AN ABSTRACT OF THE THESIS OF

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Title: AN ECONOMIC ANALYSIS OF PULP, PAPER AND BOARD EXPORTS FROM THE PACIFIC NORTHWEST

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Abstract approved: Robert O. McMahon

The objective of this study is to investigate those economic considerations that may limit the ability of the Pacific Northwest's pulp and paper industry to compete with other regions producing pulp, paper and board for world markets.

The share of the Pacific Northwest and the United States in world trade of pulp, paper and board, together with products exported and their destinations, are presented first.

A review of the literature on demand analyses for paper and board provided a framework for specifying a demand equation. However, more insight into phenomena of substitution threatening exports or domestic demand for paper and board was gained by gathering information of increased exports of chips from the Pacific Northwest, greater use of hardwood pulp, recycling of waste paper and the development of synthetic fibers and papers. The extent to which pulp, paper and board products from the Pacific Northwest are differentiated on the basis of the wood species used was also considered.

Comparison of the competitive advantage of the Pacific Northwest, Finland, Sweden, the Southern United States and East and West Canada showed that the Pacific Northwest has a competitive advantage -- defined as the difference between the C.I.F. price and total cost (production plus transportation costs) -- in the shipment of kraft linerboard to Japan and, if economies of scale are achieved, to Europe also. The same results would be obtained for bleached kraft pulp and newsprint.

Planned investments for the period 1969 to 1974 in several regions of the world were presented to see whether or not this additional information would confirm the results of the comparison of competitive advantage, assuming that investment will be attracted where competitive advantage is the greatest. It appears that in the immediate future the United States will have a lower rate of growth than other regions of the world, and that the Pacific Northwest will attract less investment than the rest of the United States. The discrepancy between the results of the study of competitive advantage and the location of planned investments was explained by the cost differential existing between the Pacific Northwest and British Columbia and the low profitability in the pulp and paper industry due to world excess capacity. This excess capacity was verified by comparing estimates of world consumption and production capacities for all pulp grades from 1971 to 1975, and for kraft linerboard from 1971 to 1973.

In order to obtain a better framework for specifying an econometric model, and also to relate its implications to the existing behavior of the industry, a review of marketing practices was undertaken. This showed that the major producers have some ability to control price by reducing production, that product differentiation exists based on brands and that integration is frequent between producer and foreign customers through the purchase of foreign subsidiaries.

A quarterly econometric model from 1961 to 1969 was developed explaining prices and exports of kraft linerboard from Sweden and the United States to Germany and the United Kingdom, as well as price and quantities demanded in the US market. This product and these countries were selected because kraft linerboard is the major US pulp, paper and board export commodity and the countries considered are the two largest exporters and the two largest importers of this product in the world. The model was useful from two standpoints: (1) it provided information for planning regional marketing strategies, such as investment planning in the Pacific Northwest, and for determining effects of tariff, cost factors and freight increases on price and quantities traded, and (2) it was able to forecast prices and quantities demanded in the US domestic market and international trade flows.

Finally, implications of the study are summarized for the building of econometric models and for pulp and paper export prospects of the Pacific Northwest. Also, some important steps to consider in the planning of marketing strategy are pinpointed.

An Economic Analysis of Pulp, Paper and Board Exports From the Pacific Northwest

by

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AN ECONOMIC ANALYSIS OF PULP, PAPER AND BOARD EXPORTS FROM THE PACIFIC NORTHWEST

I. INTRODUCTION

Discrepancies between locations of accessible forest resources and areas of pulp and paper consumption have given rise to substantial international trade representing about 15 percent of the total world production of paper and paperboard (Organization for Economic Cooperation and Development (OECD), 1970).

Among the regions of the United States participating in this world trade, the Pacific Northwest (including the States of Washington, Oregon, Idaho and Montana) has been one of the most export oriented in that it ships abroad a higher percentage of its pulp and paper production than other US producing regions (which include the South and the East of the United States).

In the coming years, however, this region may be facing a reduction of its foreign markets. Additional pulp and paper capacity is being built in British Columbia, Latin America and Scandinavia to meet increasing world demand. The annual increase in capacity in these regions from 1970 to 1973 is forecast at about 5 percent, while for the United States it is 2.5 percent (Food and Agriculture Organization (FAO), 1969). This new US capacity will be constructed primarily in the Southeastern States and to a much less extent in the Pacific Northwest (Slatin, 1969; Pollitzer, 1972). This casts doubt on the ability of the Pacific Northwest to keep its share and to compete effectively in world markets in the near future.

This situation certainly cannot be due to a lack of raw material as 1.8 million bone-dry short tons of pulp chips were exported from the Pacific Northwest in 1970 (Darr, 1971). The question then arises: Is the Pacific Northwest headed toward a position of lesser importance in the US pulp and paper industry and, consequently, in foreign trade of pulp and paper? What factors are responsible for this situation? Can this region expect to maintain its share of world trade?

The objective of this study is to investigate those economic considerations that may limit the ability of the Pacific Northwest's pulp and paper industry to compete with other regions producing pulp, paper and board for world markets.

To pursue such an objective an econometric approach is adopted, as a mathematical model is useful for directing the collection of relevant data and for explaining economic phenomena underlying the international trade of pulp and paper. It can be used also for exploring the effects of factor changes, searching for optimal courses of action for exporters, and for estimating future levels of trade. The model will be accepted if it yields statistically valid and meaningful predictions about trade flows and rejected if it does not.

Results of the study should be of interest to exporters and importers, to producers for making future plans and investments and to governmental agencies whose decisions concerning tariffs and taxes might affect the competitive advantage of a particular region.

According to the literature, no real attempt has been made to explain econometrically the interrelationships of international trade flows of pulp and paper. Approaches usually taken are based on analyses of trends without attempting to use mathematical techniques (Guthrie, 1950, Hunter, 1952). Only the Wohlenberg (1966) study used a linear programming transportation model whose objective function minimized manufacturing and transportation costs. His model was applied only to trade between Canada and the United States and no attempt was made to incorporate trade with other countries.

On the other hand, econometric studies of international trade including all commodities have been undertaken.

One of the simplest models for analyzing flows between individual countries was formulated by Tinbergen (1962). According to this model, the value of trade between any two countries is determined by income in each country and by geographical distances between them. This model has been modified and extended by both Linneman (1966) and Waelbroeck (1961).

Linneman modifies the model by including populations of the importing and exporting countries as separate variables. However, he omits prices because his is a cross-sectional model. Waelbroeck, on the other hand, introduced prices, making his model more useful for analytical purposes.

Other models have been developed seeking primarily to establish the main relationships between the level of domestic economic activities and foreign trade in various countries so as to see how fluctuations in the former affect the latter. Metzler (1950) focuses attention on changes in investment, Neisser and Modigliani (1953) on income and capital flows, and Polak (1953) on autonomous investment and price changes. Rhomberg and Boissonneault (1964) developed a more complete model where income, capacity and also prices are the exogenous variables. More recently, a model has been developed by Adams (1969) involving other exogenous variables such as relative competitiveness, pressure of demand and excess inventory measure. These variables, and others, can be incorporated in a model presented by Armington (1969) which assumes that a product is distinguished not only by its place of production but also by its place of demand. According to this model, international trade flows can be represented by a set of demand and supply relationships.

This combination, appearing to be relevant in the case of international trade of pulp, paper and board, has been used in this study.

Because the Pacific Northwest is only a small segment of the total world picture which must first be understood, the model will be applied to total US exports of pulp, paper and board; nevertheless, considerable effort will be devoted to drawing inferences about the competitive ability of the Pacific Northwest and economic conditions that will affect future export levels from this region.

However, as the model is based on supply and demand relations, factors affecting demand and supply will be reviewed first, together with marketing practices in the international trade of pulp, paper and board, as these latter help in specifying the model and interpreting its implications.

The purpose of Chapter II is to pinpoint what has been the position of the United States and Pacific Northwest in the world trade of pulp and paper. The review will consider which regions of the world are net importers or net exporters, what has been the trend over time of the foreign trade of these regions, which products have been the most exported from the United States and the Pacific Northwest and to which destinations, and what is the share of the United States and the Pacific Northwest in the imports of selected world areas.

In Chapter III factors affecting demand for pulp, paper and board will be investigated as a preliminary to specifying a demand equation for the econometric model that is consistent with real world conditions and relationships. For this purpose, answers to several questions will be sought: What implications can be drawn from demand studies already done in the field of pulp and paper? As the Pacific Northwest and the United States export specific qualities of pulp, paper and board, what are the possibilities of substitution between pulp qualities? What are the trends in pulpwood exports? What are the effects of the recycling of waste paper on demand for pulp? How is the development of synthetic fibers and papers going to affect demand for pulp and paper?

In Chapter IV, factors influencing supply are analyzed. A review of international trade theories is used as a guide for determining causes of trade. Then the competitive positions of areas supplying pulp, paper and board to Germany and Japan -- countries representative of two major importing regions -- are examined. The competitive position of each supplying area is determined (1) directly, by estimating the margin (gross profit) from exporting pulp, paper and board to Europe and Japan and (2) indirectly by analyzing the location of new capacity to be installed from 1971 to 1975 to meet increasing world demand. In Chapter IV also, estimated consumption of pulp and kraft linerboard by world area is compared with world capacity increases from 1971 to 1975 to indicate whether the Pacific Northwest will still have potential foreign markets at the prevailing price.

In Chapter V product differentiation, channels of distribution and pricing policy are reviewed in order to provide a better framework for specifying an econometric model, and also to relate its implications to the behavior of the international trade of pulp and paper.

In Chapter VI the information gathered in the preceeding chapters is integrated with economic concepts in the specification of a general model of the international trade of a particular pulp and paper product: kraft linerboard. The model will be applied to a study of North American-Scandinavian competition in the UK and German markets for the years 1961 through 1969.

In the final chapter, implications of the study are summarized with their bearing on the initial questions posed in the introduction and on the pulp and paper export prospects of the Pacific Northwest.

II. POSITION OF THE UNITED STATES AND THE PACIFIC NORTHWEST IN WORLD TRADE OF PULP, PAPER AND BOARD

In this chapter pulp, paper and board markets of the United States, the Pacific Northwest and competing countries are analyzed in terms of net imports and exports. Next are presented the chief pulp, paper and board exports from the United States and the Pacific Northwest, the importance of US and Pacific Northwest exports in relation to production, the destinations of exports, and finally the share of the United States and the Pacific Northwest in imports of selected world areas.

The United States' Share of World Trade in Pulp, Paper and Board

World Trade Picture

The total world pulp, paper and board production reached 236 million tons in 1970 (World Review, 1971), of which 17 percent crossed international borders to reach its final place of consumption. Table 1 shows the importance of different world areas in the production of pulp, paper and board. The United States is in the lead, producing more than 36 percent of the world total, followed by Canada and the three countries of Northern Europe: Finland, Norway and Sweden. Considered as a whole, North America is a surplus area (if the difference between exports and imports is negative, the country is said to have a deficit; if positive, it is said to be a surplus area). In Europe, the only net exporters of pulp, paper and board are Finland, Norway and Sweden. The remaining continents -- Africa, Asia and Oceania -- are deficit areas. Only the

Table 1. Production, imports and exports of pulp, paper and board by main geographic regions and comparison of foreign trade with production for each region, 1970.

Region	Pulp, paper and board production		Imports		Exports		Ratio of exports plus imports to production
			Wood pulp	Paper and board	Wood pulp	Paper and board	
	1,000 Metric[a] tons	Percent	1,000 Metric tons		1,000 Metric tons		Percent
North America	113,669	48.0					
USA	85,897	36.3	3,869	7,993	3,404	3,126	17.7
Canada	27,772	11.7	50	245	6,421	9,027	46.9
Europe	66,855	28.3					
Finland, Norway & Sweden	26,613	11.3	190	193	796	7,335	54.9
EEC	20,692	8.7	5,384	5,747	335	2,320	66.6
United Kingdom	5,411	2.3	2,738	2,505	-	229	101.1
Other	14,139	6.0	1,568	2,364	698	1,960	46.6
USSR	13,418	5.7	250	349	391	473	9.8
Asia and Oceania	34,820	14.7					
Japan	21,774	9.2	913	99	12	507	7.0
Other	13,046	5.5	980	2,937	168	299	33.6
Latin America	5,896	2.5	615	2,001	134	205	50.1
Africa	1,802	0.8	142	900	414	117	87.3
TOTAL	236,460	100.0					

Source: World Review, 1971.

[a]1 Metric ton = 1.102 short tons.

USSR is self-sufficient.

The importance of foreign trade for each area is expressed by taking the ratio of total imports and exports over the production of the respective country or region (last column of Table 1). The United Kingdom has the highest ratio, showing its high degree of dependence on foreign imports in relation to production. Canada, Finland, Norway and Sweden depend heavily on exports, while Africa, Latin America and in particular the European Economic Community (EEC) depend on imports (the EEC includes Belgium, France, Germany, Italy, Luxembourg and the Netherlands but not the United Kingdom as at the time of writing negotiations were not yet concluded). The low ratio for the United States indicates the extent to which domestic production overshadows foreign trade.

Figure 1 is a dynamic description over time of the net trade balance of several world areas plotted on a semilog basis for direct comparison of rates of change. If the difference between exports and imports of a country or region is positive, the export is shown by a solid line; if negative the import surplus is represented by a dashed line. Since 1948, the rate of increase in exports from Norway, Finland and Sweden has been greater than that of Canada, showing the eagerness and ability of these countries to export. Among the countries with an import surplus, the EEC is by far the fastest growing net importer. The United Kingdom's imports are also growing, but at a much slower pace. The only country with a decreasing import surplus is the United States. Explaining this trend requires knowledge of the production of pulp, paper and board in the United States as well as its foreign trade composition.

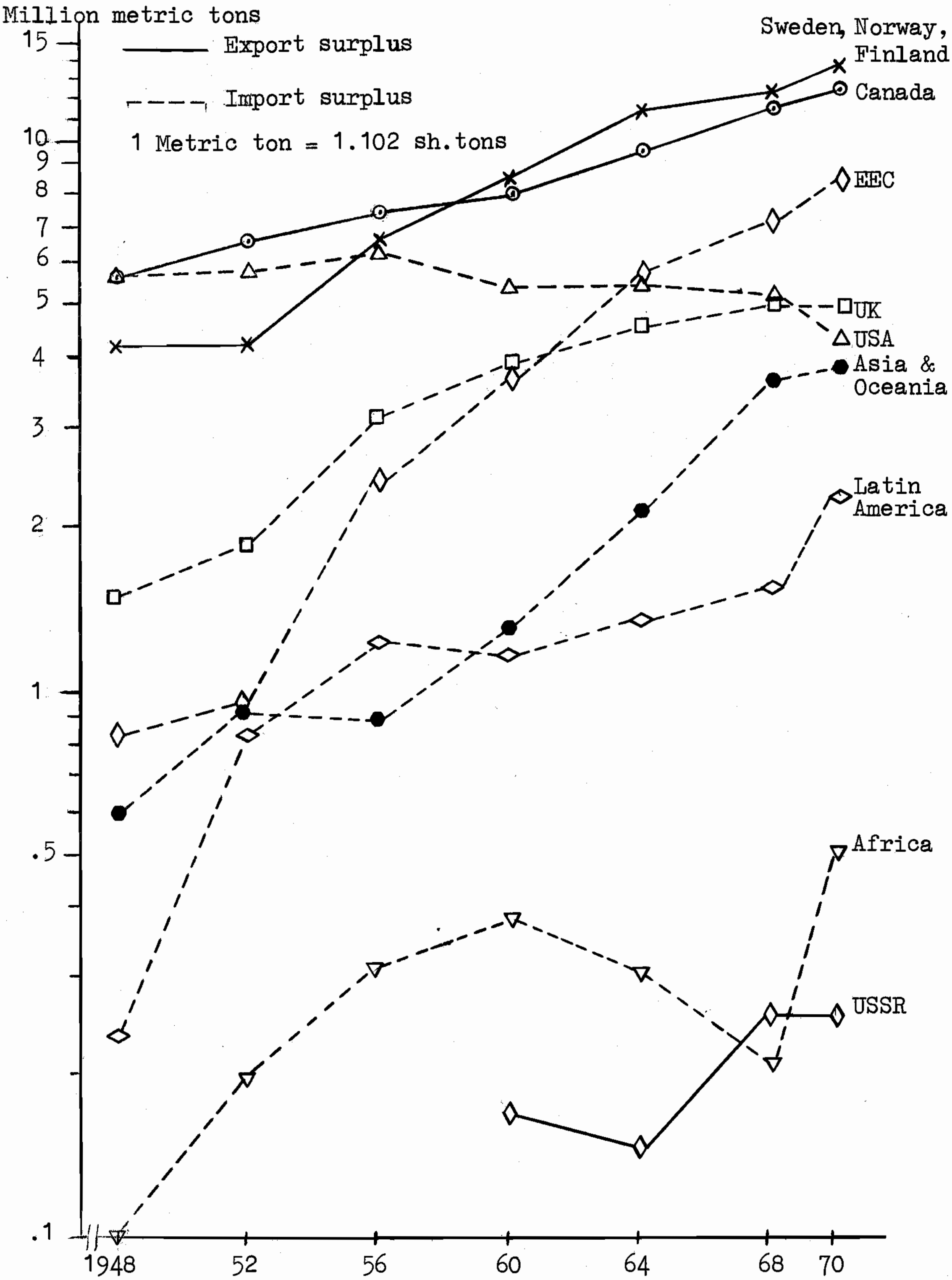


Figure 1. Import or export surplus of pulp, paper and board in different world areas, 1948–1970.

Source: FAO, 1948–1969; World Review, 1971.

US Pulp, Paper and Board Production

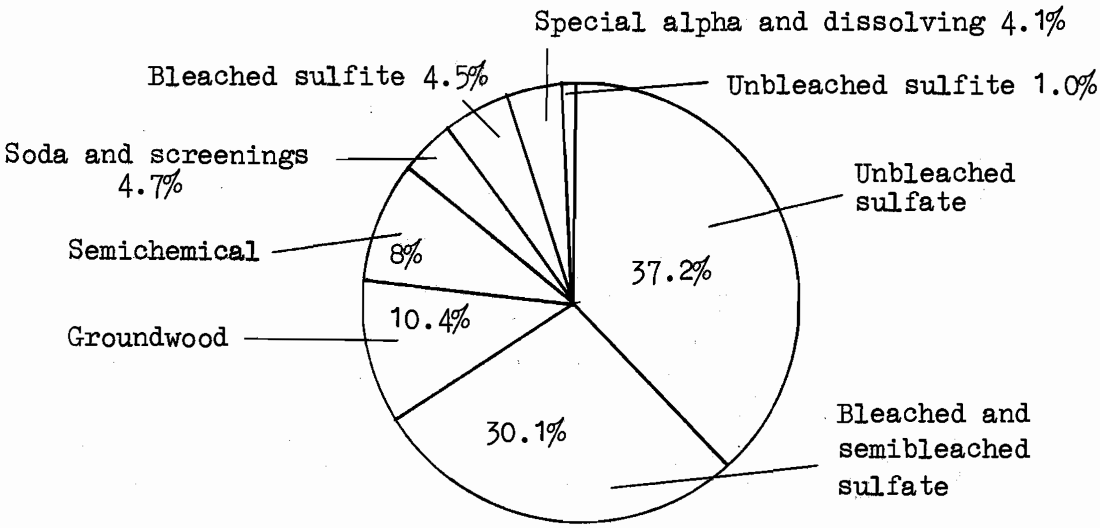
Figures 2 and 3 give a background of pulp, paper and board production patterns in the United States. Definitions of the products are given in Appendix A. Among pulp grades, unbleached sulfate pulp is the principal one produced followed by bleached and semi-bleached sulfate pulp, groundwood, semi-chemical pulp, bleached sulfite pulp, special alpha and unbleached sulfite pulp.

