WOOD TRADE FLOWS: AN EMPIRICAL ANALYSIS OF GREEK WOOD IMPORTS

PANOS FOUSEKIS, CHRISTOS J. PANTZIOS, AND ALEXANDRA VAKROU*

ABSTRACT

The Greek aggregate import demand for fuelwood, unprocessed timber, processed timber and, timber-for-layers during 1971–1995 is empirically analysed using a flexible CBS model. Policy implications are derived based on the examination of standard measures such as price, expenditure and, substitution elasticities over time. Imports of unprocessed and processed timber are found to be price-inelastic, in contrast to fuelwood and timber-for-layers imports. Fuelwood imports are found to be expenditure-elastic while timber imports are expenditure-inelastic. Substitution possibilities initiated by changes in the import price of unprocessed or processed timber, appear to increase in the early 1990s.

Keywords: demand analysis, elasticities, fuelwood, Greece, timber, wood imports.

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INTRODUCTION

Greece cannot rely on domestic resources to satisfy its needs for wood and timber, given the tree species grown domestically and the conditions prevailing in the country's forests. The largest portion of domestic wood production is fuelwood while annual forest production has been falling at an accelerating rate. Since, Greece has been increasingly importing wood. From an economic point of view therefore, studying the country's demand for wood imports and monitoring their evolution over time, is an issue that merits careful examination. Analyses of this kind may not only improve our understanding of the economic structure of Greek wood imports, but they may also suggest improvements in domestic forest management (i.e., through the implementation of practices leading to a better utilisation of domestic wood production).

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Within this context, the objective of this paper is an empirical investigation of the demand for wood imports in Greece during the last 25 years. The analysis allows quantification of the responses of different types of imported wood to changes in prices and expenditure. The price, expenditure, and substitution elasticities (which are the main outcomes of empirical import demand systems) constitute the building blocks in developing trade models; they enable researchers to measure the costs and benefits associated with changes in market or domestic policies. Finally they may serve as exogenous information in a more detailed (i.e., disaggregated) analysis, along the lines of a "multi-stage" approach (e.g. Anderson & Neary, 1992, 1994; Abler & Shortle, 1992a, 1992b; Theil, 1976, 1980);

At present, despite the heavy reliance of Greece on wood imports, empirical economic research on the country's demand for foreign wood is scarce. The results therefore of the present study may be of particular interest to policy makers, the domestic wood industry as well as forest management experts. The rest of the paper is organised as follows: We begin by presenting a brief overview of the Greek wood sector, and then follows the theoretical framework. We continue by showing the empirical model and the results, and end the paper with our conclusions.

The Greek Wood Sector

The average composition of domestic wood production during the last twenty five years has been composed of fuelwood (71%), round wood (28.5%), and railroad timber (0.5%). Moreover, only 40% of the total fuelwood production is used by the wood industry for further processing, and only 15% is processed into pulpwood or technical wood (Spanakis, 1986). This is in contrast to other, mainly north European countries, where only about 8% of the fuelwood produced is not processed industrially. Consequently, the country's wood industry relies heavily on imported wood to cover input needs; indeed, wood imports account for more than 70% of total timber and wood products utilised by the Greek wood industry (Stamou, 1996).

The dependence of the domestic wood industry on imported wood is not the same for all types of enterprises of the sector. The greatest dependence can be observed in the case of the technical wood industries and wooden furniture enterprises, which rely on imports to cover 95% of their input needs for plywood and 90% for veneers and MDF. Furniture makers import 70% to 80% of their wood inputs. Sawmills, enterprises specialised in wooden floors and to a lesser extent packaging enterprises are less dependent on imports (Stamou, 1996).

Industry practices seem to affect the types of wood imports, as imported wood (e.g. timber for layers) is routinely used by the domestic industry for the production of veneers and chipboard. It is worth noting that although in most countries producing chipboard (C/B), recycled wood is also used, chipboard in Greece is produced mainly from fuelwood, small round wood of low quality and imported fuelwood (Alexiou, 1998). Lastly, the country's construction activity also seems to have played a role in the types of imported wood, particularly via the domestic timber industry. Thus, during the 1980s the volume index of the Greek timber industry exhibited a sharp decrease of 24.3%, while the industrial index as a whole showed an increase of 1.7%. The main reason for this decline was a significant drop in construction activity during the same period. Consequently, wood imports used as an input in the domestic timber industry also contracted during the 1980s. However, due to the construction boom, which started in 1988–89 (with a short decline between 1991 and 1992) the growth index of the timber industry has started to increase. At the same time, the volume index of wooden furniture production has been exhibiting a downward trend in parallel with an increase in the production volume index of metal furniture. This provides evidence of a decline in wooden furniture production in Greece, and therefore to the imported wood inputs used in the industry (ICAP, 1992; 1997).

