences, we avoid Winter's criticism that the import demand allocation decision should depend on domestic goods price as well as imported goods prices.

The second-stage budgeting process in Winter's study would involve the further allocation of expenditure on manufactured imports among the 10 export supplying countries. The demand equation for these "individual" goods in the imported group are conditional demand equations, conditional on the real expenditure of the group which is influenced by the domestic relative price index. This conditional demand equation for good i in group S_g is

(12) $$w_i^* \, d(\log q_i) = \theta_i^* \, d(\log Q_g) + \phi_{gg} \sum_{j \in S_g} \theta_{ij}^* \, d(\log p_j/P_g^*)$$

where $w_i^* = w_i/W_g$, $\theta_{ij}^* = \theta_{ij}/\Theta_{gg}$, $\theta_i^* = \Sigma_{j \in S_g} \theta_{ij}$, and ϕ_{gg} is defined in (11). By combining p_j with P_g^*, we can simplify (12) to

(13) $$w_i^* \, d(\log q_i) = \theta_i^* \, d(\log Q_g) + \Sigma_j \, \pi_{ij}' \, d(\log p_j)$$

where $\pi_{ij}' = \phi_{gg} \, (\theta_{ij}^* - \theta_i^* \theta_j^*)$ and are the conditional Slutsky price coefficients (compare (13) with (8)). Again, one can operationalize (13) by assuming θ_i^* and the π_{ij}''s are constant to obtain the absolute version of the Rotterdam model for the conditional demand for good i in group S_g

(14) $$\bar{w}_{it}^* \, Dq_{it} = \theta_i^* \, DQ_{gt} + \Sigma_j \, \pi_{ij}' \, dp_{jt} + \epsilon_{it}$$

where $\bar{w}_{it}^* = (w_{it}^* + w_{i,t-1}^*)/2$, $dx_{it} = \log x_t - x_{t-1}$, and ϵ_{it} is a random error term (compare (14) with (9)). When imposing the theory of rational random behavior (Theil 1980), the error terms in the conditional demand equations will be independent of those in the composite demand equations for the groups. This strengthens the concept of hierarchal allocation.

The Import Demand for Citrus Juices in Japan: Example One

In this section, a conditional demand system based on (14) is fit to Japanese import data for citrus juices from five sources (Argentina, Brazil, Israel, the U.S. and the rest of the world (ROW)) for the years 1973-87. The influence of domestic price for citrus juices enters at the "higher" allocation level for group demand and does not enter at the stage of budgeting. The data were provided by the Japanese Ministry of Finance import statistics. Orange, grapefruit and all other citrus juices are combined into the one category, citrus juices.

Parameter estimates are reported in Table 1. All conditional marginal shares, θ_i^*, are positive except for Argentina's which is not significantly different from zero ($\alpha = .05$). Those of the U.S., Israel and Brazil are twice the size of their standard errors. All the own-price coefficients are negative. Israel's is significantly different from zero at α = .05 while that of Argentina's is significant at α =.10. Israel's cross-price parameters are significant and positive except the one for U.S.-Israel, while that of Argentina-Brazil is negative and significant. All others are statistically the same as zero.

Conditional expenditure elasticities of demand can be calculated from $\eta_i^* = \theta_i^*/\bar{w}_i^*$. These are reported in column (2) of Table 2. These estimates indicate that the conditional expenditure elasticity of import demand for Brazilian citrus juices is elastic while that of all other suppliers is inelastic; all but Israel's are significantly different from one although Argentina's conditional expenditure elasticity is not statistically different from zero. Thus, if Japanese expenditure for imported citrus juices increases by one percent, we expect expenditures on Brazilian citrus juices to increase by over three percent while those on U.S. and Israel citrus juices to increase by .37 and .55 percent, respectively; those of Argentina and ROW would not change significantly.

Conditional Slutsky price elasticities (holding real income constant) can be obtained by simply dividing the conditional Slutsky price parameters by $\bar{w}_i^*$ (ie. $S_{ij}' = \pi_{ij}'/\bar{w}_i^*$). Frisch price elasticities (holding the marginal utility of income constant) can be obtained from $F_{ij} = v_{ij}'/\bar{w}_i^*$ where $v_{ij}' = \pi_{ij}' + \phi_{gg}\,\theta_i^*\,\theta_j^*$. Theil and Clements (1987, Section 5.) show that the conditional and unconditional Frisch price elasticities are comparable. The conditional Cournot price elasticities of demand can be obtained from $C_{ij}' = \pi_{ij}'/\bar{w}_i^* - \theta_i^*\bar{w}_j^*/\bar{w}_i^*$. These three types of price elasticities are presented in columns (3) - (17) in Table 2. All own-price elasticities are negative. All three of Israel's and those of ROW are significantly different from zero at α = .05; Israel's indicate elastic own-price demand while those of ROW indicate inelastic own-price demand. Brazil's Frisch own-price elasticity is elastic and significantly different from zero (α = .05) while all other own-price elasticities are inelastic although insignificant (α = .05).