Printing and writing papers, excluding newsprint, rank first among different types of paper products. Packing and industrial paper is the next most important category. For paperboard, kraft linerboard and corrugating medium are the principal commodities.

US Foreign Trade of Pulp, Paper and Board

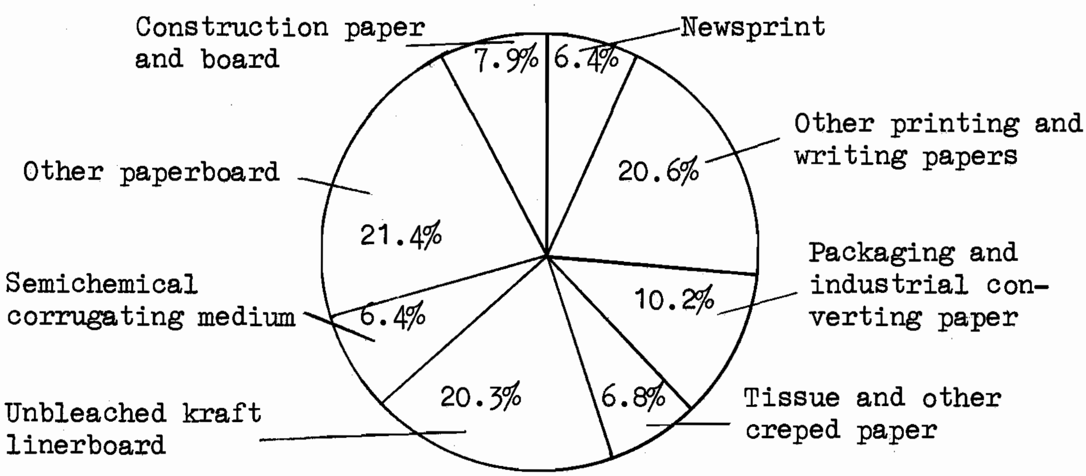
The geographic distribution of 1970 exports is shown in Figure 4. Western Europe as a whole takes 48 percent of total US exports. The six nations of the EEC, if considered as a single entity for trade, represent by far the chief foreign market for products of the US paper industry. After the EEC, in decreasing importance, come the Asiatic countries, the countries of the European Free Trade Association (EFTA, including Austria, Denmark, Finland, Norway, Portugal, Sweden, Switzerland and the United Kingdom), Central America and South America.

Kraft linerboard in 1970 was the major US export item (Figure 5), followed by bleached sulfate pulp, dissolving pulp, waste paper, bleached sufite pulp, unbleached sulfite pulp, newsprint and boxboard. These eight items represented 86 percent of total US exports of pulp, paper



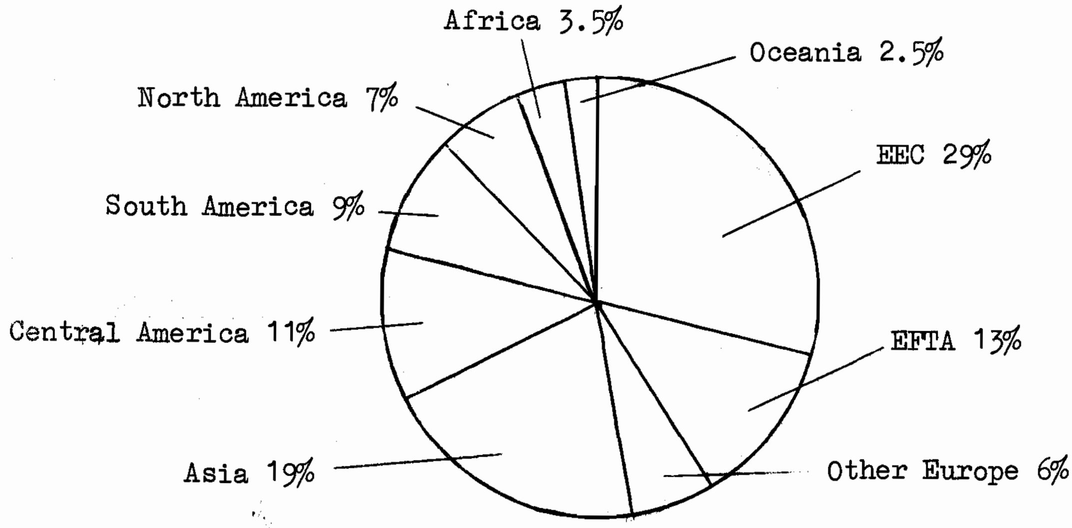
Total pulp grades: 41,806 thousand short tons.

Figure 2. US wood pulp production in 1970.
Source: Smith, 1971, p. 34



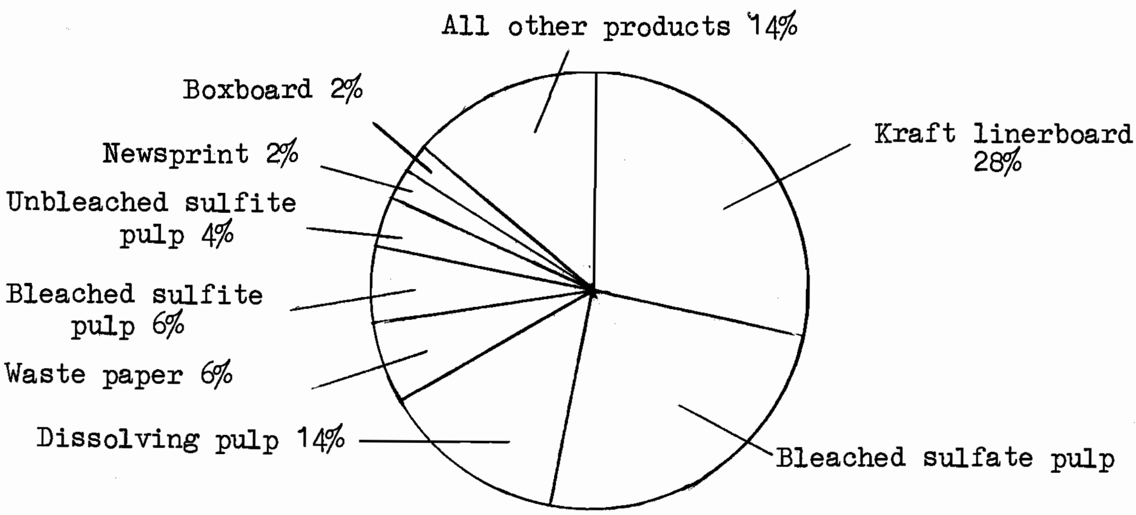
Total paper and board production: 52,452 thousand short tons.

Figure 3. US production of paper and board in 1970
Source: Smith, 1971, p. 37.



Total exports: 6,400,000 short tons.

Figure 4. US exports of pulp, paper and board by destination in 1970.
Source: Smith, 1971, p. 8.



Total exports: 6,400,000 short tons.

Figure 5. US exports of pulp, paper and board products in 1970.
Source: Smith, 1971, p. 9.

and board in 1970. Among the rest were kraft wrapping paper, kraft shipping sack paper, coated book paper and special industrial paper, corrugating medium, fine coated groundwood paper, special food board, cotton pulp and unbleached sulfite pulp.

The relative importance of exports and imports as compared to US production is illustrated in Figure 6. Among imports, the major item is newsprint, for which the equivalent of 196 percent of US production is imported and 4 percent exported. The principal export commodities having a positive trade balance or export surplus are dissolving and special alpha pulp, kraft linerboard and to a lesser extent waste paper.

Canada is the principal supplier of pulp, paper and board products to the United States, providing 94.4 percent of US import requirements. Other countries of origin, in decreasing importance, are: Finland, South Africa and Sweden (US Department of Commerce, 1971, p. 37).

The Pacific Northwest's Share of World Trade in Pulp, Paper and Board

Pulp, paper and board exports from the Pacific Northwest region in 1969 reached 100 million dollars, 9 percent of the total exports of this region. From the Oregon customs district alone, which includes ports of the northern bank of the Columbia River, pulp, paper and board exports counted for 20 percent of the total exports from Oregon.

Ten percent of the pulp, paper and board production of the Pacific Northwest was exported in 1969 (Northwest Pulp and Paper Association, 1971). These exports counted for 23.2 percent of the total pulp, paper and board exports of the United States, that is, 30 percent of total US

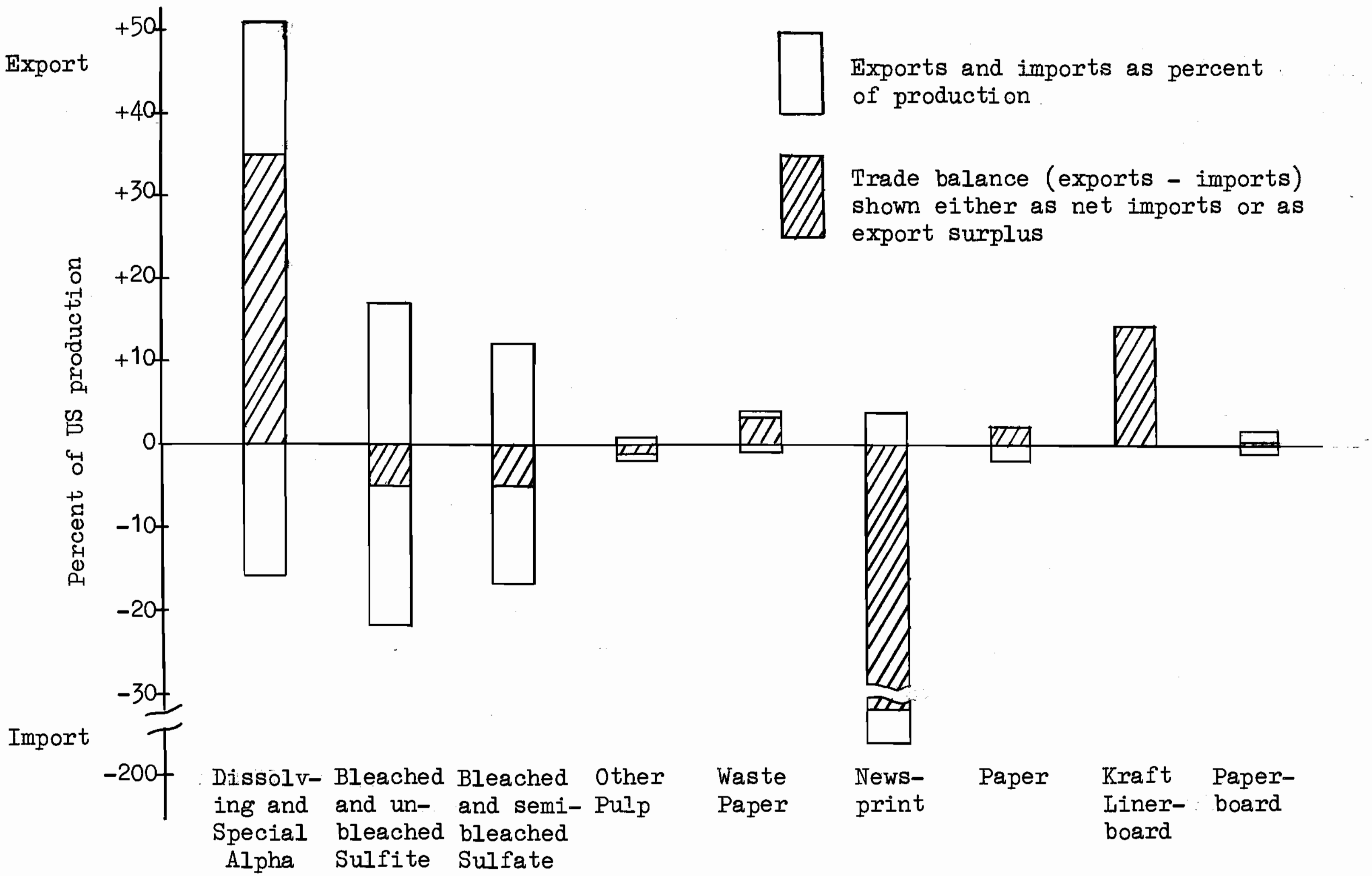


Figure 6. 1970 trade balance of pulp, paper and board products, shown in relation to US production of each item.
Source: Smith, 1971.

pulp exports and 16.6 of total US paper and board exports.

Among pulp, paper and board exports from Oregon and Washington, softwood pulp predominates. Only about 7,000 tons of hardwood pulp were exported from these states in 1969 (Table 2). In terms of quantity, bleached sulfite softwood pulp, alpha and dissolving pulp and kraft linerboard constitute the bulk of the exports.

Oregon and Washington export 94 percent of the total US exports of bleached sulfite pulp. Sulfate pulp is also exported, particularly unbleached sulfate which accounts for 43 percent of the total US exports of this item. Bleached and semi-bleached sulfate pulp exports are also substantial, their respective percentages of the US total being 26.9 and 39.8.

Of paper and board exports, kraft linerboard is predominant in terms of quantity -- more than 250,000 short tons are exported from Oregon and Washington, representing 15.3 percent of US exports in this commodity. The remaining paper and board exports, though not large in quantity, constitute a substantial part of total US exports -- 43.7 percent in the case of paper and 21.7 percent in the case of paperboard. Although the United States is an extensive importer of newsprint, some is also exported, probably to meet special orders abroad.

Besides the quantities exported from Oregon and Washington, it is necessary to know also their principal markets, which other regions of the United States export these commodities, and how the Pacific Northwest ranks among them. Such information is summarized in Tables 3 and 4 for five regions of origin: Washington and Oregon, California, the Gulf Coast, the Atlantic Coast and other states. The Gulf Coast region

Table 2. 1969 exports of pulp, paper and board from Washington and Oregon customs districts by volume, and percentage of total US exports of each product.

Product	From Washington[a] customs district	From Oregon[a] customs district	Washington and Oregon exports as percentage of US exports
	short tons	short tons	percent
Pulp, paper and board	512,377	488,563	23.2
Pulp	422,739	209,508	30.0
Alpha and dissolving	167,425	21,144	25.3
Sulfate, unbleached	54,692	-	43.1
Sulfate, bleached, hardwood	3,578	86	0.8
Sulfate, bleached, softwood	57,738	40,996	26.8
Sulfate, semi-bleached	9,668	50,943	39.8
Sulfite, unbleached	87	12,108	88.2
Sulfite, bleached, hardwood	781	2,715	52.3
Sulfite, bleached, softwood	128,770	81,516	94.0
Paper and board[b]	89,638	279,055	16.6
Newsprint	14,035	4,572	14.6
Kraft linerboard	28,430	231,532	15.3
Paper: wrapping, bag and converting, unbleached, kraft; kraft shipping sack; other kraft paper	23,886	31,728	43.7
Other kraft paperboard; paperboard: special including cardboard and other bending and non-bending board	23,287	11,223	21.7

[a]The Oregon customs district includes the north bank of the Columbia River.
[b]Only major commodities included, representing 81 percent of all US paper and board exports.

Source: US Bureau of the Census, 1969.

Table 3. US pulp exports by geographic origin and destination, 1969.

Destination	Oregon and Washington		California		Gulf Coast		Atlantic Coast		Other	
	1,000 Sh. tons	Per-cent	1,000 Sh. tons	Per-cent	1,000 Sh. tons	Per-cent	1,000 Sh. tons	Per-cent	1,000 Sh. tons	Per-cent
Canada	6	0.9	1	0.6	0	0.0	13	2.4	7	3.5
Central America	-[a]	0.1	-	0.0	68	11.5	12	2.3	-	0.2
South America	69	11.0	3	1.7	40	6.7	56	10.8	1	0.7
EFTA	68	10.8	3	1.7	147	24.9	80	15.5	-	0.2
EEC	161	25.5	47	30.0	193	32.7	237	46.5	1	0.4
Other Europe	11	1.7	0	0.0	72	12.2	42	8.1	3	1.2
Asia, Western area	0	0.0	3	1.7	-	0.0	3	0.6	0	0.0
Other Asia	277	44.1	98	62.5	57	9.7	55	10.7	196[b]	93.5
Australia & Oceania	35	5.6	-	0.2	13	2.1	3	0.6	-	0.0
Africa	2	0.3	2	1.6	1	0.2	13	2.5	-	0.3
TOTAL[c]	632	100.0	157	100.0	591	100.0	515	100.0	210	100.0

[a]Less than one thousand tons.
[b]Exported mostly from Alaska.
[c]May not add because of rounding.

Source: US Bureau of the Census, 1969.

Table 4. US paper and board[a] exports by geographic origin and destination, 1969.

Destination	Origin									
	Oregon and Washington		California		Gulf Coast		Atlantic Coast		Other	
	1,000 Sh.tons	Per-cent	1,000 Sh.tons	Per-cent	1,000 Sh.tons	Per-cent	1,000 Sh.tons	Per-cent	1,000 Sh.tons	Per-cent
Canada	23	6.3	0	0.0	0	0.0	163	18.8	71	97.7
Central America	45	12.2	13	45.3	189	21.5	63	7.2	1	1.3
South America	7	1.8	5	16.4	77	8.7	89	10.3	-[b]	0.0
EFTA	6	1.7	-	0.2	214	24.3	51	5.9	-	0.2
EEC	112	30.3	-	0.9	270	30.7	328	37.7	-	0.4
Other Europe	3	0.9	0	0.0	50	5.7	33	3.8	0	0.0
Asia, Western area	13	3.6	0	0.0	23	2.6	29	3.4	0	0.0
Other Asia	141	38.3	10	35.2	16	1.9	55	6.3	-	0.4
Australia & Oceania	10	2.6	-	1.0	8	0.9	5	0.6	0	0.0
Africa	8	2.3	-	1.0	33	3.7	52	6.0	-	0.0
TOTAL[c]	369	100.0	29	100.0	879	100.0	869	100.0	72	100.0

[a]Only major commodities included, representing 81 percent of all US paper and board exports.
[b]Less than one thousand tons.
[c]May not add because of rounding.

Source: US Bureau of the Census, 1969.

includes all customs districts from the Mexican border to the tip of the Florida peninsula and the Mississippi River. The Atlantic Coast region includes all customs districts along the Atlantic Ocean. The group "other states" includes Alaska and all customs districts along the American-Canadian border. Chosen destinations are the principal world markets.

Oregon and Washington's exports of pulp, paper and board go mostly to Asia and the EEC, while those of the Gulf Coast are directed to Central America, Europe and to a lesser extent to Australia and Oceania. Atlantic Coast exports go mostly to Europe and some to Canada. Dissolving pulp only is exported from Alaska and goes to the Asian countries. From the US interior shipments go mostly to Canada, while California exports only a modest volume.

It remains now to examine the US and Pacific Northwest shares of total imports of major world marketing areas (Table 5). Although the United States has larger relative shares of the Latin American, African and Asian and Oceanian markets, the combined volume exported to the EEC and United Kingdom nearly equals that of the first three areas, making the European market extremely important for the United States in absolute terms. The share of the Pacific Northwest in the imports of foreign countries is modest, the greatest share being in Asia and Oceania. Canada is the dominant supplier to Asia and Oceania, while Finland, Sweden and Norway have 50 to 70 percent of the European market.

Table 5. Proportion of total pulp, paper and board imports of major world market areas originating from the United States and the Pacific Northwest, 1969

Market area	Total imports	Proportion originating from			
		United States		Pacific Northwest	
	1,000 Sh.tons	1,000 Sh.tons	Percent	1,000 Sh.tons	Percent
EEC	8,470	1,348	15.9	273	3.2
United Kingdom	5,550	526	9.6	74	0.1
Asia & Oceania	4,180	1,051	25.1	476	11.4
Latin America	2,090	737	35.3	121	5.8
Africa	385	113	29.4	10	2.6

Sources: World Review, 1970; US Bureau of the Census, 1969.

Conclusion

The United States is a substantial exporter of kraft linerboard and pulp, particularly bleached sulfate pulp, but imports on the other hand large quantities of newsprint from Canada. Almost half of the US pulp, paper and board exports go to the European market.