Theoretical Framework

Modern import demand analysis is based on the implementation of flexible systems referring to groups of similar goods, rather than on single equations. The CBS model is a prominent specification of this kind, commonly utilized in empirical demand research (e.g. Keller & van Driel, 1985; Weatherspoon & Seale, 1992; van Driel *et al.*, 1997). This model is also used here for the analysis of Greek wood imports.[1]

To briefly introduce the CBS model, let a group of $i = 1,\ldots,n$ similar goods with q_i, p_i, and w_i denoting the quantity, price, and expenditure share of the ith good, respectively. If the demand for these goods is described by a CBS specification then, the demand equation of ith good may be written as

$$w_i d\log q_i = (\beta_i + w_i)\, d\log Q + \sum_j^n \pi_{ij} d\log p_j \tag{1}$$

where βi, and π_{ij} are estimable parameters; and,

$$d\log Q = \sum_i^n w_i d\log q_i$$

is an index number (the Divisia volume index) denoting changes in real expenditure. The expression ($\beta_i + w_i$) is the marginal budget share of the ith commodity, that is, the proportion of a unit increase in real expenditure allocated to that commodity. The parameters π_{ij} are the compensated prices effects (Slutsky terms). Consistency with demand theory properties requires that the estimable parameters in system (1) satisfy the following restrictions:

$$\sum_i \beta_i = 0, \quad \sum_i \pi_{ij} = 0, \text{ (adding-up) ;} \tag{a}$$

$$\pi_{ij} = \pi_{ij} \text{ (symmetry); and} \tag{b}$$

$$\sum_j \pi_{ij} = 0 \quad \text{(homogeneity),} \tag{c}$$

The expenditure, compensated, uncompensated price elasticities for the ith good are calculated as

[1] As shown by Barten (1993), the CBS model belongs to a family of differential systems which also includes the Rotterdam (Barten, 1964; Theil, 1965), the differential AIDS (Altson & Chalfant, 1993), and the NBR (Neves, 1987) specifications. All these models were tried in the present study using both economic and statistical criteria to formally select among them. Only the CBS specification however, gave theoretically consistent results. The results of our selection process leading to the CBS specification as our model of choice are available from the authors upon request.

$$\eta_i = \frac{\beta_i}{w_i} + 1 \tag{2}$$

$$\varepsilon_{ij} = \frac{\pi_{ij}}{w_i} \tag{3}$$

$$\eta_{ij} = \varepsilon_{ij} - n_i w_{i,} \tag{4}$$

respectively. The expenditure elasticiticity (η_i) gives the percentage change in the demand for the ith good induced by 1% percent change in real expenditure allocated to the group of the goods considered, and holding prices constant. The compensated price elasticity (ε_{ij}) gives the percentage change in the demand for the ith good induced by 1% change in the price of the jth good, holding the real expenditure allocated to the group constant. The uncompensated price elasticity (η_{ij})captures both the substitution and the expenditure (in percentage terms) effects, which are brought about by an 1% change in the jth price.

The Empirical Model and the Results

We model Greek wood imports as a four-commodity demand system which includes: q_1 = fuelwood imports; q_2= unprocessed wood imports; q_3 = processed wood imports; and q_4 = wood import-for-layers. Import quantity and values for the period 1970–1995 (expressed in metric tons and thousands of drachmas, respectively) were taken from the National Greek Statistical Service; for estimation purposes prices and quantities were converted to indices (1970 = 1).

The selection of the products involves the assumption of weak separability (Theil, 1980; Deaton & Mulebauer, 1980b). Under this assumption Greece may be thought as allocating, at a first stage, aggregate expenditure over primary, composite goods such as "domestically produced wood", "imported wood", "finished wood products" etc. Next, the country may be thought of, as allocating the given expenditure for "imported wood" within a second-level group made-up from the major categories of imported wood (fuelwood, unprocessed, processed, and wood for layers). Weak separability is very common in applied import demand analysis (e.g. Weatherspoon & Seale, 1992;

Moschini & Visa, 1993). The assumption appears to be quite realistic here, since, in contrast to other countries, wood imported into Greece cannot (with the possible exception of fuelwood) be regarded as close substitutes for the same types produced domestically — indeed several types are in fact not produced domestically, at all. The reliance of the Greek wood-processing sector on imported wood ranging from 70 up to 90 percent of total wood input — already mentioned in the previous section — in this respect, is illuminating.[2]