Table 1. Parameter estimates of Japanese import demand for citrus juices, 1973-87.

Exporting Countries (1)	Conditional Slutsky parameter, π'_{ij} USA (2)	Israel (3)	Argentina (4)	Brazil (5)	ROW (6)	Conditional marginal shares, θ'_i (7)
USA	-.048 (.120)[a]	.011 (.043)	-.019 (.022)	.040 (.124)	-.016 (.033)	.226 (.080)
Israel		-.203 (.072)	.086 (.023)	.103 (.044)	.028 (.012)	.045 (.022)
Argentina			-.019 (.011)	-.041 (.019)	-.006 (.009)	-.005 (.012)
Brazil				-.115 (.159)	.013 (.032)	.712 (.102)
ROW					-.025 (.016)	.022 (.023)

[a]Asymptotic standard errors are in parentheses.
ROW = Rest of the world.

Table 2. Conditional expenditure and price elasticities of Japanese import demands for citrus juices, 1973-87.[a]

Exporting country	Conditional expenditure elasticities	USA			Israel			Argentina			Brazil			ROW		
	·	F	S′	C′	F	S′	C′	F	S′	C′	F	S′	C′	F	S′	C′
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
USA	.370[c]	-.121[d]	-.079[d]	-.305[d]	.010[d]	.018[d]	-.012[d]	-.030	-.031	-.044[d]	-.066[d]	.066[d]	-.015[d]	.022[d]	.026[d]	.006[d]
	(.115)[b]	(.200)	(.196)	(.217)	(.071)	(.070)	(.070)	.037	(.036)	(.036)	(.207)	(.204)	(.207)	(.056)	(.055)	(.054)
Israel	.547	.076	.138	-.195	-2.499	-2.487	-2.531	1.054	1.053	1.034	1.077	1.262	1.142	.028[d]	.034[d]	.004[d]
	(.270)	(.527)	(.523)	(.567)	(.885)	(.886)	(.884)	(.277)	(.277)	(.278)	(.547)	(.534)	(.544)	(.152)	(.153)	(.149)
Argentina	-.153[c]	-.540	-.557	-.464	2.510[d]	2.510[d]	2.520[d]	-.567	-.566	-.561	-1.152	-1.207	-1.173	-.175[d]	-.177[d]	-.168[d]
	(.362)	(.653)	(.641)	(.729)	(.660)	(.660)	(.659)	(.317)	(.317)	(.315)	(.578)	(.553)	(.564)	(.265)	(.266)	(.259)
Brazil	3.243[c]	-.183	.183	-1.793	.396[d]	.468[d]	.203[d]	-.180[d]	-.188[d]	-.299[d]	-1.677	-.521	-.123	.022[d]	.058[d]	-.120[d]
	(.464)	(.574)	(.564)	(.621)	(.203)	(.198)	(.199)	(.090)	(.086)	(.085)	(.825)	(.722)	(.740)	(.150)	(.143)	(.140)
ROW	.236[c]	.242	.288	.043	.042[d]	.051[d]	.018[d]	-.109[d]	-.110[d]	-.124[d]	-.309	.233	.145	-.466	-.461	-.483
	(.221)	(.618)	(.610)	(.710)	(.225)	(.227)	(.226)	(.165)	(.166)	(.162)	(.893)	(.573)	(.590)	(.285)	(.288)	(.280)

[a]Estimated at sample means.
[b]Asymptotic standard errors in parentheses.
[c]Significantly different from 1.0 (α = .05).
[d]Significantly different from $|1.0|$ (α = .05).
F = Frisch price elasticities calculated assuming Frisch own-price elasticity for citrus juices group is -.5.
S′ = Conditional Slutsky price elasticities.
C′ = Conditional Cournot price elasticities.
ROW = Rest of the world.

The Frisch, conditional Slutsky and conditional Cournot cross-price elasticity estimates are often quite different, even in sign, for the same country. However, for those that have Slutsky price parameters with relatively small standard errors, these three measures are reasonably close (eg., USA-Argentina, USA-ROW, Israel-Argentina, Israel-Brazil, Israel-ROW). The three types of elasticities based on insignificant conditional Slutsky parameters are noticeably different. All significant cross-price elasticities are positive with the exception of Brazil-Argentina. This may be due to both countries producing in the southern hemisphere at the same time of the year.