The principal exporting regions of the world are Canada, Norway, Sweden, Finland and Russia, representing the major competitors of the United States and Pacific Northwest in the world market.

The Pacific Northwest ships 23.6 percent of total US pulp, paper and board exports, which represents 10 percent of pulp, paper and board production of this region. The Pacific Northwest is a predominant exporter to Asia and Oceania, but faces strong competition from the Gulf and Atlantic coasts in exporting to Europe. US exports to Latin America originate predominantly from the Gulf Coast.

In terms of total imports into major world market areas, the United States is not a dominant supplier to any of them. It supplies one fourth of the import requirements of Asia and Oceania, one third those of Latin America and Africa. Canada is the major exporter to Asia and Oceania while Sweden, Finland and Norway have a dominant position in the European market.

Imports originating from the Pacific Northwest are of much less importance to the major importing areas, except for Asia and Oceania where 11.4 percent of all import requirements come from the Pacific Northwest.

In terms of absolute volume, however, the EEC and United Kingdom are major markets for the United States, and are second in importance, after Asia, to the Pacific Northwest.

III. WORLD DEMAND FOR PULP, PAPER AND BOARD

This chapter aims at showing which factors might affect demand for pulp, paper and board products exported from the Pacific Northwest. This information will be useful (1) in understanding production in the Pacific Northwest and export patterns from this region and (2) in specifying a demand equation, for either foreign or domestic demand as both are related, for a particular pulp, paper or board commodity. It should be understood that all the information provided here, dealing with several products, is not only of direct interest in building the econometric model for kraft linerboard presented in Chapter VI but could also be used to specify a model for other pulp, paper and board commodities important to the foreign trade of the United States and the Pacific Northwest.

Demand theory conventionally specifies that for an individual consumer the quantity of a commodity consumed depends upon its price, prices of competing and complementary goods, individual incomes, population and factors that reflect changes in tastes and preferences. In the case of the several categories of pulp exported from Oregon and Washington, it is of particular importance to know which products compete with each other and why, as changing demand patterns in the world might lead to a shift from one product to another, greater shifts resulting from greater substitutability. Several types of substitution could occur: limitation of pulp, paper and board exports because of increasing chip exports; increasing substitutability between kraft pulp and sulfite pulp, leading to reduced production and thence to reduced exports of sulfite pulp from the Pacific Northwest; greater acceptance of hardwood pulp in the world, reducing the need for softwood pulp which is one of the major export commodities of the Pacific Northwest; changing demand patterns for dissolving pulp because of the development of substitutes; emergence on the market of synthetic papers and non-woven material, leading to lesser foreign demand for certain pulp, paper and board commodities; and the growing emphasis on environmental quality, leading possibly to a greater use of waste paper and consequently to less import needs on the part of consuming countries. All these phenomena will be reviewed in this chapter.

Demand patterns for specific paper and board products are a little more difficult to ascertain because of the numerous products and the rather differentiated characteristics of each. Consequently, future consumption of these products will be reviewed by presenting results of published forecasts and by specifying assumptions underlying these forecasts. From them foreign demand could be deduced for commodities exported from the Pacific Northwest.

Before studying the several phenomena of substitution that might affect exports of pulp, paper and board from the Pacific Northwest, however, the principal regional demand studies for these products will be reviewed to see how factors influencing demand, such as prices, income, technological change or taste preferences, were integrated in the several models. Results of the review are then applied in specifying the demand function of the econometric model presented in Chapter VI.

Review of Demand Analyses for Paper and Board

Because of rapid growth in demand for paper, board and wood pulp, businessmen and government administrators concerned with plant expansion in the industry, or with the adequacy of timber resources, have felt a continuous need for appraisals of future trends in demand. In response to this need, a series of demand studies have been prepared by public and private agencies. These studies can be grouped according to three prediction techniques: those using a single equation model, a multi-equation model or an input-output model.

The Single Equation Model

The bulk of demand studies have used this kind of model. The dependent variable, usually the consumption of a grade of paper or board, is a function of one or several independent variables. The form of the equation is D = f(x) where

D = the dependent variable

x = the independent variable(s)

f(x) = a specified form of relationship between the dependent and independent variable(s).

The term "projected demand" is defined in these studies as the volume of paper and board that will be consumed in the projection years if explicit and implicit assumptions concerning changes in population, economic activity, prices and other determinants of consumption are realized. The usual assumption concerning supply is that no significant change is anticipated in the relative price of the product in question during the projection period. This implicitly assumes a highly elastic long run supply curve.

As numerous models have been used over the past 20 years, a summary of the principal ones is given in tabular form (Table 5) to emphasize similarities and differences. These models differed not so much with respect to the explanatory variables as to the form of the relationship between consumption and independent variables. Selection of the type of equation in each case was made according to the purpose in hand and the relationships reflected in the historical data for the products in question.

Demand studies for the world or for extensive areas, including a large number of countries with a broad income spectrum, have shown a clear tendency for the elasticity coefficient to decrease with a rise in income level (FAO, 1960, p. 5). For this reason, several studies used a function implicitly including decreasing income elasticity (FAO, 1955, 1960, 1963; United Nations, 1963). In other studies (FAO, 1954; US Congress, House of Representatives, 1957), however, a constant elastic demand function was used, leading to higher projection levels, which were justified under the assumption that specific grades of paper or board were being introduced during the projection period as new markets were taken over and new uses developed.

Hair (1967, p. 17) compared three types of relationships (see Table 5) and found through statistical analysis that the equation D = a+blogX (the one with decreasing income elasticity) fitted best past data on US consumption. He did not, however, reject use of the other two equations, particularly the linear relation D = a+bX, which he considered best for projecting consumption of sanitary and tissue paper as well as containerboard.

Table 6. Summary of principal single-equation models used to project paper and board demand.

Relationship	Independent variables	Authors and comments
$D = a + bX_1 + bX_2 + cX_3 + dX_4$	X_1 = population X_2 = real disposable income X_3 = trend X_4 = other optional appropriate variables according to grade of paper and board	Stanford Research Institute, 1954, p. 255-294 (Study of the US market).
$\log \frac{D}{X_1} = a + b\log \frac{X_5}{X_1}$	X_5 = national income in constant price (FAO). X_5 = industrial production or the real disposable income according to grade of paper and board (US Congress)	FAO, 1954. (World market study) US Congress, House, 1957, p. p. 34-37 (US market study).
lognormal function	national income	FAO, 1960 (World market study) FAO, 1963 (Western European market study).
$\log D = a + b\log X_6 + c(\log X_6)^2$	X_6 = national income	FAO, 1955, p. 44; FAO, 1963, p. 14 (Both Latin American market studies).
$\log D = a + b\log X_7$ or $D = a + bX_7$ or $D = a + b\log X_7$	X_7 = real disposable income index or industrial production	Hair, 1967, p. 15 (US market study. The relationship was chosen according to grade of paper and board).
$\frac{D}{X_6} = aT + b$	T = time (1,2...n)	Slatin, 1970 (US market study).

Another recent study (Slatin, 1970) did not make explicit use of mathematical formulae relating consumption and income. The basis for the forecasting procedure was to project the trend of the ratio of total US consumption of one product to real GNP. From the projected ratio in 1975 and 1980 and the estimation of GNP for these years consumption was then derived.

In conclusion, choice of relationship depends largely on the country or group of countries under consideration and on the grade of paper and board in question. Some complex functionshave proved applicable for forecasting purposes over wide ranges of income. Simpler functions, nevertheless, can be used for predicting within a limited income range.

The Multi-equation Model

A second technique for forecasting demand employs simultaneous equations. In these models several variables, including price, are used, thus dropping the assumption of an elastic long run supply curve implicit in the single equation models. The simultaneous system is illustrated by the following:

$$Q_s = f(p, \ldots)$$

$$Q_d = f(p, \ldots)$$

$$Q_s = Q_d$$

where Q_d = quantities demanded (or consumption)

Q_s = quantites supplied

p = price

In the field of pulp and paper, the only studies that have made use of this technique are those of Åberg and McKillop. Åberg (1968, p. 125) used a multi-equation model to study price elasticities of demand for paper in the EEC and EFTA markets, rather than to project demand specifically. The exogenous variables were price lagged one year, capacity of the industry and income. Results showed that the demand for paper appears to have a very low price elasticity.

Similar results were obtained by McKillop (1967) in his econometric study of supply and demand for forest products. He used several exogenous variables. His supply equation for paper included an index of manufacturing production, population, per capita income, freight rates, consumer price index, price of paperboard and price of paper. His demand equation included the price of electric power, the rate of exchange between the US and Canadian dollars, price of petroleum products, productivity in pulp and paper, a dummy variable and price of paper. Similar variables were used for the paperboard supply and demand equations. His estimates of demand price elasticity were also very low, -0.433 in the case of paper and -0.313 for paperboard, implying that demand for these products is inelastic.

These multi-equation models are more elaborate than single equation ones because they incorporate such factors as substitute products, prices and cost elements; but other factors -- penetration of paper and board in different markets and technological changes -- are not explicitly included. The input-output model discussed next, however, makes possible the inclusion of this kind of information.

The Input-Output Model

The form of these models is inspired by Leontief's work on input-output analysis. According to his model (Leotief, 1951 , p. 35) the output of each industry (measured in physical terms) equals the sum total of the amount of its products consumed by all other industries. Thus, if Xi indicates the net output (total output minus the amount of its products consumed by all other industries) of the ith industry, and a_{ij} are technical coefficients that indicate how the output Xi depends upon total production in the sector j, the output of the ith sector is determined by:

$$Xi = \sum_{j=1}^{n} a_{ij}X_j$$

An extension of this model has been applied to the fibre box industry (US Economics Corporation, 1970, and Fédération des Syndicats de Producteurs de Papiers et Cartons Français, 1967). The production of fibre boxes depends on the demand from the different economic sectors. In the American study 19 sectors were included, and 50 in the French. The technical coefficients are determined through analysis of destinations of fibre box shipments of selected companies.

When using an input-output forecasting model, two separate series are forecast (American Paper Institute, 1967, p. 65): (1) the trend of growth or decline of end use industries and (2) the rate of change of product substitution, or in other words the technical coefficients. In the Fibre Box Association's study, growth of each sector was forecast for one decade by assuming a certain level of economic activity during that decade. In the French study forecasts from the five-year plan were used.

Although the input-output model presents interesting features, the two equation model has been prefered for use in Chapter VI as this permits inclusion of price which, as seen later, is of primary interest. In addition to price, substitution effects can be included in this model. Before compiling quantitative data it is necessary to have a qualitative knowledge of substitution phenomena and technological development. The following sections present some of these factors for the principal grades of pulp, paper and board.

Analysis of Factors Affecting Demand for Different Grades of Pulp

Numerous factors affect domestic as well as foreign demand for different grades of pulp, individually or as a whole: growing exports of chips from the Pacific Northwest, the latest technical development in sulfite pulping, greater acceptance of hardwood pulp, changing market conditions for dissolving pulp, the emergence of synthetic papers and non-woven materials and growing emphasis on environmental quality, leading possibly to greater use of waste paper. These factors are reviewed in this section and their potential impact on projection of pulp demand is evaluated.

Pulp Exports Versus Chip Exports

Exports of pulp, paper or board can be replaced by exports of raw material such as pulpwood or wood residues in the form of chips. Over the years a substantial international trade in pulpwood developed, particularly from Canada and the Scandinavian countries to the major consuming areas, but has since declined and been replaced by the trade of semi-finished products such as pulp, newsprint and other paper and board products.

Another trend has recently appeared: the export of chips generated in the manufacture of lumber and other forest products. The prime example is the Pacific Northwest of the United States where the volume of chips exported has grown steadily and rapidly during the last decade from 90 thousand bone dry short tons in 1965 to 1.8 million tons in 1970 (Darr, 1971). Nearly all went to Japan.

The trend toward fewer pulpwood exports -- with the exception of chips -- can be explained by the desire of exporting countries to replace exports of raw material with more valuable products, gaining greater trade stability, increasing foreign exchange receipts, and furthering economic development of the source country. Under these circumstances it is likely that pulpwood exports will not only be substituted by pulp but that pulp in turn may be replaced by exports of finished products such as writing and printing paper. Such a trend is already a reality in the case of Sweden and Finland.

Are such trends going to continue however? Probably, as long as economic results justify them. A fairly widely accepted principle in world pulp circles is that production, to be economic, must occur where the wood is; movement of raw wood over vast distances entails an added cost factor that few firms are able to afford (Ritchie, 1970, p. 3). Sometimes, however, prices of raw materials compared to finished products are such that the former can be exported profitably. Moreover, as chips are mostly exported to Japan, the capital structure there "which is really a creature of a unique partnership between the government and business" (Knudsen, 1971, p. 63) has a profound influence, making chip exports from the Pacific Northwest more profitable not only for Japanese pulp manufacturers but also for American chip exporters. The considerable investment in recent years in chip loading facilities in the Pacific Northwest, particularly at Coos Bay (Davis, 1971), and the number of Japanese ships devoted to and built for chip transportation exclusively amply confirm the profitability of the chip trade. The thrust of the evidence suggests that exports will continue in the short run although further investment in pulp and paper capacity in the Pacific Northwest to meet foreign or domestic demand could begin to curb chip exports later.

Chip exports have certainly had a limiting effect on the possibility of increased pulp, paper and board exports from the Pacific Northwest. Exports of chips to be converted to pulp on the spot in Japan directly diminish exports in the form of pulp from the Pacific Northwest and from other exporting regions of the Pacific Rim. At present, chip exports correspond to the amount of raw material necessary to produce about one million tons of pulp, paper and board in Japan, which equals present pulp, paper and board exports from the Pacific Northwest. A shift from chip exports to exports of finished products, however, would be rather difficult since several other countries of the Pacific Rim are willing to export chips or pulpwood to Japan. Japan's imports of finished products probably depend on the amount of foreign exchange available, and moreover, a shift to imports of finished products would lead to employment problems in this country.

Hardwood Versus Softwood Pulp

As seen in the preceeding chapter, most of the pulp, paper and board exports from the Pacific Northwest are derived from softwood species. During the last 20 years, however, the use of hardwood pulp has developed considerably and to a certain extent might limit the regular markets for softwood pulp and consequently its export from the Pacific Northwest. Next will be reviewed reasons for this trend and the extent to which softwood and hardwood compete or complement each other.

Hardwood bleached pulp progressed considerably following several developments such as (Emery, 1969):

- growing demand for wood pulp that softwood forests alone could not satisfy;
- the existence of hardwood reserves that, lacking other uses, could be used to advantage in papermaking;
- rapid growth of certain hardwood trees;
- development of appropriate cooking and bleaching processes;
- use of disc refiners and size presses; and
- better knowledge and efficient use of hardwood pulps.

Because of their different chemical composition and morphological structure, hardwood fibers confer to papers different characteristics. For example, hardwood fibers are more rigid than softwood fibers and so contribute less to cohesion of the sheet. Papers made from hardwood pulp have lower density and strength and higher opacity and bulk.

By adding hardwood pulp to a softwood pulp paper properties can be complemented and improved. This is particularly so for printing and writing papers. For printing papers hardwood fibers impart a more regular structure and higher opacity, while for writing paper, hardwood pulp, if properly refined and well chosen for complementary properties, can be used in spite of a tendency to pick and fuzz. For tissue paper, hardwood pulp is much appreciated because of better absorption qualities.

From the economic point of view, hardwood pulp presents advantages for the papermaker because of favorable prices, low energy consumption required to reach a specified degree of refinement, and higher speed attainable on the paper machine due to better drainage.

In conclusion, the use of hardwood pulp does not pose technical problems and its consumption will likely increase, particularly in mixtures with softwood pulp. Hardwood pulp is not, then, a direct substitute for softwood pulp per se, since softwood pulp has definite characteristics not possessed by hardwood pulp. However, the introduction of hardwood pulp will certainly reduce future world demand for softwood pulp. The question arises whether softwood pulp from the Pacific Northwest has particular characteristics that might make it more attractive to foreign customers, allowing it to maintain its export level in spite of competition from hardwood pulp. This can be examined from two points of view: first, the pulping process and secondly the species of wood used to make pulp, paper and board. These two aspects are considered in the next section.

Pulping Process Development and Wood Species Utilization

Over the years great changes have occured in pulping processes. During past decades the Pacific Northwest has been one of the major producing and exporting regions of sulfite pulp based on hemlock, spruce and true firs with which this area is particularly well endowed. However, other pulping processes, in particular kraft and semichemical have since been developed in many regions of the world, making it possible to use not only Douglas fir but other species too, such as pine, thus broadening the geographical regions able to produce pulp and to a certain extent reducing the role of the Pacific Northwest as a supplier. Kraft production from southern pines in the southeastern United States is an example of this new development. Further details on the evolution of these pulping processes follow, and implications for exports from the Pacific Northwest are drawn.

Over the years there has been a decline in sulfite pulp from 32 percent of total US pulp production in 1935 to 8.3 percent in 1969. On the other hand, sulfate pulp has increased from 30 percent to 69 percent in the same period, and semichemical pulp from 2.1 percent to 9 percent (American Paper Institute, 1970).

In the early years the sulfite method yielded the brightest unbleached chemical pulp and the easiest one to bleach, and was therefore used for all grades where light color was of importance. But when in about 1930 it was learned how to bleach kraft pulp without any serious loss in strength, the kraft pulps began to gain ground in certain fields because of better paper strength properties. Even in the special field of dissolving pulps the sulfate process was established because of the creation of the prehydrolysis technique (Rydholm, 1965, p. 439).

Two main factors have made the sulfite industry less capable of competing with the sulfate process, namely its sensitivity to the wood raw material and the difficulty of recovering cooking chemicals. The sulfite process still uses softwoods primarily, and only softwood free from certain extractives of a phenolic character. In Europe, therefore, mainly spruce and in America spruces, firs and hemlocks are used; whereas pine, Douglas fir and larch cannot be used because their heartwood is not sufficiently pulpable by the conventional sulfite process. Hardwoods may be used but extractives often cause difficulties.

The kraft industry, on the other hand, accepts without difficulty hardwood as well as softwood of any grade and species, even pine and tannin-damaged spruce, as well as small-dimension wood and plywood residues. The kraft process is also far less sensitive to bark particles as contaminants in wood chips.

The major problem with sulfite pulping is the difficulty of recovering cooking agents. Sulfite waste liquors are a direct burden on the process's economy, as their disposal into the rivers and seas is becoming prohibited by law.

The sulfite industry has tried in several ways to remedy drawbacks of the process and develop its advantages. With certain modifications, especially the change from calcium to ammonium or sodium base, as well as from one-stage to multi-stage cooking, the cooking of hardwoods, pine heartwood and tannin-damaged spruce has become possible. Regeneration of chemicals with a base other than calcium is possible although these methods are rather costly. Only the magnesium-base sulfite pulping process permits satisfactory recovery of chemicals in addition to waste heat. Such a process is now in operation in several mills in North America and in Europe, especially in Germany where there is no production of kraft pulp because of limitations on air pollution. It is possible, then, that although sulfite pulping processes have been on the decline, their possibilities will be redeveloped in the future.

Besides sulfate pulp, semichemical pulp is also growing in importance. This and similar pulping processes have been developed with the major objectives of wood conservation and cost reduction. These objectives have directed efforts toward producing pulps with exceptionally high yields and in particular toward making pulps from hardwoods with properties approaching those of softwood chemical or groundwood pulps. Recognition in recent years of the great importance of hardwoods to the pulpwood economy of major pulp-producing countries has accelerated application of semichemical pulping methods. The neutral sufite semichemical (NSSC) pulping process, the principal one in use, is very interesting as recovery of the chemical and heat values is possible particularly when NSSC mills are associated with kraft pulp mills. The NSSC spent liquor is recovered in the recovery system of the kraft pulp mill and replaces some of the salt cake that would otherwise have to be added in the kraft process. The NSSC cooking liquor is then made from fresh chemicals. When the two processes are integrated, the capacity of the NSSC mill is 25 to 30 percent that of the kraft mill (McGovern, 1962 , p. 314).