Since structural demand systems, such as the CBS, are singular, only three equations were specified (the 'imported timber-for-layers' demand equation was dropped and its parameters were obtained residually; (Barten, 1969)). The standard demand theory properties of homogeneity and symmetry were imposed, and the CBS model was estimated using the maximum likelihood method.[3]

Table 1 presents the estimation results. Of the fourteen estimated parameters, eleven are statistically different from zero at the 5 or 10 percent level. The R^2 coefficients for the three estimated equations are 0.61, 0.52, and 0.77, respectively. The conformity of the estimated model with the demand theory was further tested by checking the semi-definiteness of Slutsky matrix $[\pi_{ij}]$, $i, j = 1,..., n-1$. Its three eigenvalues are –0.158, –0.102, –0.076 suggesting that the model conforms with the theoretical postulates.

A potential difficulty in differential demand systems is the presence of the term $d\log(Q)$ on the right hand side of Equation (1) that may cause endogeneity problems with the equation residuals (Theil, 1976; Attfield, 1985). To test for this problem we resort to the theory of rational random

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[2] An anonymous reviewer noted that wood imports may be *indirectly* affected by imports of finished wood products. Such considerations however are left out of our analysis for both methodological and practical reasons. Methodologically, we distinguish the country's demand for wood imports as intermediate goods (*inputs*) for the wood processing sector from its demand for imported wood products for the *final* consumer. Moreover, practically the inclusion of additional commodities raises the number of parameters to be estimated exponentially thus introducing a degrees-of-freedom problem (Diewert & Wales, 1987).

[3] Estimations were carried out in the computer program TSP 4.4, and parameter estimates of the residual equation were obtained via the ANALYZ command. The maximum likelihood estimation ensures that the results are robust to the equation dropped.

TABLE 1. CBS MODEL — ESTIMATION RESULTS.

	Price Coefficients				Expenditure
	Fuelwood	Timber — U [a]	Timber — P	Timber — L	Coefficients
Fuelwood	–0.1481 *	0.0104	0.0199	0.1177	0.2142 *
	(0.0478) [b]	(0.0219)	(0.0121)	(0.0442)	(0.0747)
Timber — U		–0.0790 **	–0.0096	0.0782*	–0.1119 *
		(0.0546)	(0.0400)	(0.0387)	(0.0356)
Timber — P			–0.1106 *	0.1003 *	–0.0766 *
			(0.0386)	(0.0207)	(0.0194)
Timber — L				–0.2963 *	–0.0256
				(0.0605)	(0.0706)

*[a] Letters U, P, L indicate timber unprocessed, timber processed and timber-for-layers, respectively; [b] Numbers in parentheses are standard errors); *(**) Statistically significant at 5% (10%) level.*

behavior (Theil, 1976, 1980; Duffy, 1987) according to which the term $d\log(Q)$ is exogenous if the covariances of the residuals are proportional to the price coefficients. In this study, a regression of the system's residual covariances $\text{cov}(e_i, e_j)$ on a constant and the Slutsky terms produced the regression equation: $\text{cov}(e_i, e_j)$ = 0.954E–05 (0.00092) – 0.0365 (0.0073) π_{ij}, with $R^2 = 0.75$ (the numbers in parentheses are standard errors). The insignificant intercept and the singificant negative slope term suggest that the residual covariances are indeed proportional to the price coefficients; therefore, endogeneity is not a problem in the present study.

Inference from demand models is best interpreted in terms of elasticities. Regarding price effects, positive (negative) cross price elasticities indicate a substitutability (complementarity) relationship. Regarding expenditure effects, a commodity is estimated to be inferior when $\eta_i < 0$, or non-inferior when $\eta_i \geq 0$ (Barten, 1993); in the latter case it can be an expenditure-inelastic good when $\eta_i \leq 1$, or an expenditure-elastic good when $\eta_i > 1$. Additional results about the preferences (or needs) underlying a demand model are provided by the substitution elasticities. In particular, the Morishima elasticity (Chambers, 1989; Fleissing, 1997), defined as $\sigma_{ij}^{M} = \varepsilon_{ij} - \varepsilon_{jj}$, gives the change in the ratio of good *i* to good *j* due to a change in the price of good *j*. A positive sign indicates substitutability while a negative sign indicates complementarity.