Import Demand for Apples in the UK: Example Two

Here, a conditional demand system based on (14) is fit to the UK import data for fresh apples from four exporting sources (New Zealand, South Africa, U.S., and ROW) for the years 1962-87[1]. Again the effect of the domestic relative price for apples would enter the hierarchal allocation decision at a higher level. The data are obtained from the United Nations Statistical Office. Parameter estimates are reported in Table 3. All parameter estimates of the conditional marginal shares are positive and twice the size of their standard errors. All own-price conditional Slutsky coefficients are negative. Two (that of New Zealand and the U.S.) are twice their standard errors. All cross-price parameters are positive except that of South Africa-U.S. Those of New Zealand-ROW and U.S.-ROW are twice the size of their standard errors; the others are not statistically different from zero (α = .05).

The conditional expenditure elasticities (Table 4) indicate that the UK's demand for New Zealand and U.S. fresh apples is highly elastic. A one percent increase in UK expenditures for imported fresh apples will increase demand for U.S. fresh apples by 2.7 percent and that of New Zealand by 1.9 percent. South Africa's conditional expenditure elasticity indicates unitary elasticity while that of the ROW is inelastic. As UK expenditures on fresh imported apples increase, we expect the market share of the U.S. and New Zealand to increase, that of South Africa to remain fairly constant, and that of the ROW to decline.

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[1]Apple imports from France make up on average over 90% of ROW apples.

Table 3. Parameter estimates for United Kingdom import demand for apples from four exporting sources, 1962-87.

Exporting countries (1)	Conditional Slutsky parameters, π'_{ij} New Zealand (2)	S. Africa (3)	USA (4)	ROW (5)	Conditional marginal shares, θ'_i (6)
New Zealand	-.028 (.011)[a]	.013 (.023)	.006 (.012)	.009 (.003)	.144 (.048)
South Africa		-.010 (.076)	-.016 (.031)	.013 (.066)	.230 (.108)
USA			-.060 (.026)	.070 (.029)	.118 (.046)
ROW				-.092 (.079)	.509 (.136)

[a]Asymptotic standard errors are in parentheses.
ROW = Rest of the world of which French apples make up on average over 90% of this category.

Table 4. Conditional expenditure and price elasticities of United Kingdom import demand for fresh apples, 1962-87.

Exporting country	Conditional expenditure elasticities	New Zealand			South Africa			USA			ROW		
		F	S′	C′	F	S′	C′	F	S′	C′	F	S′	C′
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
New Zealand	1.920	-.509[d]	-.370[d]	-.514[d]	-.049[d]	.172[d]	-.252[d]	-.034[d]	.079[d]	-.004[d]	-.370[d]	.119[d]	-1.150
	(.636)[b]	(.159)	(.153)	(.149)	(.362)	(.305)	(.374)	(.161)	(.163)	(.165)	(.318)	(.335)	(.491)
South Africa	1.041	-.017[d]	.058[d]	-.020[d]	-.164[d]	-.044[d]	-.274	-.134[d]	-.073[d]	-.118[d]	-.206[d]	.059[d]	-.629
	(.489)	(.111)	(.104)	(.099)	(.407)	(.343)	(.404)	(.150)	(.140)	(.138)	(.283)	(.297)	(.356)
USA	2.719[c]	-.059[d]	.137[d]	-.067[d]	-.684	-.372	-.972	-1.54	-1.380	-1.498	.924	1.616	-.182
	(1.065)	(.279)	(.283)	(.265)	(.766)	(.713)	(.846)	(.634)	(.596)	(.596)	(.650)	(.678)	(.822)
ROW	.796	-.042[d]	.014[d]	-.044[d]	-.069[d]	.020[d]	-.150[d]	.060[d]	.106[d]	.072[d]	-.335[d]	-.139[d]	-.648[d]
	(.205)	(.036)	(.038)	(.039)	(.094)	(.099)	(.120)	(.043)	(.044)	(.045)	(.143)	(.120)	(.163)

[a]Estimated at sample mean.
[b]Asymptotic standard errors in parentheses.
[c]Significantly different from 1.0 (α = .05).
[d]Significantly different from |1.0| (α = .05)
F = Frisch price elasticities calculated assuming Frisch non-price elasticity for imported fresh apples group is -.5.
S′ = Conditional Slutsky price elasticities.
C′ = Conditional Cournot price elasticities.
ROW = Rest of the world.

All three types of own-price elasticities (Frisch, conditional Slutsky, and conditional Cournot) of import demand for all export suppliers are negative. New Zealand's is price inelastic while that of the U.S. is price elastic. The conditional own-price elasticities of ROW are inelastic; those of South Africa are statistically the same as zero. As seen from the previous example, the three types of cross-price elasticities vary markedly when derived from conditional Slutsky parameters with large standard errors. Conservatively, most of these estimates should be considered highly inelastic (zeros).