In addition to variations in pulp characteristics and qualities imparted by different pulping processes, the tree species used in a given process also imparts distinctive pulp differences. Two main pulp types are produced which have been broadly classified as Scandinavian and North American types. The former is characterized by higher tensile and bursting strength and the latter by a higher tear strength. These differences arise from the different sizes and shapes of wood fibers in the raw material. "The southern and eastern American pines and Douglas-fir have a higher basic density, 0.46 to 0.56, as compared to the Scandinavian scots pine, 0.38 to 0.44, and some northern American and Canadian softwoods, such as western red cedar, Engelmann spruce and alpine fir, 0.3 to 0.4" (Rydholm, 1965, p. 611). The light-weight woods contain more springwood, whereas in the heavier wood species summerwood dominates. There is an increasing pulp production in Canada from light-weight softwoods, which yields a Scandinavian type pulp. The high percentage of thick-walled summerwood fibers of Douglas-fir as well as some southern pines gives a coarser paper with less inter-fiber bonding, which is the reason for the extreme properties of those pulps.

The characteristics of Douglas-fir pulp can, however, be modified by mixing it with that of other species. Mixtures of Douglas-fir and western hemlock pulps produce paper comparable to that of the best spruce pulps (Scroggins and Currier, 1971). However, pulp made from mixtures of species remains rather limited due either to the difficulty in obtaining secondary wood species or to the technological research necessary to develop appropriate mixtures.

In conclusion, the Pacific Northwest had an advantage a few decades ago in the production and export of sulfite pulp because of its endowment in hemlock, spruce and true fir. Serious competition has arisen from other pulping processes, particularly from kraft and neutral sulfite semichemical processes which permit use of other species such as pines and Douglas-fir, formerly little used for pulping, at the same time reducing water pollution and producing pulps with excellent strength properties.

The Pacific Northwest can still, however, remain in a predominant position in the export of sulfite pulp made from spruce, hemlock and true firs, as long as the industry switches to less polluting pulping processes such as magnesium-base sulfite. This will mean a restructuring of the industry, which is in fact taking place at present (Everett, Wash. mills closing down, 1972).

Concerning kraft pulp production, the Pacific Northwest does not have an advantage in producing a particular pulp grade destined for export as other softwood regions, particularly British Columbia and Northern Europe, are able to produce pulps with a high bursting strength, a quality much appreciated in packaging. Douglas-fir pulp, however, with its high tearing strength, is also a satisfactory pulp for this purpose. Differentiation of kraft pulp from the Pacific Northwest on the basis of qualities confered by wood species is limited, then, unless these commodities can be differentiated on another basis, such as marketing practices.

Factors Affecting Demand for Alpha and Dissolving Pulp

Alpha and dissolving pulp is one of the principal export items from the Pacific Northwest. In this section, then, major factors influencing world demand for dissolving pulp are reviewed in order to draw implications concerning prospects of continued exports of this product from the Pacific Northwest.

On the North American market, 43 percent of the total consumption of dissolving pulp goes into textile rayon and 21 percent into acetate.

The rest goes into the production of cellophane and other products such as explosives.

Staple rayon is used to complement both synthetics and cotton in new textile fabrics and for non-woven, production of which is growing rapidly. On the other hand, the future of filament rayon hinges mainly on that will happen to rayon tire yarn. The uncertainty lies in whether the tire industry will elect to switch to radial tires, which do not use rayon, in the coming years.

Acetate is a versatile apparel fabric, and although nylon gives it severe competition in some uses, there seems to be room for growth for a fiber so well suited to styling. Cellophane has shown good stability in the face of strong competion from the polyolefins. While some decline is probable, there will still remain a large market for dissolving pulp in the foreseeable future. Some decline is likely to occur in military nitro-cellulose production.

About 51 percent of US production of alpha and dissolving pulp is exported, and this has doubled over the last ten years. Recent increases have been mainly to Europe and Latin America. At present, about half of exports consist of tire cord and acetate quality pulps, the market for which has remained strong particularly in Europe. The other fifty percent consists of pulp mainly for textile, staple and cellophane production which has not shown much recent growth. Very little of this 50 percent has been exported to Europe, in fact less than 20 thousand tons in 1968 (Dixon, 1969). The European market for these grades has traditionally been from Scandinavia but with declining Scandinavian supply and an improving European market for rayon staple and cellophane, it can be expected that the demand for North American produced pulp of this type will increase substantially over the next few years.

Summing up the overall demand picture, it seems that North American consumption of dissolving pulp should grow at a moderate rate due to a strong staple and acetate demand more than compensating for any decline in the filament rayon area, while in Europe an increasingly larger demand might develop for certain qualities of dissolving pulp. As a whole, though, it appears that no major factor is going to influence greatly the existing picture of demand for dissolving pulp. In consequence, exports of alpha and dissolving pulp from the Pacific Northwest are expected to continue as long as producers are able to change their manufacturing processes to meet air and water pollution regulations.

Virgin Pulp Versus Secondary Fibers

In the United States 81 percent of the fibrous materials used by paper and board industries comes from virgin pulp (American Paper Institute, 1971, p. 245). Waste paper makes up the rest. The proportion of virgin wood pulp used has been increasing, rising from about 73 percent in 1950 to the current level of 81 percent.

The question is whether or not this trend is going to continue, as a change in the United States or abroad might affect world demand for virgin pulp, and consequently exports of this product from the Pacific Northwest. There are several determinants involved, including available technology for using recycled as opposed to virgin pulps; the economics of using recycled rather than virgin pulps; obtaining market acceptance of products made with recycled fibers and pressures caused by concern for the environment that lead to public subsidies or controls affecting use of materials. A review of some of the issues follows.

Any grade of board, wrapping, bag, printing, office or writing paper can be made from 100 percent waste paper provided the right grades of fibers are selected. In some cases the quality is superior to that made of virgin fiber, particularly where printability and dimensional stability are important (Bergstrom, 1968).

The rate of recycling fibers differs considerably between countries: in Western Europe in 1968 the average figure was 26.9 percent; in the Netherlands it even reached 40.6 percent, while in Japan for the same year it was 36.6 percent (FAO, 1969b). Even in these countries it is claimed that more waste paper could be used. What, then, is the key factor leading to the rather low use of waste paper in the United States? The general answer is that an increased use of waste paper will only come about if economically justified.

The users of waste paper have to weigh the cost of waste paper against that of virgin pulp. It is generally thought that waste paper cost may be 35 to 40 dollars per ton less than the equivalent grade of virgin pulp (Lehto, 1971). Such a difference is required to cover the cost of the plant and the effluent treatment facilities. But in the last 20 years several mills have given up deinking for a variety of reasons, for example, virgin pulp could be produced cheaper, and the quality of waste paper was deteriorating.

The greatest difficulty is the supply of waste paper. It is collected in cities where there is "floating labor" to pick it up and where tonnage is great enough to make a profitable venture. When prices for waste paper are high, more "floating labor" will be attracted into collection of it and additional waste paper becomes available beyond the tonnage normally salvaged. Eventually, the surplus will cause a drop in prices, and the lower return discourages salvage operations, with the result that "floating labor" looks elsewhere for better paying jobs.

In spite of these difficulties, however, a certain optimism for greater use of waste paper is possible. Due to greater public concern for the quality of the environment and possible shortages of pulpwood, the federal government is committed to support recycling, as is attested by the Resource Recovery Act of 1970 which made funds available for research projects and pilot plants (Lehto, 1971, p. 900). Moreover, in his environmental message to Congress dated February 8, 1971, President Nixon stated that new specifications will require a minimum of 3 to 50 percent of recycled content, depending on the product, in Federal Government purchases (Edwards, 1971, p. 47).

In conclusion, public concern for environmental quality brings a new focus on resource recovery on the part of public officials and agencies in the Federal Government. This may bring new pressures and laws leading to increased recycling of waste paper. But this will only come about if economically justified. In the short run, at least, these new trends are not likely to have a major impact on exports from the Pacific Northwest.

Synthetic Fibers Versus Wood Pulp

Properties of papers made of wood pulp fibers are reaching levels where further improvement is difficult and costly to obtain. Problems, nevertheless, remain, such as the necessity for reducing the weight of paper while keeping its physical properties high, and maintaining properties of paper in wet or humid conditions.

Synthetics may provide more effective solutions to such difficulties. New products based on synthetic fibers have already been created and synthetic papers are developing with possiblities of making inroads in traditional paper markets (Massus, 1971; Runeberg, 1971).

Products made of either 100 percent synthetic fibers or in blends with cellulose fibers have higher wet physical strength although being soft and absorbant. These products include, for instance, interlinings, paddings, filters, backings, tapes and labels (Saunders, 1964). The greatest potential for the use of synthetic fibers, however, remains in the disposable field, with towels, wiping cloths, sheets, pillow cases, bandages, pad coverings and clothing. They would be used particularly in hospitals and the hotel, motel and food service industries, and also in certain manufacturing industries (Wilson, 1969).

Although such products are not directly competitive with already existing paper products, they represent new outlets for wood pulp if natural cellulose fibers are included. On the other hand, the use of synthetic paper might become a real substitute for certain categories of traditional papers.

Japan has been a leader in the development of synthetic papers, perhaps because of the problem of supply of cellulose fibers, and also because of the novelty of the products, making exports possible and the selling of patents and machinery.

Synthetic papers are made in three phases:

- preparation of a polymer synthesized from oil (polyethylene, polypropylene, polystyrene);
- plastic extrusion into a thin film; and
- stretching of the film and special treatment to confer properties similar to those of paper.

Good printability and dimensional stability in humid conditions, together with good physical properties, justifies the use of synthetic paper for maps, book covers, posters, dictionaries, labels and bags.

The development possibilities for synthetic papers depend on two elements: price in relation to that of traditional papers and solution of the disposal problems. Actual prices of synthetic papers are well above those of traditional papers, mostly because of special properties. Certain Japanese firms, however, aim at competing with all grades of papers, including packaging and even newsprint. For this, cost reduction will be achieved by economies of scale and technological improvement, and it is expected that prices of synthetic papers might be closer to those of traditional papers, eroding the latters' markets. In this perspective, official Japanese sources have forecast that consumption of synthetic papers for all uses in Japan will be about 2.7 million short tons in 1978 (Runeberg, 1971, p. 11), that is, about one fifth of the consumption of paper for this year.

In conclusion, products made of synthetic fibers cannot be considered as affecting directly the traditional uses of paper. Most of these products are being oriented toward new markets. On the other hand, synthetic paper can become a very important substitute for printing and writing paper. If such a development occurs, it may become substantial in five to ten years from now and be concentrated particularly in Japan. Under these circumstances Japan's pulp, paper and board import requirements could be expected to decrease from the level they would have reached if synthetic papers did not exist, and consequently exports from the Pacific northwest would probably be reduced accordingly.

Analysis of Factors Affecting Demand for Paper and Paperboard

Here, presented in a nutshell, are some of the main factors affecting the consumption of principal grades of paper and paperboard and a forecast of annual increases for the immediate future. These forecasts were obtained under the assumption of no significant change in relative price of the product in question during the projection period. This assumption will be reviewed in Chapter VI when a demand function is estimated.

Demand for Writing and Printing Papers

Newsprint

In both Europe and the United States newspapers have faced increasing competition in recent years from broadcasting media, both for the provision of news, information and entertainment, as well as for advertizing purposes. The net effect of such competition is difficult to assess; however, newsprint on the one hand and television and radio on the other tend to serve different needs, both for the information provided and for advertising, and once these differences are clearly delineatied, expansion in demand for one does not necessarily inhibit growth of the other.

Considering these factors, annual consumption growth in the coming years is anticipated to be about 3 percent in Europe (FAO, 1969a) and 2.5 percent in the United States (Hair, 1967).

Other Printing and Writing Paper

In Europe, the overall outlook for printing and writing paper looks favorable, and a 5.5 percent annual increase is foreseen for the total categories (FAO, 1969a). This estimate is in accordance with a detailed private study (Business Intelligence Service, 1970) which analyzed for each European country the market for printing and writing paper, divided into fifteen submarkets: general printers, consumer magazines, trade and technical magazines, book printing, label printing, post and greetings cards, maps and music, cheque and security work, in-plant printing, duplicating, typewriting, envelopes, exercise and account book, office systems and continuous stationery. For each of these markets consumption estimates were made, taking into consideration technological change and substitution effects.

In the United States a demand study (Slatin, 1970) of printing and writing paper indicated that demand will grow in the coming years at an annual rate of 4 to 5 percent.

Demand for Other Paper and Board

Concerning factors affecting demand for kraft linerboard, shrinkable plastic film used for overwrapping goods on a paperboard tray is the major compeitive product for corrugated board, which is the end-product of kraft linerboard. Although shrink-pack, in markets where it now predominates, may gain further ground at the expense of corrugated board, the latter finds increasing demand in the packing of fruit, vegetables and liquids. Consequently, demand for kraft linerboard is expected to remain strong, with an annual increase of 6 percent in Europe (Thevenon, 1970) and 5.5 percent in the United States (US Economic Institute, 1970).

In conclusion, examination of these trends suggests that world demand for paper and board will expand. Of particular interest is the continued forecast growth of demand for kraft linerboard, as this product counts for about 70 percent of the total exports of paper and board from the Pacific Northwest, giving an optimistic tone to export prospects. However, kraft linerboard exports from the Pacific Northwest will depend also on the ability of this region to produce the product competitively. The sustained demand growth also suggests that there will be continued demand for the raw material, pulp.

Conclusion

The review of paper and board demand studies showed that a linear relationship would be appropriate within a limited income range for the specification of a demand equation, that income is a relevant variable and that price can be included in the equation although demand elasticity is expected to be low.

Analysis of factors influencing foreign and domestic demand for the different grades of pulp led to the following points. Export of chips from the Pacific Northwest affects the export of finished products such as wood pulp and other paper and paperboard products. Continuance of this trend will depend on the export price of chips as compared to the price of finished products and on policies of the Japanese government.

Concerning export of particular grades of pulp, sulfate versus sulfite or hardwood versus softwood, it has been shown that technological progress and the mixing of different pulp grades has led to greater substitutability between grades of pulp. As kraft pulp produced in the Pacific Northwest is not differentiated, exports depend directly on fluctuations of world demand and supply relationships. Continued demand for the Pacific Northwest's sulfite pulp and alpha and dissolving pulp is expected, to the extent that manufacturers in this region convert their production processes to reduce water and air pollution.

Due to greater concern for the quality of the environment, recycling of waste paper will probably grow in the future, lessening to a certain degree demand for virgin pulp, but no direct impact on the Pacific Northwest's export is expected.

Synthetic papers represent direct substitutes for wood pulp as they are made from oil derivatives. However, production capacity increases for synthetic papers are as yet limited in volume and are expected to take place mainly in Japan. No effect on the Pacific Northwest's exports is foreseen before 5 or 10 years. The uses of synthetic fibers will certainly grow, but seem to be oriented toward new products. Thus no major inroads in traditional markets for paper are expected.

Consumption of paper and paperboard are assumed not to be greatly influenced by factors other than income. It is on this basis that consumption projections have been established. Printing and writing paper and kraft linerboard are forecast to have an increase in consumption in excess of 5 percent both in the United States and Europe, while newsprint consumption is expected to have a lower increase of 2.5 to 3 percent.

Such anticipated increases in paper and board consumption suggest there will be continued world demand not only for these products but also for pulp, constituting export opportunities for the Pacific Northwest if potential exporters there are willing and able to enter and compete in foreign markets.

IV. WORLD SUPPLY OF PULP, PAPER AND BOARD

In this chapter the second determinant of trade is examined -- the ability of the Pacific Northwest and of other producing areas of the world to supply consuming areas. The purpose of this examination is (1) to predict and explain flows of trade between regions and (2) to help specify a supply equation for a pulp, paper or board commodity in an international trade model (the international trade of kraft linerboard is taken as an example in Chapter VI).

The first section is devoted to a review of international trade theories which will be used as a guide for determining causes of trade. Then the competitive position of areas supplying pulp, paper or board to Europe and Japan will be examined from two standpoints: (1) directly, by estimating the gross profit (margin) from exporting pulp, paper and board to Europe and Japan and (2) indirectly, by analyzing planned installations of capacity for the period 1971 to 1975 to meet anticipated world demand. In conclusion, implications will be drawn concerning the specification of a supply function for pulp, paper and board and the future of Pacific Northwest exports.

International Trade Theory as a Guide for the Study of Trade in Pulp, Paper and Board

A large part of classical, neoclassical and modern theories of international trade are based on the doctrine of comparative advantage first presented by David Ricardo (1895). According to him, each area tends to produce those products for which its ratio of advantage is greatest, or its ratio of disadvantage least, as compared to other areas.

The principle of comparative advantage applied to the determination of trade in one commodity necessitates knowledge of the costs of all commodities produced by a country for domestic or foreign markets, making an exact measurement of comparative advantage almost impossible because of the large amount of information required.

It seems simpler and more promising, then, to investigate some of the reasons for a country's comparative advantage. The Heckshar-Ohlin theory can give an answer. The essence of this theory is that:

> Each region has an advantage in the production of commodities into which enter considerable amounts of factors abundant and cheap in that region (Ohlin, 1966, p. 12).

Relative scarcity tends to be reflected in prices, and the products embodying a relatively high proportion of abundant factors are likely to be less expensive than those containing more of the scarce ones. As trade between nations opens up, a country's export list will be heavily weighted with products containing a high proportion of its abundant factors, while imports will be biased toward items containing a high proportion of scarce factors.

In this form the theory can be more easily applied to the case of pulp and paper production which tends to develop in areas where the raw material, wood, is plentiful.

The economists who elaborated the law of comparative advantage did not consider the possible effects of transportation costs. It was a later generation of economists who brought forth what is now known as location theory. Most notable among this group were Von Thunen and Alfred Weber. They emphasized not only production costs but also location as expressed by transportation costs. This provided the basic ground/work for location theory which can be summarized in the following way: "Competition for land tends to distribute various types of land use in such a way that each site is occupied by the use that can earn the highest rent there" (Hoover, 1948, p. 102).

Even in this framework, however, which is in fact a reformulation of the law of comparative advantage where transportation costs are included, empirical research remains difficult because of the numerous data required.

Consequently, as full determination of comparative advantage in pulp, paper and board remains beyond the scope of this study, an indirect approach will be taken to study which areas are likely to continue to play an important role in the international trade of these products. The presumption of comparative advantage suggested by the HeckshER-Ohlin theory will be complemented by a study of the competitive advantage of certain regions and countries in supplying the main world consuming areas, the competitive advantage being expressed in terms of returns or margin (total revenue minus total costs) per ton of product produced and delivered to a market. Regions having the highest return or margin will be the most likely to export pulp, paper and board products and will be prime candidates for installation of new capacity.

The next section, then, will treat (1) the direct computation of the margin of competitive advantage of world producing regions likely to have a comparative advantage in the production of pulp, paper and board products and (2) comparison of results from (1) with an analysis of locations where new production capacity is to be installed between 1971 and 1975.

Forest Resources Endowment

In a study by Thevenon (1970) the distribution of forest resources in several regions of the world was reviewed. In the temperate zone, Canada, particularly British Columbia, and the western region of the United States are the best endowed. Results of FAO studies (1964 and 1969a) suggested that North America and the USSR would be possible suppliers of an increasing raw material deficit in Europe at the present market price. Indeed, in spite of the large forest resources of the Scandinavian countries and Finland, it appears that Europe as a whole will not be able to meet its own demands for raw material during the seventies.

The vast forest areas in tropical and subtropical zones could also be possible exporting regions. There are, however, several limitations to the usefulness of these vast forest areas: uneven distribution of forests with regard to population, and the predominance of mixed broad-leaved forests. This makes their exploitation more difficult and might offset the advantages of these regions to export pulp and paper products.