Results and Analysis

Tables 2 through 4 and Figure 1 present information on the price, expenditure and substitution elasticities, computed from the CBS parameter estimates.[4] Average (i.e., computed at the mean budget shares) price and expenditure elasticities are shown in Table 2. Similarly, Table 3 presents the average Morishima elasticities of substitution. In addition to average estimates, the evolution of these elasticities over time is examined. Table 4 shows the point (annual) estimates of own-price and expenditure elasticities; moreover, the time path during the 1971–1995 period of selected elasticities of substitution is depicted in Figure 1.

Starting with the price elasticities (Table 2), it may be observed that, on average, aggregate demand for imports of timber-for-layers and fuelwood is elastic to own price changes; by contrast, demand for processed and unprocessed timber imports is inelastic. More precisely, in the case of timber-for-layers imports, a 1% rise in the own price is estimated to cause a *ceteris paribus* average reduction of 1.3% to the import volume during the 1971–1995 period. Similarly, in the case of fuelwood imports, the same rise in the own import price is estimated to cause an average reduction of 1.07% to the import volume. On the other hand, the volumes of unprocessed and processed timber imports are estimated to drop *ceteris paribus* by only 0.45 and 0.72 percent, respectively, given a 1% rise in the corresponding import prices.

Table 4 provides a more detailed picture of the evolution of the aforementioned elasticities over time. Fuelwood and timber-for-layers imports exhibit own price elasticities, steadily within the elastic range, throughout the period examined (exceptions are the periods 1974 and 1975).

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[4] According to Barten & Bettendorf (1989) the compensated price elasticities are imperfect indicators of commodity interrelationships. This because the homogeneity restriction $\sum_i \pi_{ij} = 0$ along with the negative definitenesss of the Slutsky matrix entail dominance of positive cross-price effects (i.e. dominance of substitutability). Hence, the cross-price compensated elasticities should be interpreted with caution. The appropriate measures of interrelationships for policy analysis are the uncompensated elasticities, which reflect both the substitution and the expenditure effects of price changes.

Table 2. Average Price and Expenditure Elasticities of Greek Timber Imports: 1971–1995.

	Compensated (Slutsky) Price Elasticities				Expenditure
Imported:	Fuelwood	Timber — U	Timber — P	Timber — L	Coefficients
Fuelwood	–0.620 * (0.200)	0.044 (0.092)	0.083 (0.051)	0.492 * (0.185)	1.896 * (0.312)
Timber — U	0.034 (0.073)	–0.262 ** (0.181)	–0.032 (0.132)	0.259 * (0.128)	0.629 * (0.117)
Timber — P	0.112 (0.068)	–0.054 (0.226)	–0.625 * (0.218)	0.567 * (0.117)	0.567 * (0.110)
Timber — L	0.417 * (0.157)	0.277 * (0.137)	0.356 * (0.073)	–1.051 * (0.215)	0.908 * (0.250)
	Uncompensated (Marshallian) Price Elasticities				
Imported:	Fuelwood	Timber — U	Timber — P	Timber — L	
Fuelwood	–1.703 * (0.170)	–0.529 * (0.146)	–0.252 * (0.083)	–0.042 (0.088)	
Timber — U	–0.115 * (0.060)	–0.451 * (0.192)	–0.143 (0.136)	0.081 * (0.033)	
Timber — P	–0.022 (0.056)	–0.225 (0.230)	–0.725 * (0.222)	0.406 * (0.031)	
Timber — L	0.200 (0.135)	0.003 (0.017)	0.195 * (0.090)	–1.307 * (0.242)	

*(**) *Statistically significant at the 5% (10%) level. Standard errors (in parentheses) were computed as in Kmenta (1986).*

Table 3. Average Morishima Elasticities of Substitution between Greek Timber Imports: 1971–1995.

	Price Coefficients			
Imported:	Fuelwood	Timber — *U*	Timber — P	Timber — L
Fuelwood	0	0.305 (0.220)	0.708 * (0.232)	1.543 * (0.214)
Timber — U	0.654 * (0.234)	0	0.593 (0.337)	1.310 * (0.214)
Timber — P	0.732 * (0.232)	0.207 (0.370)	0	1.617 * (0.214)
Timber — L	1.037 * (0.200)	0.539 * (0.180)	0.980 * (0.218)	0

*(**) *Statistically significant at the 5% (10%) level. Standard errors (in parentheses) were computed as in Kmenta (1986).*

TABLE 4. WOOD IMPORTS: PRICE AND EXPENDITURE ELASTICITIES DURING 1971–1995.