CONCLUSION

In this paper, a hierarchal import allocation model was derived using the differential approach and blockwise dependence which allows domestic prices to enter the import allocation decision at the group level but not at the goods level. Further, a conditional import demand system was developed which allocates expenditures for a good among suppliers of that good. Two examples, the Japanese import demand for citrus juices and the United Kingdom's import demand for fresh apples, were presented and estimated by the Rotterdam model for illustrative purposes. In both cases, estimated marginal shares for exporters were consistent with economic theory and statistically significant for seven of nine of these estimates; all nine own-price parameters were negative.

The argument has often been made that U.S. citrus juices and Brazilian citrus juices were not homogenous, with U.S. citrus juices embodying higher quality and more services than Brazilian juices. Evidence for this was found in the Japanese import demand analysis for citrus juices. Japanese demand for U.S. citrus juices was not price responsive while that for Brazilian citrus juices was as measured by the Frisch own-price elasticity of import demand. Further, as the Japanese relax their import quota on imported citrus juices, we expect to see demand for U.S. citrus juices to increase but not as much as that for Brazilian citrus juices. Accordingly, we expect to see Brazil take an increasing share of the imported citrus market as more citrus juices are allowed to enter Japan.

In the case of U.K. import demand for fresh apples, the own-price elasticity of import demand for U.S. apples was elastic. This was also the case for the import expenditure elasticity of demand for U.S. (and New

Zealand) apples. Thus, we would expect the U.S. market share to increase as more expenditures are made on imported apples.

The analyses suggest that pricing strategies to increase Japanese demand for U.S. citrus juice would not work effectively but would in the United Kingdom's market for imported fresh apples. Additionally, Japan's decision to allow greater quantities of citrus juices to enter its market would seem to benefit Brazil more than the U.S. Still, we expect increased quantities of U.S. citrus juices into Japan but a decreasing market share.

REFERENCES

Armington, P. S. "A Theory of Demand for Products Distinguished by Place of Production." International Monetary Fund Staff Paper 16 (1969): 159-78.

Barten, A. P. "An Import Allocation Model for the Common Market." Cahiers Economiques de Bruxelles 50 (1971)3-14.

Barten, A. P., G. d'Alcantara, and G. J. Carrin. "COMET: A Medium-term Macroeconomic Model for the European Economic Community." European Economic Review 7 (1976):63-115.

Christensen, L. R., D. W. Jorgenson, and L. J. Lau. "Transcendental Logarithmic Utility Functions." American Economic Review 65 (1975):367-83.

Clements, K. W. "The Trade Balance in Monetary General Equilibrium." Ph.D. dissertation, University of Chicago, 1977.

Clements, K. W., and H. Theil. " A Simple Method of Estimating Price Elasticities in International Trade." Economics Letters 1 (1978):133-37.

Dean, A. S., and J. Muellbauer. Economics and Consumer Behavior. Cambridge: Cambridge University Press, 1980.

Deppler, M. C. and D. M. Ripley. "The World Trade Model: Merchandise Trade." International Monetary Fund Staff Papers 25 (1981):147-206.

Hickman, B. G., and L. J. Lau. "Elasticities of Substitution and Export Demand in a World Trade Model." European Economic Review 4 (1973):347-80.

Laitenen, K. "Why Is Demand Homogeneity So Often Rejected?" Economics Letters 1 (1978):187-91.

Marwah, K. A. "A World Model of International Trade: Forecasting Market Shares and Trade Flows." Empirical Economics 1 (1976):1-39.

Meisner, J. F. "The Sad Fate of the Asymptotic Slutsky Symmetry Test for Large Systems." Economics Letters 2 (1979):231-33.

Polak, R. A. and T. J. Wales. "Estimation of Complete Demand Systems from Household Budget Data: The Linear and Quadratic Expenditure Systems." American Economic Review 68 (1978):348-59.

Ranuzzi, P. "The Experience of EEC Eurolink Project in Modeling Bilateral Trade Linkage Equations." Journal of Policy Modelling 3 (1981):153-73.

Stone, R. "Linear Expenditure System and Demand Analysis: An Application to the Pattern of British Demand. Economic Journal 64 (1954):511-27.

Theil, H. Theory and Measurement of Consumer Demand, Volume 2. Amsterdam: North-Holland Publishing Co., 1976, Chapter 7.

Theil, H., and K. W. Clements. "A Differential Approach to U.S. Import Demand." Economics Letters 1 (1978):249-52.

Theil, H. and K. W. Clements. Applied Demand Analysis: Results from System-Wide Approaches. Cambridge, MA: Ballinger Publishing Co., 1987.

Theil, H., C.-F. Chung, and J. L. Seale, Jr. International Evidence on Consumption Patterns. Greenwich, CN: JAI Press Inc., 1989.

Winters, L. A. "Separability and the Specification of Foreign Trade Function." Journal of International Economics 17 (1984):239-63.