In Asia, the distribution of forests in relation to population is uneven (Streyffert, 1968, p. 56). Only Southeastern Asia has abundant forest resources but is not yet substantially involved in the production of pulp and paper. Japan is the major present and prospective consumer of paper and paperboard in Asia. But even with the rather intensive silviculture practiced in Japan, the limited extent of its forest area will not yield the increasing amounts of pulpwood required for its rapidly increasing consumption of paper and paperboard, so Japan will probably continue relying on foreign sources for its supply of pulp and pulpwood.

In conclusion, examination of forest endowment suggests that North America and Northern Europe are likely to have a comparative advantage in the manufacture of forest products, including pulp, paper and board.

Competitive Advantage of the Major Areas Supplying Pulp, Paper and Board to Germany and Japan

A more detailed study is now necessary to compare the Pacific Northwest's competitive advantage with that of other producing areas in supplying two major importing countries, Germany and Japan, which represent two consuming areas, Europe and Southeast Asia. This information will be used to indicate which world area is most likely to export pulp, paper and board. As examination of competitive advantage necessitates computation of the difference (or margin) between price and manufacturing and transportation costs, presented next are the cost items involved in the manufacture of the principal pulp, paper and board commodities traded world-wide: bleached kraft pulp, newsprint and kraft linerboard. The trend of these cost items over time is also presented to see if any conclusions can be drawn concerning coming years.

The regions considered are those likely to have a comparative advantage in manufacturing forest products, and likely, therefore, to compete with the Pacific Northwest in foreign markets. These are: Sweden, Finland, the southern region of the United States, Eastern and Western Canada, and the Pacific Northwest itself.

Cost elements in Western Canada (British Columbia) and the Pacific Northwest are listed together as they vary by about only 2.5 percent

(Haviland, 1968, p. 41), the lowest being in British Columbia. The analysis will examine successively pulpwood costs, wages, scale economies, total cost of production, the process of integration and transportation costs.

Pulpwood and Mill Residue Costs

The cost of pulpwood and mill residues is of great importance, representing about 45 to 65 percent of the total manufacturing cost of pulp and paper products. An estimate of the cost of pulpwood and mill residues per ton of linerboard delivered at the millsite is given in Table 7. In these estimates (R. A. Daly and Co. Ltd., 1969) mill residues account for 25 percent of wood requirements, except in Western Canada and the Pacific Northwest where they are assumed to account for 45 percent. Prices of mill residues are about 80 percent those of the equivalent volume of pulpwood. In the case of pulp or other products, pulpwood cost will be of the same order but will differ according to species and cooking yield. Finland and Sweden have the highest raw material costs: cost in the Southern United States is only 60 percent and in Western Canada and the Pacific Northwest only 50 percent of that in Sweden.

In another study (Streyffert, 1968, p. 173), pulpwood costs in developing countries, East Africa and Chile, were compared with those in Finland and the Pacific Northwest of the United States. It appeared that these former countries have the lowest costs in the world, representing 45 percent of Swedish costs.

Since the figures presented were for one particular year, it is

Table 7. Pulpwood cost per ton of kraft linerboard in major producing regions, 1968.

Country	Cost	Percentage of cost in Sweden (Sweden = 100)
	US dollars	Percent
Sweden	61.10	100
Finland	47.20[a]	77
Southern United States	37.00	60
Eastern Canada	46.20	75
Western Canada and Pacific Northwest	30.50	50

[a]Reflects reduced stumpage charges and 17 percent devaluation.

Source: R. A. Daly and Co. Ltd., 1969, p. 70.

Table 8. Deflated average hourly earnings in the paper industry in selected countries for 1958 and 1967.

Country	1958	1967	Percentage increase
	US dollars		Percent
Canada	2.02	2.35	15.0
USA	2.22	2.63	18.4
Sweden	1.23	1.59	29.2
Finland	0.80	1.02	27.5

Source: International Labor Office, 1968.

helpful to see how they have evolved over time by studying two of their components: stumpage prices and wages. Four time series on the price of raw material are given in Figure 7:

- Stumpage price of southern pine, 1955 to 1969
- Stumpage price of spruce pulpwood in Finland, 1950 to 1969
- Crown stumpage price in Ontario, Canada, 1950 to 1964, and
- Pulpwood price in France, 1958 to 1969.

These time series are deflated and presented as indices (1963 = 100) as comparison in absolute value would be obscured by the various species taken into consideration and the computation method of stumpage price.

Indices for the United States and Canada show a slight decline, meaning that stumpage rates have not kept pace with inflationary influences in the general economy. Finnish prices do not show a steady trend, being greatly influenced by prices of finished products and also general market conditions. High prices in 1952 were caused by the Korean war. General indices in France are also declining, but probably not for the same reason as in North America: competition from imported wood and forest products seems perhaps the major reason (Commission des Communautés Européennes, 1968, p. 10).

Wage rates and productivity of labor also affect pulpwood costs. As will be seen in the next section, American wages are about twice those in Scandinavia, but increase less over time.

Productivity depends greatly on the degree of mechanization, which has been very important in all regions due to rising wages in the forests. However, "the big forest expanses in Canada and the Soviet Union

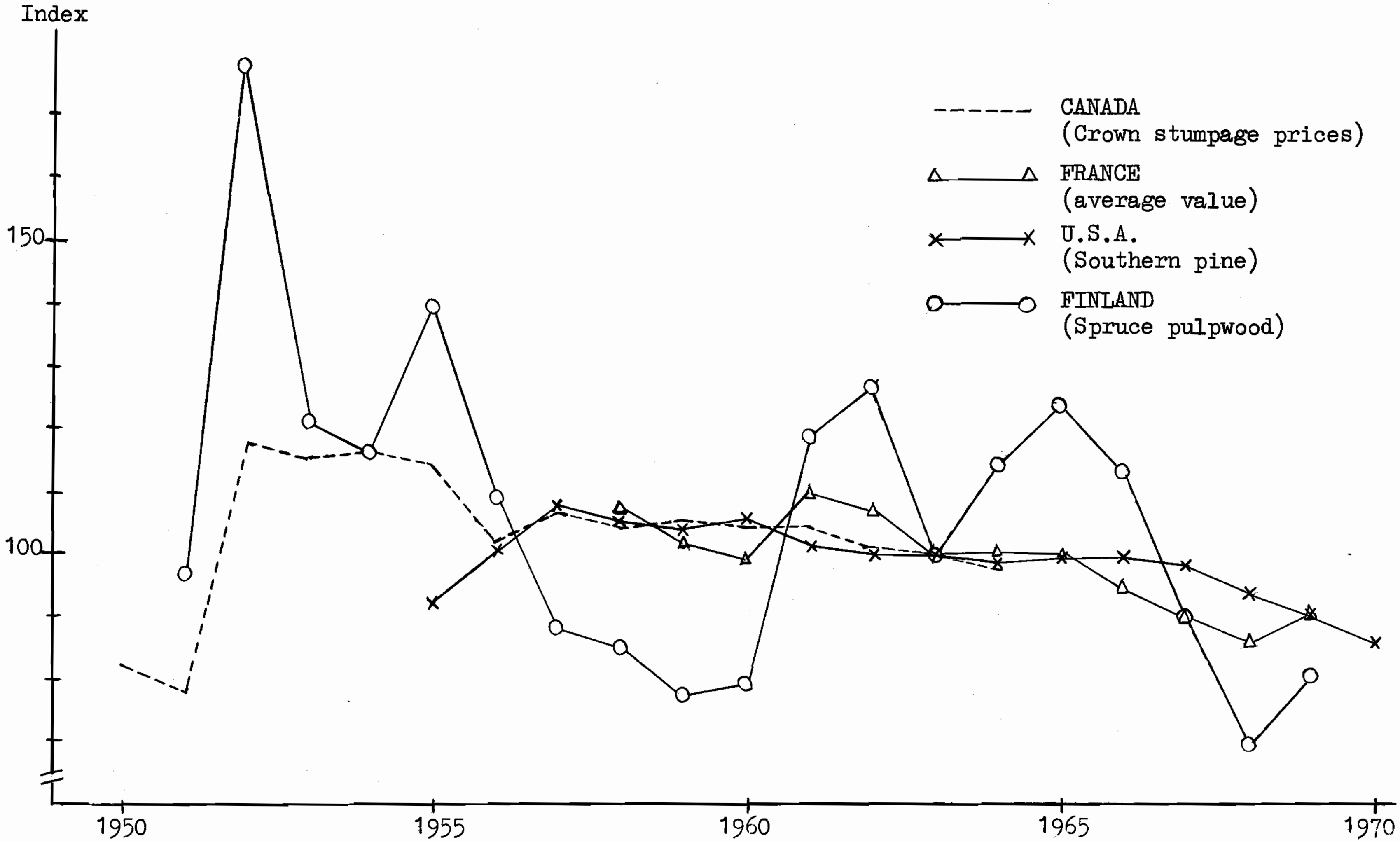


Figure 7. Index of deflated prices of pulpwood in Canada, Finland, France and the Souther United States.

Source: FAO, 1970, p. 73; Hair, 1970, p. 70; Institutum Forestale Fenniae, 1970; Streyffert, 1968, p. 138.

afford better conditions for mechanization than the forests in the old settled countries of Northern Europe" (Streyffert, 1968, p. 209).

There remains another problem to be elucidated before examining future trends of world pulpwood prices: does the price of pulpwood reflect its cost of production? This difficult question will not be treated in detail here, but the main points need to be raised because of their impact on calculation of margin.

In the first place, the cost of harvesting pulpwood and delivering it to a mill must be recovered in the price at point of delivery. Therefore the price of pulpwood is a limiting factor in its supply. But the price of pulpwood is actually decided by the interplay of forces of supply and demand.

Demand for pulpwood is derived from the pulp and paper industry's need for raw material in competition with other users of small logs; thus the first limitation on pulpwood price is that it cannot exceed what the pulp industry can pay.

As for supply, certainly costs of logging and transporting the wood, together with administrative costs, have to be considered. In addition, price of stumpage charged by timber growers (either public or private), the planning of allowable yearly cuts in conjunction with sustained yield management, and investments in silvicultural measures are all important elements affecting the supply of pulpwood, and may have a major impact on its price.

In the light of so many factors, it is difficult to foresee the prices of pulpwood for the different countries. Probably, in Scandinavia and the rest of Europe, pulpwood prices are reaching a level beyond which the industry cannot afford to go, unless modernization results in lower manufacturing costs or more investment in silvicultural practices reduces raw meterial prices. In North America, as long as reserve supplies are ample, prices are not expected to increase greatly. However, certain regions, such as the Southern United States, might experience increases due to rising wages and a higher demand for pulpwood.

Wages

In the manufacture of kraft linerboard, wages and salaries count for about 7 to 17 percent of total costs according to the different countries. Table 8 shows that wage increases have been highest in Northern Europe, and this tendency will probably continue. Although comparisons among wages of different countries are difficult because of differences in methods of computation, American wages are still two to two and a half times Finnish wages, but less than twice Swedish wages. In modern Scandinavian plants average productivity is as great as in North America (R. A. Daly, 1969, p. 63), and so, because of differences in wages, Scandinavian countries have an advantage.

Scale Economies

In the pulp and paper industry substantial scale economies exist. Plant costs are related to capacity in an exponential fashion according to the general formula (F. T. Moore, 1959):

$$\frac{K_1}{K_2} = \frac{S_1}{S_2}^{\frac{2}{3}}$$

K_1 and K_2 are capital costs for plants of different size.

S_1 and S_2 are capacities of these plants.

If investment in a pulp mill of 300 tons per day is 25 million dollars, the cost of a pulp mill of 500 tons per day will be:

$$25 \frac{500}{300}^{\frac{2}{3}} = 35 \text{ million dollars}$$

Besides capital scale economies there are also labor scale economies, of great importance in the pulp and paper industry. Scale economies are demonstrated in Figure 8. Economies of scale exist not only for pulp but also for paper and board manufacturing.

Mills in Canada, the United States and Northern Europe take advantage of economies of scale. However, they seem to have a limit because of the problem of pulpwood supply. Only regions with large reserves of timber can profit fully from these economies.

Vertical Integration

Vertical integration is an important phenomenon in the paper industry. It refers to the combination of two or more consecutive stages of the production process. Marketing of pulp has given rise to an important international trade, pulp being manufactured in Scandinavia or Canada and shipped to consumer areas for futher processing in paper mills. It appears that in certain cases tangible savings can be realized by integrating production of pulp and paper.

It is, however, difficult to reach generalized conclusions. An example, as presented by Risto Eklund (1967), will help to show the factors at stake when a decision on integration has to be made. Decision making in the production of foodboard to be delivered to the

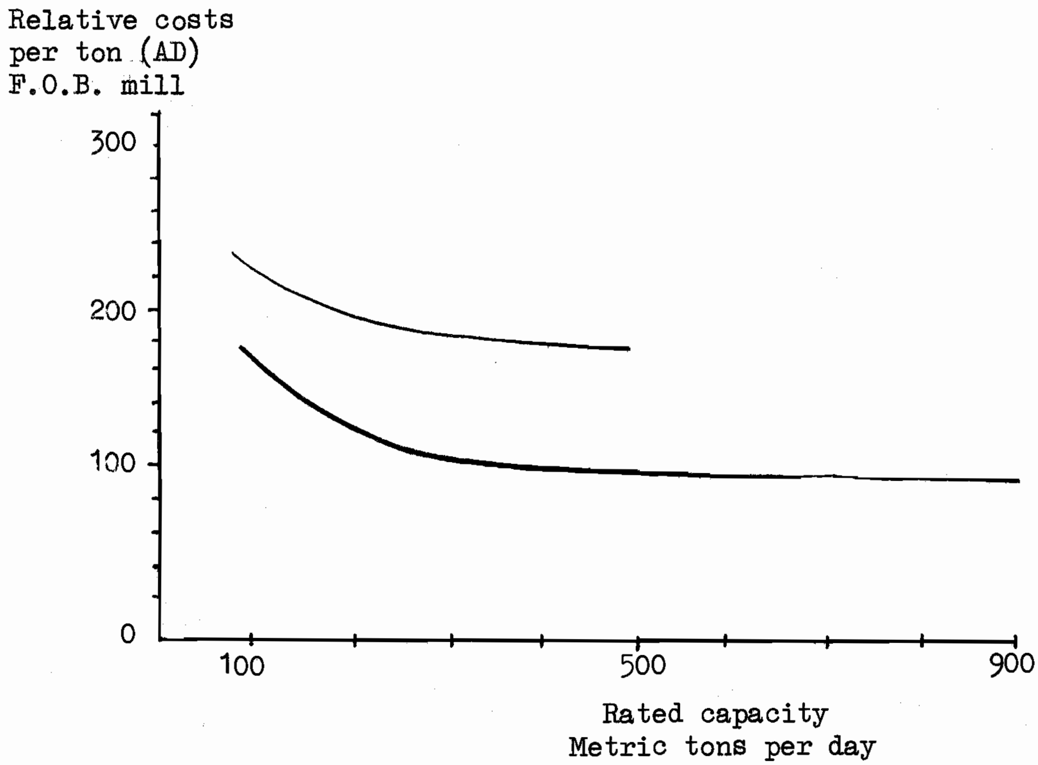


Figure 8. Manufacturing costs of airdried unbleached pine sulfate pulp(1), and of sack paper in a non-integrated mill (2) as a function of mill size.

Source: Eklund, 1967, p. 21.

German customer leads to a comparison of three situations: (1) non-integrated production: bleached sulfate pulp is manufactured in Scandinavia and foodboard produced in Germany; (2) non-integrated production: foodboard is produced in Germany based on market pulp, and (3) integrated production: both bleached sulfate pulp and foodboard are manufactured in Scandinavia. The difference between (1) and (2) is that in situation (1) the commissions of the middlemen are saved, and for the small pulp mills involved economies of scale cannot be achieved. Cost comparison is given in Figure 9, including 15.2 percent customs duty on paper, 8 percent tax on imported paper, 4 percent tax on domestic paper and 4 percent tax on imported pulp. Because of the high customs duty on paper, it appears that food board production in Germany (1) is more profitable than integrated production in Scandinavia. Non-integrated production based on market pulp (2) in large German mills is the most profitable if the size of the market is sufficiently large.

In conclusion, although integration might lead to substantial savings, it is not necessarily the best alternative in foreign trade.

Transportation Costs

Transportation is an important cost item counting for about 10 to 20 percent of the total costs. Freight rates for kraft linerboard are presented in Table 9. Kraft linerboard, however, is a bulky commodity, and freight rates for pulp are lower by 10 to 20 percent. Some new trends in transportation are currently developing.

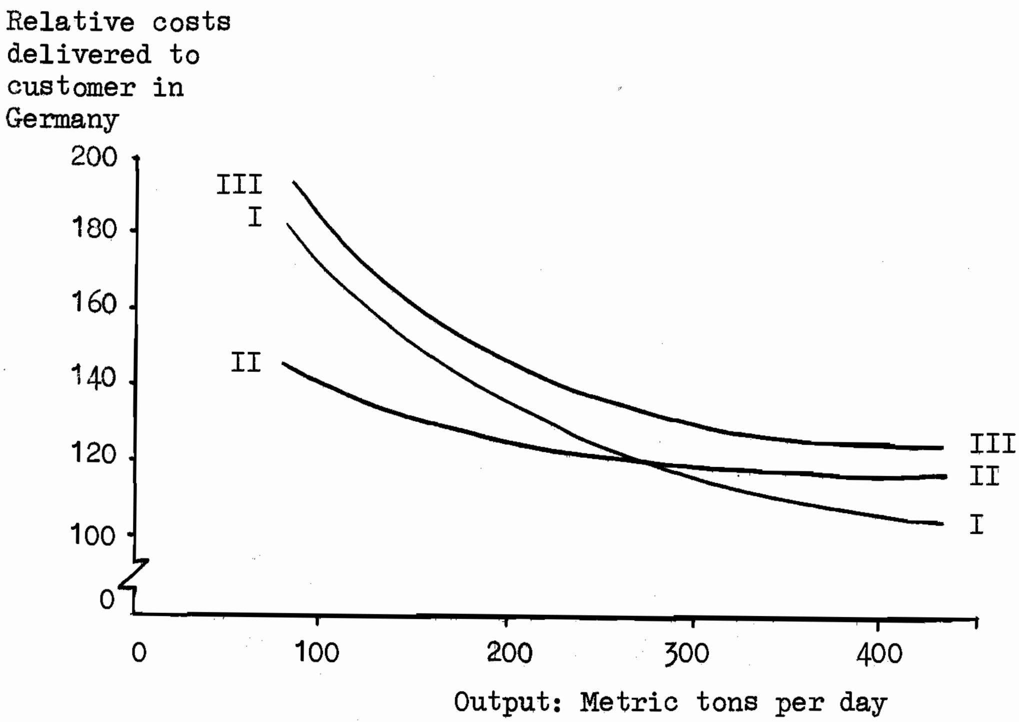


Figure 9. A comparison of costs of integrated and non-integrated foodboard production (C.I.F. customer in the Federal Republic of Germany) in Scandinavia and the Federal Republic of Germany.

I Non-integrated production: bleached sulfate pulp in Scandinavia, foodboard in Germany.

II Non-integrated production: foodboard in Germany based on market pulp.

III Integrated production: bleached sulfate pulps and foodboard in Scandinavia.

Source: Eklund, 1967, p. 26

Table 9. Some average freight rates for kraft linerboard from the United States and Finland to Europe and Japan.

Origin	Destination	Rate
		US dollars per sh.ton
US Pacific Coast	Europe	37.42
US Atlantic Coast	Hamburg	28.50
US Atlantic Coast	Italy	30.50
Finland	Hamburg	11.70
US Pacific Coast	Japan	28.80

Source: Information obtained by letter in 1969 from:
- Pacific Coast European Conference, San Francisco.
- North Atlantic Continental Freight Conference, New York.
- Finnish Board Mills Association

Containerization

Containerization is a future possibility for transport between the United States and Europe that could reduce the handling costs of pulp, paper and board. Shipment by charter is, however, the principal means of transportation at present.