	Marshallian Own-Price Elasticities				Expenditure Elasticities			
Year	Fuelwood	Timber Unproc.	Timber Proc.	Timber – Lyers	Fuelwood	Timber Unproc.	Timber Proc.	Timber – Lyers
1971	–1.040	–0.452	–0.632	–1.423	1.814	0.567	0.669	0.895
1972	–1.028	–0.451	–0.678	–1.360	1.781	0.574	0.614	0.902
1973	–1.007	–0.450	–0.732	–1.391	1.712	0.585	0.560	0.899
1974	–0.984	–0.450	–0.779	–1.812	1.559	0.600	0.516	0.856
1975	–0.987	–0.456	–0.760	–2.017	1.609	0.657	0.533	0.836
1976	–1.123	–0.490	–0.667	–1.861	2.007	0.726	0.626	0.851
1977	–1.400	–0.532	–0.653	–1.954	2.510	0.766	0.643	0.842
1978	–1.237	–0.540	–0.665	–2.440	2.227	0.772	0.629	0.797
1979	–1.176	–0.544	–0.657	–3.102	2.112	0.775	0.637	0.737
1980	–1.365	–0.569	–0.664	–2.738	2.450	0.790	0.629	0.770
1981	–1.376	–0.544	–0.629	–2.532	2.469	0.775	0.673	0.788
1982	–1.647	–0.530	–0.604	–2.181	2.910	0.764	0.714	0.821
1983	–1.997	–0.540	–0.611	–1.927	3.452	0.772	0.699	0.845
1984	–1.588	–0.518	–0.635	–1.686	2.816	0.755	0.665	0.868
1985	–1.329	–0.480	–0.658	–1.431	2.388	0.713	0.637	0.894
1986	–1.415	–0.468	–0.654	–1.304	2.535	0.691	0.641	0.909
1987	–1.541	–0.454	–0.636	–1.197	2.741	0.645	0.664	0.922
1988	–1.439	–0.471	–0.693	–1.078	2.575	0.476	0.599	0.944
1989	–1.614	–0.561	–0.792	–1.065	2.857	0.259	0.505	0.955
1990	–1.848	–0.672	–0.858	–1.078	3.223	0.057	0.448	0.960
1991	–1.572	–0.769	–1.021	–1.085	2.790	-0.105	0.316	0.961
1992	–1.015	–1.031	–1.321	–1.063	1.739	-0.515	0.089	0.953
1993	–1.045	–1.902	–2.277	–1.185	1.374	-1.796	-0.597	0.924
1994	–1.126	–2.560	–3.250	–1.464	1.306	-2.743	-1.281	0.891
1995	–1.072	–2.529	–2.791	–1.236	1.346	-2.698	-0.959	0.917
Mean 71–95	–1.073	–0.451	–0.725	–1.307	1.896	0.629	0.567	0.908

Timber-for-layers imports appear to have been most elastic to own price changes during the 1978–1982 period. Thereafter, their own price elasticity steadily drops (remaining, however, within the elastic range) over the 1983–1992 period, but exhibits a higher elasticity after 1992. In the case of fuelwood imports, the own price elasticity is in the area of unity during the first half of the 1970's. It becomes increasingly more elastic (with variations, nonetheless) thereafter, but it is turning to less elastic (fairly close to unity) after 1991.

Regarding cross price relationships among the timber imports examined, Table 2 indicates complementarity in the cases of fuelwood for unprocessed timber and fuelwood for processed timber. Substitutability appears in the cases of unprocessed timber for timber-for-layers and processed timber for timber-for-layers. Thus, 1% increases in import unit values of unprocessed and processed timber appear to cause *ceteris paribus,* average drops of 0.409 and 0.369 percent in the volume of fuelwood imports, respectively. On the other hand, an 1% increase in the import unit value of timber-for-layers appears to cause an average increase of 0.069 percent in the volume of unprocessed timber imports. Similarly, the same increase appears to cause *ceteris paribus* an average increase of 0.466 percent in the volume of processed timber imports.