Shipment by Charter

This means of transportation is a way of offsetting transportation disadvantages from the Pacific Coast to Europe. Integrated companies ship cargoes composed of kraft linerboard and other forest products. Moreover, charter freight rates are reduced by exporting forest products and importing European products, such as cars, on the ship's return journey. Similar arrangements are also made in exporting to Southeast Asia.

Improvement of Handling Techniques

Several pulp and paper companies are inaugurating new overseas shipping systems. One company ships from the Southern United States to Europe in a vessel specially designed to handle large rolls. Sailing every 30 days, this ship assures a dependable delivery with reduced damage to the rolls. Moreover, regular delivery makes possible a reduction of overseas inventory.

Improved performance will also be accomplished by a system developed by another company. The heart of the new system will be a specially designed 43,000-ton cargo liner with a back-up fleet of 233 identical 400-ton barges. The liner will carry 73 pre-loaded barges that can be hoisted directly into or out of holds at 15 minute intervals by a giant 500-ton crane permanently aboard ship. Plans call for the vessel to carry different pulp and paper products outbound from the Gulf of Mexico and southeastern ports of the United States to the United Kingdom and Europe, returning inbound with a general cargo. A 30-day turnaround cycle is expected. The vessel will carry more than 250,000 tons of paper products per year. Its principal advantage will be a substantial reduction in handling costs. Such improvement in the overseas systems can be expected to reduce North America's transportation disadvantage in supplying European markets.

Total Manufacturing Costs of Kraft Linerboard, Bleached Kraft Pulp and Newsprint in Different World Areas

In this section the agregate manufacturing cost is presented for bleached kraft pulp, newsprint and kraft linerboard, with emphasis on this last one (Table 10). What can be said for one product is largely true of the others also. For the sake of comparison between regions with widely varying manufacturing conditions for wood pulp, it is necessary to base the study on identical mills in the different regions. Pulpwood and manufacturing costs have been taken from R. A. Daly and Company's study (1969). The capacity of the mills has been chosen at 150,000 tons per year, with a further model at 250,000 tons per year in Western Canada and in the Pacific Northwest, where ample pulpwood supplies would permit building a mill of this size to capture economies of scale.

Manufacturing costs are low in the case of Finland because of the 1967 devaluation. Before 1967, however, costs were at the same level as

Table 10. Net manufacturing cost of kraft linerboard in an integrated mill of 150,000 tons per year with the influence of scale economies in Western Canada and the Pacific Northwest, 1968.

	Finland[a]	Sweden	Southern U. S.	E. Canada	W. Canada and Pacific Northwest	
Capacity (1,000 tons)	150	150	150	150	150	250
			US dollars[b]			
Pulpwood costs	47.20	61.10	37.00	46.20	30.50	30.50
Conversion costs	30.50	35.10	41.60	37.90	37.90	35.20
Total manufacturing cost	77.70	96.20	78.60	84.10	68.40	65.70
Capital costs	12.80	15.70	15.70	15.70	15.70	12.80
Total cost	90.50	111.90	94.30	99.80	84.10	78.50

[a]Figures after 17 percent devaluation of the Finnish mark.
[b]Before 1971 devaluation.

Source: R. A. Daly and Co. Ltd., 1969, p. 72

those of Sweden. This reflects the possibility of using monetary policy to influence the competitive position of a country and to change directions of trade.

The cost of pulpwood accounted for 64 percent of the total manufacturing cost of linerboard in Sweden, but only 44 percent in Western Canada and the Pacific Northwest. This shows the effect of pulpwood costs on the final price of linerboard. Sweden, and Finland before devaluation, had the highest pulpwood costs.

Conversion costs, on the other hand, are lowest in Finland and highest in the Southern United States, while Eastern and Western Canada occupy an intermediate position. For a 250,000 ton mill in Western Canada and the Pacific Northwest, the conversion cost is lower than in Sweden.

It has been assumed that the plants in the model were identical and new. However, in Northern Europe in particular, new capacity is often brought about by expanding existing mills. Capacity can thus be increased at about half the cost of a new mill. In this way capital costs are lower and the competitive position of Northern Europe is increased.

Table 11 shows a comparison of costs of bleached kraft pulp, newsprint and kraft linerboard. Sweden has the highest cost for all these items, but would have a comparative advantage in the production of newsprint since for this product the difference between the highest and lowest costs is the smallest. This means that it would be more to the advantage of the Pacific Northwest to specialize in products other than newsprint.

Table 11. Comparison of manufacturing costs per ton of bleached kraft pulp, newsprint and kraft linerboard in selected world areas, 1968.

Area	Bleached Kraft Pulp		Newsprint		Kraft Linerboard	
	US Dollars	Index	US Dollars	Index	US Dollars	Index
Sweden	131	100	92	100	104	100
Finland	108	82	73	79	84	81
Southern United States	107	81	89	85	82	
Eastern Canada	118	90	86	93	91	87
Western Canada and Pacific Northwest	96	73	79	85	74	71

Source: R. A. Daly and Co., Ltd., 1969.

Estimated Margin Per Ton of Kraft Linerboard Shipped to Germany (EEC) and Japan from Major Supply Areas

The competitive advantage of regions supplying the EEC and Japan will be estimated by the difference between the C.I.F. price of kraft linerboard in the EEC and Japan and the total manufacturing costs including transportation. This difference will be defined as the margin or gross profit.

To simplify the illustration, the competitive advantage of areas exporting to the EEC will be measured for shipments to Hamburg, Germany, the harbor of the principal EEC country importing kraft linerboard. The margin will be calculated as the difference between the C.I.F. price in Hamburg and total costs. Table 12 presents the margin for different supplying areas. Finland, because of devaluation, has the highest margin, then comes Western Canada and the Pacific Northwest due to scale economies; next is Sweden on account of its nearness to the Western European market; then the Southern United States and finally Eastern Canada.

The competitive advantage of the United States in supplying Europe has been illustrated by shipments to only one harbor in Northern Europe: Hamburg. Different results would be obtained in considering a destination in southern Europe. North America would have a greater competitive advantage in the Mediterranean area than in the North Atlantic area of Europe. For example, ocean freight per ton of kraft linerboard from Sweden is 10 dollars to Hamburg, Germany, and 23 dollars to Italy, a difference of 13 dollars. From the US Atlantic Coast, however, ocean freight is 28.50 dollars to Hamburg and 30.50 dollars to Italy, a difference of only 2 dollars. The competitive advantage of Sweden over North America

Table 12. Calculation of margin of competitive advantage for principal producers of kraft linerboard shipped to Hamburg, Germany, in 1969, illustrating the effect on the margin of economies of scale in Western Canada and the US Pacific Northwest.

	Finland[a]	Sweden	Southern U.S.	E. Canada	W. Canada and Pacific Northwest	
Capacity (1,000 tons)	150	150	150	150	150	250
			US dollars[b]			
Total Cost (Table 10)	90.50	111.90	94.30	99.80	84.10	78.50
Inland Freight	5.00	-	-	6.00	-	-
Insurance and Commission	4.00	4.00	5.50	5.50	5.50	5.50
Ocean Freight	11.70	10.00	28.50	28.50	37.40	37.40
Cost Delivered	111.20	125.90	128.30	139.80	127.00	121.40
Price of Kraft Linerboard C.I.F. Hamburg	145.00	145.00	145.00	145.00	145.00	145.00
MARGIN	33.80	19.10	16.70	5.20	18.00	22.60

[a]Figures after 17 percent devaluation of Finnish mark.
[b]Before 1971 devaluation of US dollar.

would then be decreased by 11.00 (13.00 - 2.00) dollars per ton.

Table 13 illustrates the margin of competitive advantage for countries potentially capable of exporting linerboard to Japan. Western Canada and the Pacific Northwest appear to have the greatest competitive advantage. Eastern Canada, Finland and Sweden, on the other hand, have negative margins, making export to Japan much less attractive, if not actually unprofitable.

Computation of the margin per ton of kraft linerboard has shown that Sweden and Finland have a definite competitive advantage in Germany. Western Canada and the Pacific Northwest would also have an advantage in Germany if economies of scale are achieved. Sweden and Finland have a lesser competitive position in the Mediterranean countries due to higher transportation costs. The Pacific Northwest and Western Canada have the highest competitive position for supplying the Japanese market. Export from Northern Europe and Eastern Canada to Japan is very unlikely as the margin is negative.

Although competitive advantage has been computed for kraft linerboard only, similar results would be obtained for kraft pulp and newsprint, whose manufacturing costs were presented earlier.

It should be said finally that among those regions assumed to have a comparative advantage in the manufacture of pulp, paper and board have been selected those having the highest competitive advantage and who consequently are most likely to export. Another way of seeing which regions have a competitive advantage is to analyze where capacity increases have taken place.

Table 13. Calculation of margin of competitive advantage for principal producers of kraft linerboard shipped to Japan in 1968, illustrating the effect on the margin of economies of scale in Western Canada and the US Pacific Northwest.

	Finland[a]	Sweden	Souther U.S.	E. Canada	W. Canada and Pacific Northwest	
Capacity (1,000 tons)	150	150	150	150	150	250
			US dollars[b]			
Total Cost (Table 10)	90.50	111.90	94.30	99.80	84.10	78.50
Inland Freight, Insurance and Commission	9.00	4.00	5.50	11.50	5.50	5.50
Ocean Freight	50.00	50.00	38.50	43.50	28.80	28.80
Cost Delivered	149.50	165.90	138.30	154.80	118.40	112.80
Price of Kraft Linerboard C.I.F. in Japan	145.00	145.00	145.00	145.00	145.00	145.00
MARGIN	-4.50	-20.90	6.70	-9.80	26.60	32.20

[a]Figure after 17 percent devaluation of the Finnish mark.
[b]Before 1971 devaluation of the US dollar.

Analysis of Pulp, Paper and Board Capacity Increases

Examination of capacity increases shows a posteriori which regions were considered by management decision makers to be the most profitable -- that is, possessing a competitive advantage for meeting increasing world demand. Capacity surveys by the FAO or pulp and paper associations are based on answers to questionnaires on projects of individual companies over the next four-year period.

Table 14 presents capacity increases from 1969 to 1974 as given by the OECD (1970, p. 13). By far the highest growth rate is in Japan, while the Scandinavian countries and Finland have higher growth rates than North America, which implies that they will keep their shares of the European market.

A recent survey by the American Paper Institute (1971) of announced installations of pulp, paper and board capacities by regions in the United States indicated that from 1971 to 1973 expansion in the Pacific and Rocky Mountain regions of the United States would be 5.5 percent in wood pulp production compared to a 10 percent average increase for the United States as a whole. For paperboard a 10 percent increase was indicated for the Pacific and Rocky Mountain regions and 10 percent also for the US average; for paper 3 percent in the Pacific and Rocky Mountain regions and 10 percent for the United States.

Regionally it appears, then, that relatively low capacity increases will take place in the West as compared to the rest of the United States. Examination of individual expansion projects (Pollitzer, 1972) also indicates that very little capacity increase will take place in Oregon and

Table 14. Planned increases in production capacity between 1969 and 1974 for wood pulp and paper and board in selected countries.

	Wood Pulp			Paper and Board		
	Production Capacity		Increase	Production Capacity		Increase
	1969	1974		1969	1974	
	1,000 Metric Tons		Percent	1,000 Metric Tons		Percent
United States	36,375	40,949	12.6	48,916	57,090	16.7
Canada	18,672	22,280	19.3	12,477	15,045	20.9
EEC	4,846	5,979	23.4	16,470	20,854	26.6
United Kingdom	439	589	34.2	4,965	6,107	23.0
Sweden	8,180	10,280	25.7	4,630	5,940	28.3
Finland	6,340	7,950	25.4	4,230	6,160	45.6
Norway	2,080	2,555	22.8	1,530	1,800	17.6
Japan	8,929	11,211	38.9	11,723	18,819	60.5

Source: OECD, 1970, p. 16-17.

Washington in particular.

The FAO (1969c) capacity survey included Latin America, Africa, the Near and Middle East, the Far East and Oceania. Rates of capacity increase in these regions surpass those of North America, indicating that the pulp and paper industry is becoming well established in these countries.

In conclusion, examination of capacity increases points to Northern Europe as retaining the world lead in attracting investment, showing that the Scandinavian countries and Finland have a definite competitive advantage.

Nevertheless, the domestic industries of the consuming areas in Europe, Japan and developing countries remain lively, indicating some advantage in supplying their own consumption. North America, in spite of its low production costs, has the lowest capacity increase for the period 1969 to 1974. This low capacity increase is especially marked for the Pacific Northwest of the United States.

This information, although seemingly a little incompatible with the cost analysis in the preceding chapter, can be explained in two ways: first, the Pacific Northwest has costs approximating those of British Columbia, but the slightly lower costs in British Columbia might be sufficient to attract investments there rather than to the Pacific Northwest. This would justify the major pulp and paper investments planned in British Columbia. Secondly, managers plan carefully to avoid excess world supply at a given price, thus assuring a satisfactory rate of return.

This last element suggests that the relationship between supply and demand may be a key factor in inducing capacity increase in a particular area. The relation between world consumption and production at prevailing prices for the immediate future will therefore be investigated to see if investment in pulp and paper in the Pacific Northwest can be justified at a level exceeding that currently planned, to the extent that foreign markets will be available.

World Supply and Demand Balance for Pulp and Kraft Linerboard

Balancing pulp and paper production at the world level is a valuable tool for investment decisions and for foreseeing directions of trade. This kind of study, however, requires extensive information, and generally, when dealing with specific products, such data are only available from private sources or are restricted to members of an association. In the course of research for this thesis, two studies were made available to the author: one concerning the prospective supply-demand position of chemical paper grade market pulp, 1971 to 1975, and the other dealing with kraft linerboard from 1971 to 1973. Both studies are particularly relevant as these products cover about 60 percent of total US pulp and paper exports.

World Balance for Chemical Paper Grade Pulp, 1971 to 1975

This study was carried out by the secretariats of the Pulp and Paper Associations in North America and Scandinavia. It concerns market pulp only, which is produced for sale to pulp consumers in competition with pulp from other producers. It excludes pulp for use or consumption by a producing mill or for shipment by a producing mill to other mills within its supply region which it owns, controls or is affiliated with.

Demand was defined in this study as the amount of market pulp that each region was normally expected to require from the North American and Scandinavian industries in the years under review. Demand figures were derived in the following way: tonnage produced domestically or imported from sources other than North America and Scandinavia was deducted from estimated consumption based on an assumption of continuance of present economic trends.

Supply (or capacity) in the context of the report was the amount of market pulp that would normally be available from each supply area under conditions of full demand and assuming an adequate supply of labor, material and power. The balance was the difference between the supply and the demand of total market pulp (Table 15).

It appears there will be a balance in the world between 1971 and 1975. A ratio superior to 95 percent is considerd to be full capacity utilization, 100 percent cannot, in fact, be obtained on the basis of historical experience.

The study was also carried out for particular pulp grades. For all grades the demand-supply ratio exceeded 95 percent for the 5-year period, although the individual-year ratio for unbleached sulfite was 91 percent in 1972 and 93 and 94 percent for unbleached sulfate in 1973 and 1974 respectively. This indicates excess capacity. The single instance where the ratio exceeded 100 was for bleached sulfate in 1972, showing a possible shortage for this year. For the following year, however, the balance between supply and demand was restored.

Table 15. Estimated balance of supply and demand of chemical paper grade market pulp for 1971 to 1975.

Country	1971	1972	1973	1974	1975
			1,000 Metric Tons		
Supply					
Canada	5,240	5,625	6,235	6,770	7,015
U.S.A.	3,435	3,475	3,840	4,160	4,480
Scandinavia	6,590	6,805	7,115	7,150	7,200
Total	15,265	15,905	17,190	18,080	18,695
Demand					
Canada	555	580	610	635	660
U.S.A.	4,380	4,630	4,810	4,960	5,095
Scandinavia	1,195	1,290	1,340	1,400	1,435
U.K.	1,860	1,920	1,980	2,040	2,110
Western Europe	4,860	5,250	5,610	5,970	6,420
Eastern Europe	230	230	230	230	210
Latin America	350	300	260	260	250
Japan	770	850	940	1,030	1,130
Oceania	220	220	230	235	220
Asia and Africa	430	445	460	480	480
Total	14,850	15,715	16,470	17,240	18,010
Balance	+415	+190	+720	+840	+685
Ratio: Demand/Supply	97%	99%	96%	95%	96%

Source: Secretariats of the Pulp and Paper Associations in North America and Scandinavia.

World Balance for Kraft Linerboard: 1971 to 1973

A projection of home demand is given in Table 16 for the United States, Canada and Scandinavia, as well as the import needs of Continental Europe, the United Kingdom, Latin America and all other import areas in Africa and the Near and Far East. Comparing world-wide capacities versus projected demand reveals operating rates for the North American and Scandinavian industries of 94 percent in 1970, 95 percent in 1971, 94 percent in 1972 and 96 percent in 1973. However, capacities listed are rated capacities under ideal production conditions without strikes, unscheduled maintenance, less productive grade mixes and many other reasons that can reduce production. These reasons usually eliminate about 3 percent of potential capacity, that is , a 97 percent operating rate is just about the best maximum practical production that can be accomplished. Comparing projected operating rates for the three years it is possible to deduce that there will be an over-supply of kraft linerboard of roughly 3 percent in 1970, 2 percent in 1971, 3 percent in 1972 and 1 percent in 1973.

Implications for the Pacific Northwest and for the Specification of a Supply Function

The Pacific Northwest has a competitive advantage in the shipment of pulp and paper to Japan, as well as to Europe if economies of scale are achieved. However, analysis of planned investment indicates that in the immediate future the Pacific Northwest will attract less investment than the rest of the United States. This can be explained by the fact that costs in British Columbia, although close to those of the Pacific

Table 16. Estimated world balance for unbleached kraft linerboard and ratio of import demand to export capacity, 1971 to 1973.

	1971	1972	1973
		1,000 Sh. Tons	
Average Capacity USA/Canada/Scandinavia	14,621	15,667	16,182
Projected Demand:			
USA	10,475	11,140	11,725
Canada	570	605	640
Scandinavia	127	132	137
EXPORT CAPACITY	3,449	3,790	3,680
Import Demand:			
Europe	1,940	2,095	2,290
Latin America	388	400	412
Africa, Near & Far East	397	345	363
TOTAL IMPORT DEMAND	2,725	2,840	3,065
BALANCE	724	950	615
Import Demand / Export Capacity	95.0%	93.9%	96.2%

Source: Marketing research department of a US pulp and paper company, November, 1970.

Northwest, are lower, and the differential is enough to attract investment. Another factor that may limit further increases in investment in the Pacific Northwest is the anticipated general price situation for pulp and paper which would make further investment unprofitable. For this reason, estimated consumption and production capacity for the next few years were compared and appeared to be approximately balanced. Any investments in addition to those already planned might therefore lead to price decreases, making further investment less profitable.

A need becomes apparent at this point to know more about the responsiveness of price to change in the industry's production in the market for finished products such as pulp or kraft linerboard. This will be investigated in Chapter VI.

Before closing this chapter some implications can also be drawn concerning the specification of a supply function for the econometric model of Chapter VI. In theory, the quantity of an economic good supplied during a given time period is a function of the price of the commodity, factor costs of the industry, and the prices of alternative products that the industry might produce. In practice it is now possible to be more specific. For instance, supply of kraft linerboard might be expressed as a function of its price, pulpwood price, average hourly earnings, price of wood pulp (its major alternative product), industry capacity (to reflect investment decisions), and transportation cost (a key factor determining competitive advantage in a given market).