Average expenditure elasticities (also appearing in Table 2) indicate that on the average, and for the period examined, fuelwood imports are expenditure-elastic, while timber imports are expenditure-inelastic. Moreover, inspection of Table 4 reveals that in the context of wood imports, fuelwood is consistently expenditure-elastic throughout the period examined. In addition, fuelwood imports appear to be highly responsive to changes in the aggregate expenditure allocated to wood imports, during the second half of the 1970s and throughout the 1980s; they become however increasingly less responsive in the first half of 1990s. Unprocessed and processed timber imports are steadily inelastic with respect to aggregate expenditure on timber imports throughout the 1970s and 1980s. In the first half of the 1990s however, they become abruptly less expenditure-elastic and eventually turn into inferior goods during the last periods. This may well be related to the sharp decline in the country's construction activity, observed throughout the 1980s. To the extent that demand for timber used in construction dropped, following the decrease in construction activity, less of the country's expenditure on wood imports was allocated to imported timber used in construction. On the other hand, demand for timber-for-layers imports is consistently inelastic throughout the 1971–1995 period with relatively steady expenditure elasticity.

These expenditure elasticity estimates are in accordance with, first, the heavy reliance of the domestic wood-using industry on foreign (imported) inputs and, second, the composition of wood types, produced domestically. More precisely, as domestic wood production consists largely of fuelwood, the country's demand for *imported* fuelwood is naturally sensitive to expenditure changes; that is, this demand changes by a larger amount to a given change in the aggregate expenditure the country allocates to the four wood imports examined here. By contrast, the lack of domestically produced timber makes the country's demand for imported timber insensitive to changes in the aggregate expenditure it allocates to wood imports.

The average Morishima elasticities of substitution (shown in Table 3) indicate that substitutability prevails among wood imports. The highest degree of substitutability appears in the case of timber-for layers for each of the remaining wood imports, given a change in their import price — as shown in the last line of Table 3. By contrast, the lowest degree of substitutability appears in the case of unprocessed timber for each of the rest wood imports, given a change in their import price (third line of Table 3). The most stable degree of substitutability appears in the case of the fuelwood for processed timber (and vice versa) which remains the same despite import price changes of either fuelwood or processed timber imports. Finally, the largest degrees of substitutability appear in the ratios of the rest of wood imports to timber-for-layers, given a change in its import price (shown in the far right column of Table 3).

An efficient way to show the evolution of Morishima elasticities of substitution during 1971–1995 is through graphs. In Figure 1, graphs (a) through (d) depict the time paths of four such elasticities, namely, the Morishima elasticities of substitution: (a) between unprocessed timber and fuelwood with respect to the import price of fuelwood, (b) between timber-for-layers and unprocessed timber with respect to the import price of unprocessed timber, (c) between timber-for-layers and processed timber with respect to the price of processed timber, and (d) between fuelwood and timber-for-layers with respect to the price of timber-for-layers. As shown in (a), changes in the import price of fuelwood appear to have caused a considerably varying degree of substitution in the ratio of unprocessed timber to fuelwood until 1991. During 1991–1995 these elasticities of substitution fall, thus suggesting falling

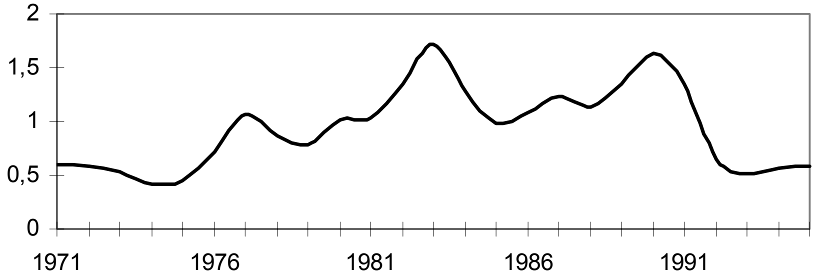

FIGURE 1A. TIMBER — U FOR FUELWOOD WITH RESPECT TO IMPORT PRICE OF FUELWOOD.

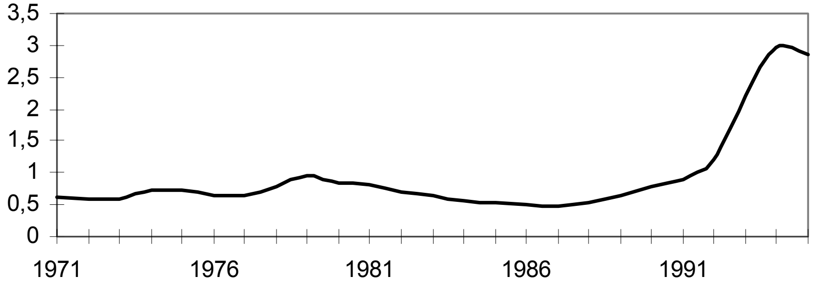

FIGURE 1B. TIMBER — L FOR TIMBER — U WITH RESPECT TO IMPORT PRICE OF TIMBER — U.

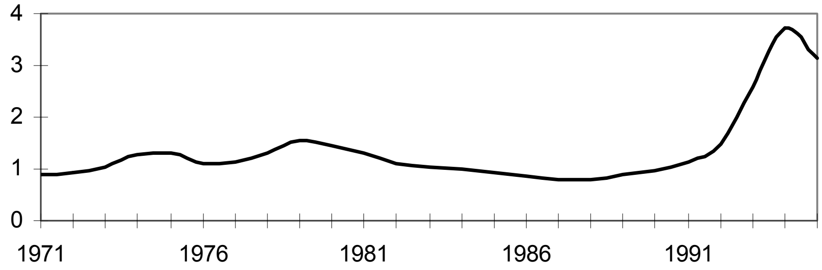

FIGURE 1C. TIMBER — L FOR TIMBER — P WITH RESPECT TO IMPORT PRICE OF TIMBER — P.

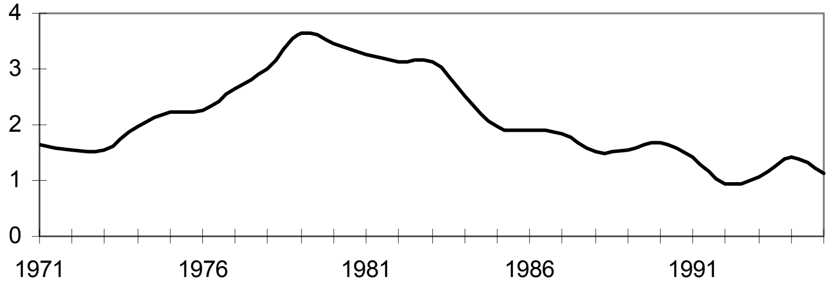

FIGURE 1D. FUELWOOD FOR TIMBER — L WITH RESPECT TO IMPORT PRICE OF TIMBER — L.

substitution possibilities between unprocessed timber and fuelwood imports. Changes in the import price of unprocessed timber — graph (b) — imply relatively stable degrees of substitution between timber-for-layers and unprocessed timber until the late 1980s; thereafter, sharp increases in these substitution possibilities appear. The same path also appears in the case of substitution possibilities between timber-for-layers and processed timber, due to changes in the import price of processed timber — graph (c). By contrast, the substitution possibilities in the ratio of fuelwood to timber-for-layers, due to changes in the import price of timber-for-layers, while rising in the 1970s fall sharply throughout the 1980s, but stabilize in the first half of the 1990s. In all cases, the patterns of these elasticities of substitution σ_{ij}^{M} are primarily shaped by the time paths of the value shares of both the imports i and j, involved. This is easy to see if one recalls that $\sigma_{ij}^{M} = \varepsilon_{ij} - \varepsilon_{jj}$ and the compensated elasticities ε_{ij}, ε_{jj} are computed as ratios of fixed parameter estimates divided by the respective value shares w_i and w_j.

Utilising the Results in Policy Analysis

The empirical results presented above may be utilised in policy analysis relating to wood trade issues in a number of ways. First, the expenditure and uncompensated price elasticities can be used as inputs in constructing trade models to investigate either the magnitude of wood trade flows or to compute the cost and benefits associated with policies altering (directly or indirectly) the price or the quantity of wood inflows to the Greek wood industries. This is because trade elasticities are essential in modelling import demand, calculating changes in consumer surplus, or computing trade protection measures.[5] Second, they may be used as exogenous information in more detailed (i.e., disaggregated) empirical analyses of the Greek import demand for wood — both in the form of intermediate and final products — along the lines of a multistage approach with regard to the expenditure allocations. Third, our

[5] For instance, the Trade Restrictiveness Index (T.R.I.) developed by Anderson and Neary to measure the degree of trade protection — associated with distortions in a number of traded products — as a single index number requires information on price elasticities of demand and supply or import elasticities to aggregate over the individual trade distortions — e.g., Anderson & Neary (1992, 1994).

empirical results may be directly used for partial equilibrium simulations, in the following fashion.