In Chapter VI other variables will be investigated, particularly level of inventories, unfilled orders and the level of profit. Before proceeding to develop an econometric model, however, more information is essential on the type of competition existing in the US market and in the international trade of pulp, paper and products to provide further insight on the relationships among variables to be specified in the demand and supply functions of a model. In the next chapter, then, extent of product differentiation, channels of distribution and pricing policies are examined.

V. MARKETING PRACTICES IN THE INTERNATIONAL TRADE OF PULP, PAPER AND BOARD

This chapter contains a review of product differentiation, channels of distribution and pricing policy in the US domestic market and in the international trade of pulp, paper and board with a view to obtaining a better framework for specifying an econometric model and also to relate implications to the existing behavior of the industry. It will be demonstrated how pulp, paper and board are differentiated and how successful producers have been, in the eyes of the consumer, in differentiating products. A review of the marketing organization of exporters should reveal how strong the ties are between US exporters and foreign customers. An analysis of tariffs will reveal which products are protected and how high tariff barriers are. Examination of pricing policy will indicate what type of competition exists in the international trade of pulp, paper and board as well as the important elements to be considered.

Product Quality

Although pulp and kraft linerboard are intermediate rather than end products, they are sold with a trademark and thus are distinguished from other goods, that is, those of other producers. For instance, the Finnish classification for chemical wood pulp (Holopainen, 1960, p. 73) has eleven brands under the product unbleached sulphate pulp: two for bleachable or light and strong pulp, five for kraft pulp and four for kraft extra strong pulp. A great number of brands exist also for North American pulp and paper products. In Lockwood's Directory (1970) more than 10,000 watermarks and brands are listed as used in the American pulp and paper trade.

The reason for brands is that they protect their owners by giving a certain measure of control over demand for the product. The producer creates a preference for his product through differentiation. This does not exclude the price factor in marketing brand articles, but it diminishes its significance. Buyers are also in favor of brands which protect them as to standards of quality. In 1958 Holopainen (1960, p. 73) conducted a study of brand demands in reservation contracts concluded between the Finnish Cellulose Union and buyers in certain typical countries. It was found that "brand-mindedness" is rather common. More than 90 percent of the number of contracts were made on a one-brand basis.

Small buyers appeared to be more "brand-minded" than large buyers primarily because small scale enterprises usually specialize more than large companies. The study pointed out that traditional cellulose buyer countries are generally highly industrialized and have a paper industry and other cellulose-using industries of a high technical standard and high degree of specialization. There is keen competition between the different enterprises and they are more "brand-minded" than the newcomers, the less developed countries.

On the marketing side of the question, brands remain an important factor in sales in spite of technological progress and the increasing use of mixtures of pulp that might lead to a greater possibility of substitution between grades of pulp and eventually brands.

Concerning kraft linerboard, great effort has been made on the part of Scandinavian and North American producers to introduce specialty products -- heavyweight board and wet strength board. This type of export is expected to increase as packaging in consuming countries becomes more sophisticated.

In conclusion, differentiation is an important factor in the international marketing of pulp, paper and board. This trend will probably continue, as well as the creation of new products.

Organization of Overseas Operations and Integration

Most US exports of pulp, paper and board are made by about ten large American companies specialized in forest products. Six of these companies have sales offices abroad either in England or in other European countries. Two use US agents and one sells piggyback, that is, this company (the rider) uses established distribution facilities abroad belonging to another manufacturer (the carrier). One uses its affiliates in Europe as an intermediary. The rest of pulp, paper and board exports, probably less than 20 percent, is handled by agents who buy from diverse companies in the United States for exporting to various parts of the world. The number of these agents has been reduced during recent years from ten to five, due to large companies' increased interest in foreign trade. Most of these agents have developed a strategy that consists of broadening their product line to face the competition of large companies that tend to specialize in a few products(Thevenon,1970).

Among US exporters of pulp, paper and board, five have subsidiaries abroad that are mostly box plants, thus realizing a complete integration from the US forest to the European consumer. The fact that US companies have subsidiaries abroad affects the direction of trade. Indeed, most of these companies ship directly to these subsidiaries or affiliates.

Ties between US paper companies and foreign subsidiaries are reflected in a survey conducted by the American Paper Institute (Locke, 1969). Thirty American paper companies have invested an aggregate of about two billion dollars in 41 countries. In 1968 alone, these investments generated a total net inflow into the United States of 457 million dollars. The President of the American Paper Institute confirmed the existence of such ties and their beneficial effects by saying:

> The foreign subsidiaries of American industry as a whole are known to take about 25 percent of all American exports, and we believe the paper industry is fairly close to the norm in this respect (Locke, 1969, p. 53).

Investments abroad are undertaken not only by North American producers but also by Scandinavian producers (Skogsindustriernas Samarbetsutskott, 1971, p. 402).

In conclusion, although the US agent is still used, there is more direct trading, combined, for certain countries, with foreign agents and acquisition of foreign subsidiaries.

Tariffs

Trade barriers among member countries of the EEC were eliminated in July 1968, but a common external tariff is maintained. The Kennedy Round negotiations, held under the General Agreement on Tariffs and Trade in Geneva led to substantial tariff cuts phased over a four year period beginning in 1968.

Tariff reductions of 25 percent on pulp, paper and board were granted by the EEC. Duties were reduced from 16 to 12 percent for kraft paper, linerboard and writing and reproducing paper, and from 6 to 3 percent for wood pulp, quantities under 1,935,000 metric tons being duty free. Tariff reductions granted by the United Kingdom were from 13.5 to 10 percent on kraft wrapping paper, from 12.5 to 10 percent for linerboard and from 16.6 to 15 percent for writing and reproduction paper. Wood pulp is duty free.

Pricing Policy

This section covers pricing policy used in international trade of pulp, paper and board. Some background on pricing policy in the United States is given first. Principal aspects of pricing policy at the international level are then examined.

Pricing Policy in the US Pulp and Paper Industry

To understand different pricing practices, some information must first be given on price making factors.

Price Making Factors

Stevenson (1940), Guthrie (1950) and Armstrong (1968) have pointed out characteristics of pulp and paper demand and supply that determine, in large part, price movements of these products and explain to a considerable extent price policies of sellers.

Demand for pulp and paper in general is quite inelastic (Guthrie, 1950) because paper products constitute a relatively small fraction of the value of the finished product for which it is used. However, demand fluctuates within rather wide limits because of business activity.

When there is excess capacity, that is, when mills are not working at maximum levels of production, supply is elastic; it is inelastic when there is no excess capacity. This can be explained by the fact that a new plant represents a very substantial capital investment and requires time to build. Thus, to reduce unit costs, a manufacturer operates as closely as possible to capacity.

Because of manufacturers' tendencies to use reserve capacity (Guthrie, 1950), there is strong and almost cut-throat competition in the pulp and paper industry. However, since this industry requires much technical know-how and capital, the market structure is most aptly designated as oligopolistio.

Pricing Practices

In view of the nature of the industry, price and production policies of pulp and paper manufacturers have occasionally been directed toward reducing price competition. This has taken the form of price leadership, open price filing and collusive or concerted action among individual producers or trade associations (Guthrie, 1950, p. 114). However, such restrictions on price competition have always been limited because of opposition from consumers and federal agencies enforcing anti-trust legislation in the United States. In order not to work illegally, most companies do not engage in active restriction of price competition. They simply keep prices constant. They are to a certain extent reluctant to lower prices, while buyers are not willing to pay a higher price when the same goods (kraft linerboard is a standard product) oan be obtained from other suppliers. A certain uniformity of price results. Because of competition among manufacturers wanting to decrease costs by large-scale selling, however, announced prices are not always those actually charged. During periods of excess capacity discounts are in fact offered.

In spite of manufacturers' desires to restrict price competition, the US Antitrust Law and the nature of the industry seem to preserve competition in the domestic market.

Pricing Policy on US Exports

Monopolies and other forms of restraint of trade are illegal in the United States since the enactment of the Sherman Antitrust Law in 1890. An exception, however, is provided in the Webb-Pomerene Act (1918) which permits an association of exporters to limit, or even eliminate, competition among themselves in export trade. The purpose of this act is to put American exporters on an equal footing with foreign monopolies or cartels in exploiting export markets.

For the pulp and paper industry the Pulp, Paper and Paperboard Export Association, formerly the Kraft Export Association, was organized under the Webb-Pomerene Law in 1952 (Travaglini, 1970).

It was not possible to get information directly from this Association. According to secondary sources, however, its major functions are to establish uniform prices and to distribute information concerning foreign markets. Its members, including about 15 companies, export 80 percent of the total US exports of pulp, paper and board.

In spite of the ability of the Pulp, Paper and Paperboard Export Association to fix prices in overseas markets, there is at present rather strong competition among suppliers of pulp, paper and board to the EEC, and US members are allowed to reduce prices below the minimum price fixed by the Association in order to meet Scandinavian competition. Moreover, the Association does not have an export monopoly. Twenty percent of pulp, paper and board exports come from non-members of the Association who are free, according to the US Antitrust Law, to export at prices other than those fixed by the Export Association (Curry, 1968; Beuter, 1969).

Scandinavian countries, as well as the United States, also have large export sales organizations: Scannews for newsprint, Scanfin for printing and writing paper, Scankraft for kraft paper and board, Scanpapp for paperboard and Scansulfil for paper made of sulfite pulp. In Finland most of the producers have a collective sales company called the Finnish Cellulose Union (Holopainen, 1960).

Such centralized organization makes it easier to come to international agreement. Such was the case in 1965 when, with extreme competition between Scandinavian and North American producers leading to greater and greater discounts, an arrangement called the North American-Scandinavian Gentleman's Agreement took place (Vaurs, 1968). The principal points agreed upon were: (1) that Scandinavian producers should decrease the production of their pulp mills from 85 to 70 percent; (2) that Canadians would not make any offer on the European market before August 1966 and (3) that a new pulp price list would be drawn up.

The success of this agreement was due partly to the good economic situation in the United States that led to an increase in US pulp consumption, thus absorbing excess Canadian production.

Cartel regulations were envisaged in the Havana charter for the International Trade Organization which was to have been created after the Second World War (Snider, 1967). These regulations, however, like the organization were never realized. Monopolies and other forms of trade restraint are illegal in numerous countries but law enforcement is confined within a country's boundaries (Scott, 1969). Restrictive practices therefore continue and their elimination will depend on coordinated international efforts.

Exchange of statistics which now takes place between North American and Scandinavian producers tends to reduce possible cases of over capacity. A difficulty remains, however, in that most consumers of this pulp, paper and board do not participate in these consultations. The consumer, though, still has the possibility of refusing the price list.

Most purchases of pulp, paper and board are based on an annual reservation. In the reservation are stipulated the quantity of cellulose or product ordered, the brand and an outline delivery schedule. Guidelines are given for prices, which are finally agreed upon quarterly, usually in an addendum drawn up in the month preceding each quarter of the year. Despite the reservation, buyers reserve the right to refuse an order in cases where the price is not satisfactory. Pulp, paper and board are sold exclusively on C.I.F. terms, with the seller responsible for chartering ships, purchasing transport insurance and arranging shipments.

Conclusion

This chapter has shown the importance of product differentiation in international trade of pulp, paper and board. This differentiation is accentuated by the existence of brands and also by increasing integration between producers and foreign customers through subsidiaries.

Pricing policy abroad is characterized by the existence of a US export association, one of whose main purposes is to fix prices for US exporters. There exist also in Scandinavia and Finland central marketing organizations that in fact reduce the number of sellers and consequently competition. It appears, then, that world suppliers of pulp, paper and board have the ability to avoid a collapse of the market by reducing production.

In spite of the fact that major producers have a certain ability to control price, competition exists between North American and Scandinavian suppliers and in order to participate in world trade it is useful to understand better the interrelationship of these competitive forces. As price decisions are made on a quarterly basis, it is appropriate to build a quarterly model representing competition between Scandinavia and North America.

VI. ECONOMETRIC MODEL OF US - SCANDINAVIAN COMPETITION IN THE KRAFT LINERBOARD MARKETS OF THE UNITED KINGDOM AND GERMANY

In Chapter IV the need became apparent for further knowledge of the responsiveness of price to change in the industry's production in markets for pulp, paper and board. Such knowledge would be of particular importance to potential exporters from the Pacific Northwest who might have to justify investments in pulp and paper and to evaluate their profitability.

For the Pacific Northwest two markets were identified: Southeast Asia, with Japan in a predominant position, and Europe. It was shown that exports in pulp and paper to Southeast Asia were mostly from the Pacific Northwest or British Columbia, and were conditioned particularly by the export of chips. Further research on exports from the Pacific Northwest to Southeast Asia would involve a study of the best location for a plant to serve Southeast Asia, taking into consideration cost of production, transportation, availablility of chips and the capital structure existing in Southeast Asia. Such an investigation, however, will not be carried out here, being beyond the scope of this study.

In the European market, Scandinavian competition seems to be the principal factor limiting exports from the Pacific Northwest. It appears most appropriate, then, to investigate factors at stake in North American - Scandinavian competition. For this purpose an econometric model was developed to represent in an organized manner the major factors influencing US exports to Europe, and to provide quantity elasticity estimates for US exports that would show the effect on price levels of marketing additional output. Some effects of tariffs also will be deduced quantitatively from the model.

A quarterly model will be constructed, because, as shown in the preceeding chapter, prices are determined on a quarterly basis by US and Scandinavian exporters. Kraft linerboard is taken as an example of pulp and paper products because of its importance in US exports. The theoretical background of the model is presented first followed by the different steps in its construction. The validity of the model is judged through its predictive power. Finally, some implications are drawn from it.

Theoretical Model

In the econometric studies concerned with international trade (Tinbergen, 1962; Polak, 1954; Linnemen, 1966; Waelbroeck, 1961), several theories have been developed. The variables included were income and geographical distances, capital flows and also price changes. Another study by Adams (1969) included other variables in a system of simultaneous equations; these were relative competitiveness, pressure of demand and an excess inventory measure. Relative competitiveness was defined as the export price of one country relative to export prices of other exporting countries; pressure of demand was the percentage deviation of production from the production trend, while the excess inventory measure was defined as the percentage deviation of inventory from trend in one country relative to percentage deviation of inventory from trend in another.

These last variables seem to be relevant to the international trade of kraft linerboard and have been incorporated in the model in order to explain the competitive forces at stake.

A theoretical framework has still to be set up, however, to incorporate and organize these variables. The work of Armington (1969)suggested that in the trade of one product between different countries several independent markets could be considered under the condition that the product could be distinghushed not only by its place of production but also by its place of destination. For example, kinds of US kraft linerboard destined for the United Kingdom or Germany are different from each other as well as different from Swedish kraft linerboard to the same destinations. Although kraft linerboard is a rather homogenous product, such distinctions are realistic, as Swedish kraft linerboard usually has a higher bursting strength than US linerboard. Furthermore, that destined for foreign markets is usually differentiated from that for the domestic market on a price basis.

For illustrative purposes the two following markets could be distinguished: the UK market for US kraft linerboard and the UK market for Swedish kraft linerboard. For each market there will be a supply curve and a demand curve: a demand curve for US kraft linerboard demanded by the United Kingdom and a supply curve for linerboard supplied by the United States to the United Kingdom.

Each kind of kraft linerboard can be expressed by X_{ij}, where i is the supplying country and j the country demanding this kind of kraft linerboard. Each X_{ij} is traded on a particular market in which there is a supply function QS_{ij} and a demand function QD_{ji}, where QS_{ij} is the quantity of kraft linerboard supplied by country i to country j, and QD_{ji} is the quantity demanded by country j from country i. In this market the product X_{ij} is traded at a price p_{ij}, charged by country i to country j.

It should be mentioned that Xij and Xji do not usually both exist at the same time. It is seldom indeed that a country be both importer and exporter of the same product (the United States being exceptional in the case of pulp, for instance). Moreover, it is probable either that these products Xij or Xji would be good enough substitutes to discourage reciprocal trade in one of them, or that tariffs or additional transportation costs would pose trade barriers in one direction or the other.

If kraft linerboard trade between the United States, Sweden, the United Kingdom and Germany is taken as an example, there would be $4^2 = 16$ potential products Xij for i = 1,2,3,4 and j = 1,2,3,4. But since the United Kingdom and Germany are strict importers and Sweden and the United States strict exporters, and since there is no significant trade between Sweden and the United States and between the United Kingdom and Germany, there actually are only eight products and consequently eight markets, each characterized by supply and demand functions (Figure 10). Each market is related to the others by prices and other variables as shown next.

First of all, Figure 11 illustrates the flow of material through the manufacturing process and inventories to the consumer. This diagram helps in organizing the variables relevant to the trade of kraft linerboard presented in preceeding chapters.

Figure 12 presents schematically an hypothesis of factors affecting the formation of prices of US kraft linerboard both in the domestic and UK markets. Each market is illustrated by supply and demand fuctions. The variables listed in each supply function are hypothesized to mater-

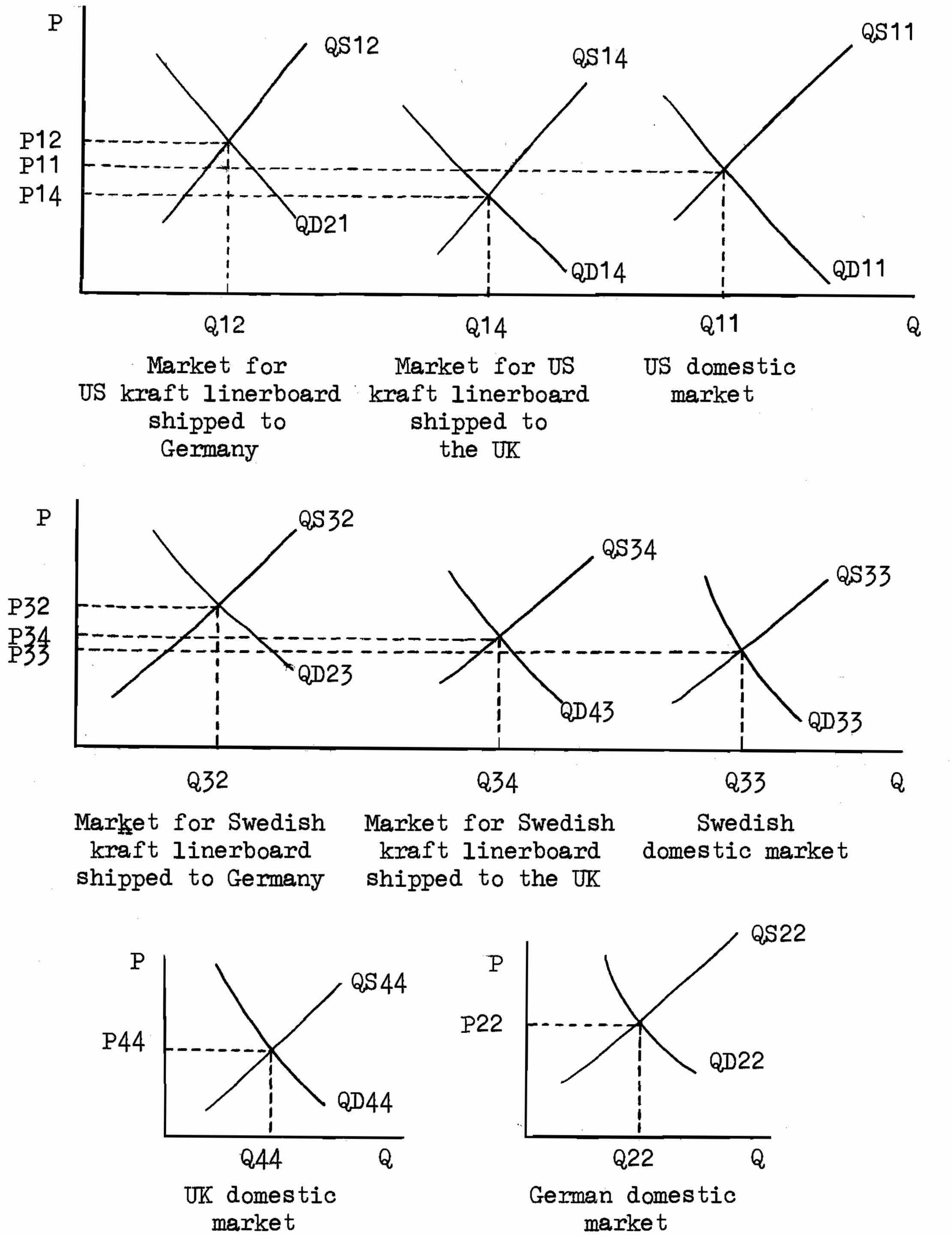


Figure 10. Graphical representation of the 8 markets describing trade-flows between two exporting countries (United States and Sweden) and two importing countries (United Kingdom and Germany).