Individual elasticities measure a commodity's response to price or expenditure changes ceteris paribus; therefore, they have the limitation of being only partial measures of change. Thus, they are not particularly helpful in identifying the change in the quantity demanded when more than one prices change at the same time. However, the differential demand models shown earlier can be readily transformed to analyze demand changes in the presence of simultaneous price (or expenditure) changes. More exactly, the *i*-th demand equation of the CBS model (i.e., Equation (1), above) can be rewritten as[6]:

$$d\log q_i = (\eta_i + 1)\left(d\log M - \sum_j^n w_j d\log p_j\right) + \sum_j^n \varepsilon_{ij} d\log p_j \quad (5)$$

or

$$\frac{\Delta q_i}{q_i} = (\eta_i + 1)\left(\frac{\Delta M}{M} - \sum_j^n w_j \frac{\Delta p_j}{p_j}\right) + \sum_j^n \varepsilon_{ij} \frac{\Delta p_j}{p_j} \quad (6)$$

where M is the aggregate monetary expenditure on all four wood imports included in the model, ε_{ij} are the compensated (Slutsky) prices elasticities shown in Table 2, and $d\log x_i \approx \Delta x_i / x_i$, $x_i = M$, q_i or p_j, are the growth rates of aggregate expenditure, quantity demanded, and prices, respectively.

This re-arrangement allows the jointly estimated demand of imported fuelwood, unprocessed timber, processed timber and timber-for-layers to be simulated given more than one simultaneous changes in prices. Consider for instance a simultaneous 1% increase in the import unit value (used here as the price) in all four wood categories examined — resulting, say from a re-alignment in the country's exchange rates. Using Equation (6) it is easy develop a four demand equation system spreadsheet

[6] Equation (6) can be obtained by dividing through Equation (1) by w_i and noting that the logaritmic differential of the aggregate expenditure $M = \sum_i^n p_i q_i$ is $d\log M = \sum_i^n w_i d\log p_i + \sum_i^n w_i d\log q_i = \sum_i^n w_i d\log p_i + d\log Q$, where $d\log Q$ is the volume Divisia index.

utilizing the expenditure and the price elasticities, shown in Table 2. The respective computations show that - taking into account the own and cross price elasticities as well as the expenditure elasticities — a simultaneous 1% increase in the import price of all four wood categories examined here reduce: imported fuelwood by 2.9%, imported unprocessed timber by 1.63%, imported processed timber by 1.62% and imported timber-for-layers by 1.9%. In other words, a simultaneous 1% increase in all four import prices would reduce fuelwood imports by almost 3 times, imports of timber-for-layers almost twice, and imports of unprocessed and processed timber by 1.5 times. Various other simulations involving simultaneous changes in two or three prices and/or in the aggregate expenditure *M* may also be considered, in this analytical framework.

Concluding Remarks

This study investigates empirically the Greek aggregate demand for four major types of wood imports using a flexible CBS model. Our empirical results indicate that fuelwood and timber-for-layers are own price elastic, while unprocessed and processed timber imports are (for most of the period examined) own price inelastic. Regarding cross price effects, imports of unprocessed and processed timber co-vary with the import price of fuelwood. On the other hand, changes in the import price of timber-for-layers imports seem to cause (on average) the demand for unprocessed and processed timber imports to move *ceteris paribus* in the opposite direction.

Fuelwood imports are elastic with respect to their expenditure, while timber imports are inelastic. To the extent that information about the past may be used as a guide for the future, one may expect firms importing fuelwood to face the largest increase in demand, given an increase in the aggregate expenditure allocated to wood imports, *ceteris paribus*. Importers of unprocessed and processed timber would face a much lesser increase in demand. Finally, importers of timber-for-layers into the country would face, *ceteris paribus*, an increase in demand by an amount almost equal to the given increase in the aggregate (country) expenditure for wood imports. This finding points out the types of wood most likely to lead wood imports into the country. Thus, combined with insights about the country's market structure in wood imports -which is beyond the scope of the present study- may offer useful information on the economic repercussions of altering the existing forest management and/or forest trade policies.

Moreover, our findings on the elasticities of substitution between the types of imports examined, suggest that changes in the import price of timber-for-layers offer the highest substitution possibilities; changes in the import price of unprocessed timber on the other hand offer the lowest substitution possibilities among wood imports. Over time, changes in the import price of unprocessed and processed imports appear to have increase the substitution possibilities between the former and the rest of wood imports; the opposite appears to be true for the import prices of fuelwood and timber-for-layer imports.

Our empirical results may be utilised in policy analyses related to forest trade in a number of ways including their use as building blocks in developing, trade models or as inputs in measuring the costs and benefits associated with changes in trade or domestic policies related to forest products. They may also be used as exogenous information in more detailed (i.e., disaggregated) empirical analyses of the Greek import demand for wood — both in the form of intermediate and final products — along the lines of a multistage approach.

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