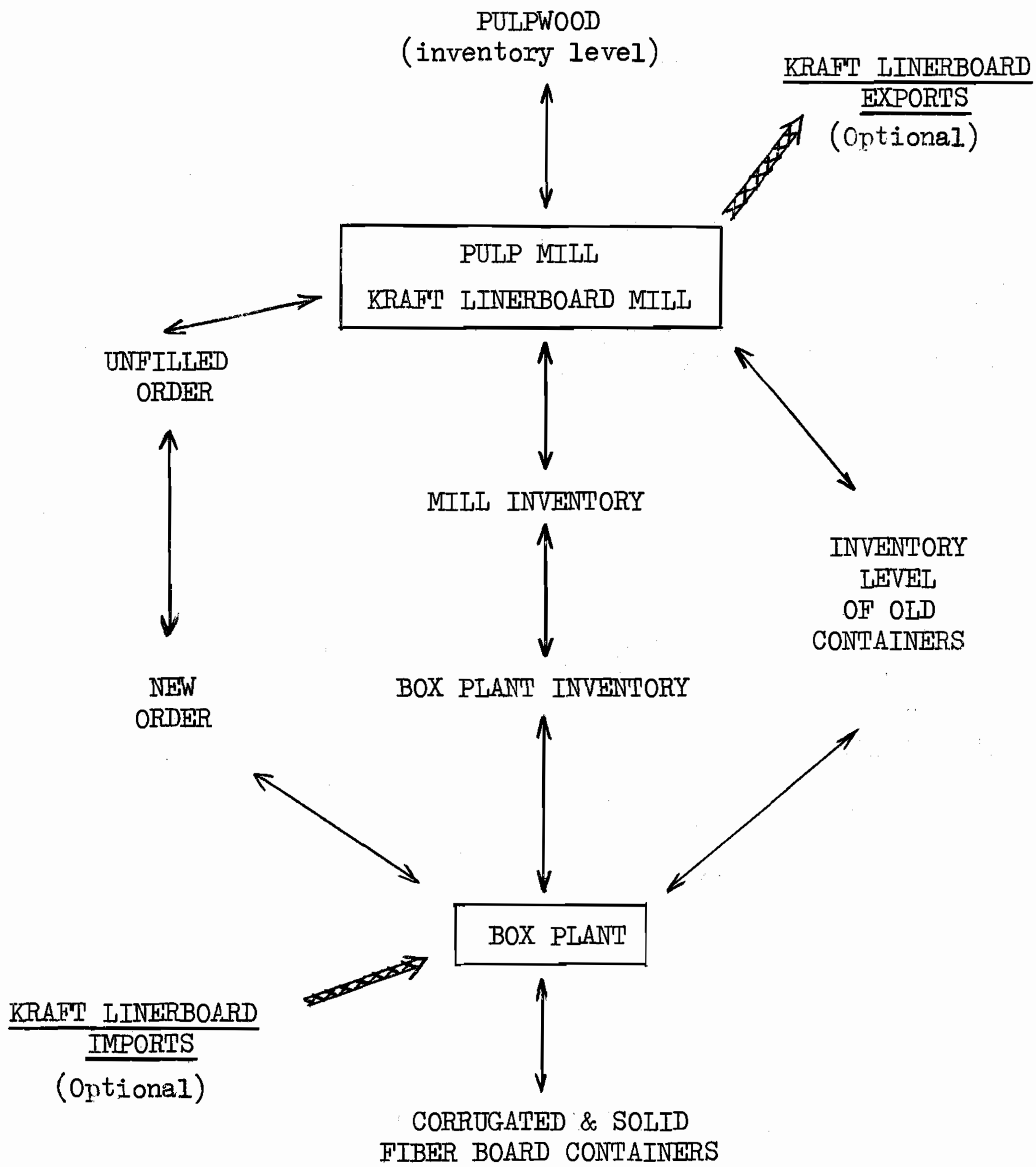


Figure 11. Market flow chart for kraft linerboard, tracing the usual flow of material from pulpwood to finished products, including recycling, foreign trade, unfilled and new orders and inventory levels.

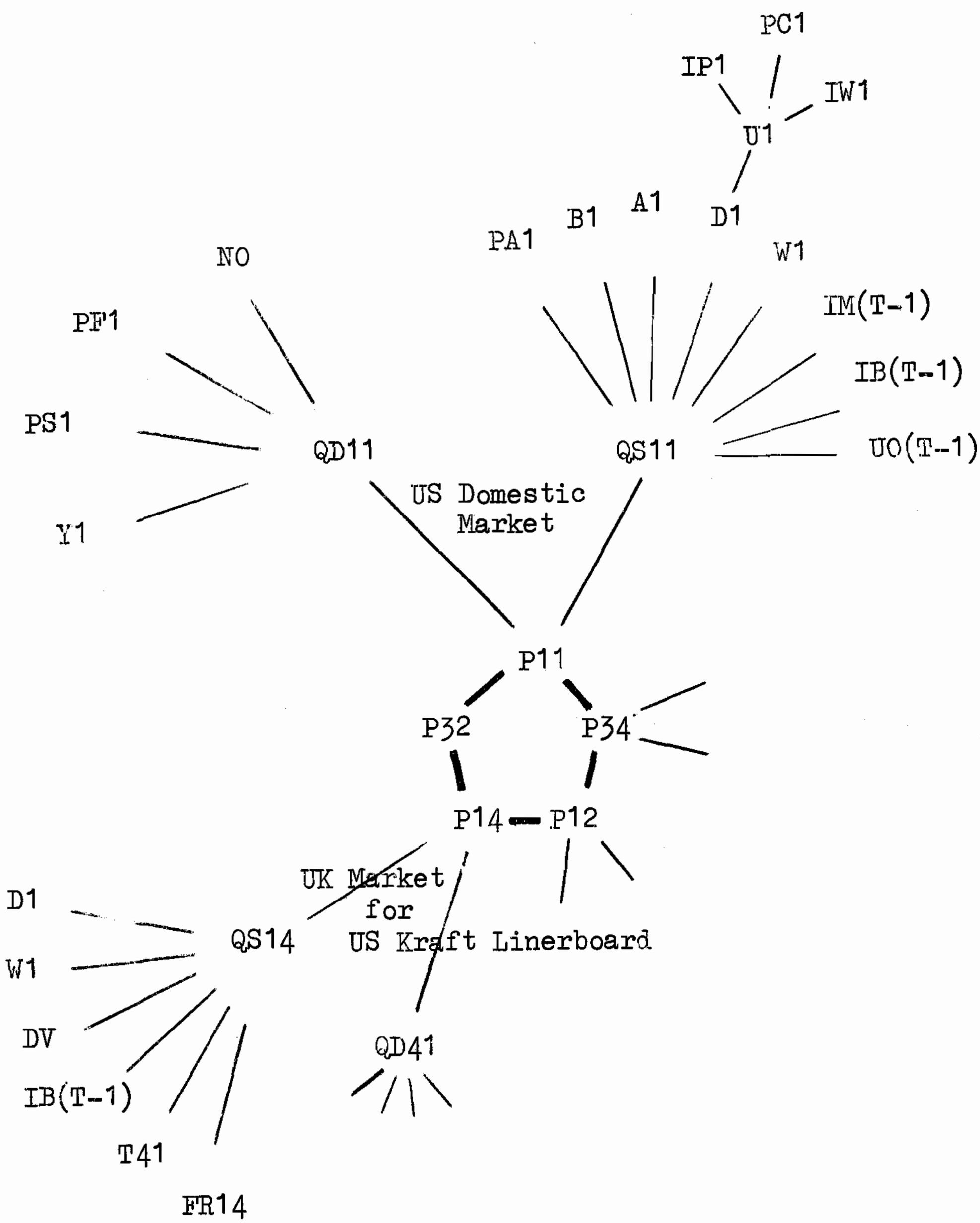


Figure 12. Hypothesis of the factors affecting the formation of prices in the US domestic market and the UK market for US kraft linerboard.

ially affect sellers' decisions, while variables in demand equations are supposed to affect buyers' decisions.

Prices and quantities are considered to be endogenous variables (that is, determined simultaneously in the system); other variables are exogenous (that is, determined outside the system). If, indeed, prices and quantities turn out to be determined accurately by the model, the market mechanism can be assumed to be satisfactorily understood.

Definitions of the variables presented in Figure 12 are as follows:

Endogenous Variables:

QDji	quantity of kraft linerboard demanded by country j from country i.
QSij	quantity of kraft linerboard supplied by country i to country j.
Pij	average price of kraft linerboard charged by country i to country j.

Exogenous Variables:

PCi	average price of old corrugated boxes in country i.
PAi	average price of unbleached kraft pulp in country i.
PFi	average price of new corrugated board in country i.
PSi	average price of a substitute for corrugated in country i (lumber).
IBi(T-1)	inventory level of containerboard in box plants at end of period T-1 in country i.
DV	dummy variable taking the value one for the years 1965 and 1966 to reflect an import surcharge imposed by the United Kingdom, and zero for the other years.
IMi(T-1)	inventory level of waste paper in country i.

IPi	inventory level of pulpwood in country i.
Di	price of pulpwood in country i.
Ni	industrial production in country i.
Wi	hourly earnings in the pulp and paper industry in country i.
Ui	percentage of waste paper used in the pulp and paper industry in country i.
Vi	productivity in the paperboard industry in country i.
Tij	index of external tariff rate of country i against country j.
Bi	ratio of profit per dollar of sales in the paper and allied products industries to the profit of all manufacturing corporations in country i.
FRij	freight rates from country i to country j.
Ri	production of kraft linerboard in country i.
Ai	new plant and equipment expenditure in country i.
NOi	new orders for paperboard in country i.
UOi	unfilled orders for paperboard in country i.

In Chapter IV it was shown that in the specification of a supply function for kraft linerboard should be included its price, the price of pulpwood, wages, price of wood pulp (alternative product), industry capacity and transportation costs. To these factors can be added also factors such as trend of inventory levels and relative competitiveness used in Adam's econometric studies (1969). In the present study use of actual levels of inventory was prefered, since in the short time period used a trend was difficult to identify. To express relative competitiveness, export prices as separate variables were used rather than ratios of export prices because absolute price values are more easily comparable to real values.

In the supply equation price of a raw material other than pulpwood, specifically old corrugated boxes, was also included. Factors affecting demand for pulp and paper products were presented in Chapter III. Quantities of a product demanded can be considered a function of the price of that product, the prices of competing and complementary goods and disposable income. In the case of kraft linerboard, lumber could be a substitute in packaging and its price has therefore been included in the equation. Price of finished products (corrugated board) is included too, as also are the levels of new orders which might be of importance in the short run. The level of unfilled orders has been assumed to affect quantities supplied.

An hypothesis has been presented here of the factors affecting the formation of US kraft linerboard prices in the domestic market and in the UK market. In the final analysis, of course, certain of these variables may be found to be statistically insignificant and thus eliminated.

Construction of the Model

The method used to build a structural model involves (a) specification of the model, (b) estimation, (c) testing, and finally (d) revision, re-estimation and re-testing until satisfatory results are obtained.

Specification

Because of the numerous possible flows of trade it was decided to concentrate on trade between four countries representing one third of the world trade of kraft linerboard. These countries are the United

States, Sweden, the United Kingdom and Germany. During the sixties, the United Kingdom was an EFTA member while Germany was a member of the EEC. Both of these countries were protected by different tariff barriers which were reduced or eliminated at different points in time, making the analysis of their imports more interesting from the point of view of international trade. Even if present negotiations for the United Kingdom's entry into the Common Market succeed, no major change will have to be made in the model. Following the theoretical framework presented above, trade between these countries can be represented by eight different markets. However, because of the importance of foreign trade to Sweden, the United Kingdom and Germany, it was assumed that domestic prices in these countries followed closely prices of imported kraft linerboard and that domestic production could be considered as predetermined. The number of markets studied was thus reduced from eight to five. The model in its general form is as follows (variables representing the domestic and UK markets for US kraft linerboard have already been presented schematically in Figure 12):

US Domestic Market

$$QS11 = f(P11, P14, D1, W1, V1, IM1(T-1), IB1(T-1), IP1, PC1, PA1, A1, B1, UO(T-1), U1, IW1) + e1$$

$$QD11 = f(P11, IB1(T-1), Y1, PS1, PF1, NO(T-1)) + e2$$

Market for US Kraft Linerboard Shipped to the United Kingdom

$$QS14 = f(P11, P14, D1, W1, DV, t, IB(T-1), T41, FR14) + e3$$

$$QD41 = f(P14, P34, DV, N4, PS4, IM(T-1), t, U4) + e4$$

Market for US Kraft Linerboard Shipped to Germany

$$QS12 = f(P12, P11, IB(T-1), N1, D1, W1, t, FR12) + e5$$

$$QD21 = f(P12, P32, N2, D2, t) + e6$$

Market for Swedish Kraft Linerboard Shipped to the United Kingdom

$$QS34 = f(P34, T43, FR34, DV, t) + e7$$

$$QD43 = F(P14, P34, N4, U4, DV, t) + e8$$

Market for Swedish Kraft Linerboard Shipped to Germany

$$QS32 = f(P34, N3, D3, W3, FR32, T23, t) + e9$$

$$QD23 = f(P32, P12, N2, D2, t) + e10$$

where

1 = United States

2 = Germany

3 = Sweden

4 = United Kingdom

ek = error term (k = 1,2...10)

t = time trend

Where time is not specified, variables are in time T.

As the structure of the international trade of pulp and paper has changed since the early sixties because of the creation of the European Free Trade Association and because American pulp and paper manufacturers have become increasingly aware of export opportunies (Smith, 1967), it was decided to include only data for recent years. Specifically, the 9-year period 1961 to 1969 was selected as the sample period, and data were gathered on a quarterly basis. 1960 was not incorporated in the data because Swedish Foreign Trade Statistics started a new detailed classification in 1961. The first quarter of 1969 was eliminated because of the longshoremen's strike of several months, reducing the number of observations from 36 to 35.

Seasonal fluctuations in the predetermined variables caused difficulty in estimating their net effects on the dependent variables. To avoid the use of dummy variables, the data were made comparable between quarters by eliminating seasonal variations. Each observation of a given variable was divided by its seasonal index number. The seasonal index numbers were the ratio between the centered four quarters moving average and the original data (Appendix B). Thus, in addition to the original set of exogenous and endogenous variables a set of seasonally adjusted variables was obtained.

A particular effort was made to study the US domestic market and the US export market to the United Kingdom. The reasons were that the data were more numerous and that it might be possible to draw from this experience some rule of thumb to study the other markets for which data are more scarce.

For the two equations QS11 and QD11 (US domestic market), time series of 19 variables were gathered. For each of these variables several lags for the inventory and cost variables were tried. A cost index was also investigated as multicollinearity could exist among the different variables. With these variables the total number investigated for these two equations was 73.

Selection of the variables for all the equations was made in two steps: first the statistical analysis of the data with the simple correlation matrix was used to determine cases of heavy multicollinearity, the choice between the correlated variables being made on the basis of economic theory and interviews; secondly, with the remaining variables, averaging from 7 to 15 according to the equation considered, a multiple-step least-squares regression program was run to determine which variables yielded a higher R^2. Where the variable of primary interest, such as price, did not appear, it was forced into the equations.

The final criterion for the choice of variables was that the R^2 value (the square of the multiple correlation coefficient) be the highest obtained subject to the following conditions: (1) that the combination of variables together appear to make economic sense after removing variables creating a multicollinearity problem, (2) that most coefficients be significant at or below the 5 percent level of significance. A variable whose parameter estimate had a low "t" value was not necessarily removed as the "t" test is used to test the hypothesis that the parameter estimate, but not the true value of the parameter, significantly differs from zero.

Estimation of Structural Coefficients

One objective of this analysis is to investigate the structure of international trade in kraft linerboard. It is essential that the least biased parameter estimates be obtained. The specified model consists of simultaneous equations with two or more endogenous variables per equation. Direct least squares estimation was therefore ruled out as a possible technique, as it would have resulted in biased and inconsistent estimates.

A parameter estimate is unbiased when its expected value is equal to the true parameter value, and consistent when it approaches its true value as the size of the sample increases. Consistent and efficient estimates of the coefficients may be obtained by full information maximum likelihood estimation, the property of efficiency being that the estimator possesses the smallest variance of all possible estimators. This method was rejected because of the large computation required. Consistent estimates could have been obtained by the "limited information" maximum likelihood method, but that was rejected in favor of the computationally easier method of two-stage least squares. With regard to the small sample properties of estimating techniques, the Monte Carlo studies, as presented by Johnson (1963, p. 275-295), suggest discarding full information maximum likelihood estimation as a practical tool, and indicate that two-stage estimation was found to be generally superior to the limited information approach.

The basic idea in two-stage least squares is to replace each endogenous variable on the right hand side of an equation by its predicted value based on the least squares regression of the endogenous variable on all the exogenous variables in the model and then to apply least squares again for each simultaneous equation (Johnson, 1963, p. 258).

This procedure provided a structural model for linerboard trade between the United States, Sweden, Germany and the United Kingdom.

US Domestic Market

$$
\begin{aligned}
QS11 = -1902 &+ \underset{(1.85)}{8.035P11} + \underset{(.32)}{1.386P14} + \underset{(1.67)}{2.005PC1} - \underset{(2.90)}{167.2IB1(T-1)} \\
&- \underset{(2.33)}{232.6UO(T-1)} - \underset{(2.04)}{3.957B1(T-2)} + \underset{(17.00)}{38.77D1} \qquad R^2 = .979
\end{aligned}
$$

$$QD11 = -737.2 - \underset{(3.46)}{9.287P11} + \underset{(27.39)}{18.35N1} + \underset{(3.01)}{85.72PF1} \qquad R^2 = .981$$

Market for US Kraft Linerboard Shipped to the United Kingdom

$$QS14 = 29296 - \underset{(1.76)}{683.5P14} + \underset{(1.10)}{1139F34} - \underset{(4.32)}{21600DV} + \underset{(2.88)}{849.1N1} \qquad R^2 = .682$$

$$QD41 = 18672 - \underset{(1.83)}{687.1P14} + \underset{(1.21)}{775.6F34} + \underset{(4.06)}{1197N4} - \underset{(5.54)}{22840DV}$$

$$- \underset{(2.27)}{24308IM(T-1)} \qquad R^2 = .752$$

Market for US Kraft Linerboard Shipped to Germany

$$QS12 = -41185 - \underset{(3.05)}{1399P11} + \underset{(2.60)}{1651D1(T-1)} + \underset{(2.72)}{28951IM(T-1)} + \underset{(1.64)}{819.3t}$$

$$R^2 = 898$$

$$QD21 = 50247 - \underset{(1.36)}{477.6P12} - \underset{(2.84)}{1093P32} + \underset{(13.20)}{1471D2} + \underset{(1.37)}{396.5N2} \qquad R^2 = .905$$

Market for Swedish Kraft Linerboard Shipped to the United Kingdom

$$QS34 = -18928 - \underset{(2.19)}{444.8P34} + \underset{(2.30)}{3380W3} + \underset{(2.95)}{511.9D3} + \underset{(4.04)}{132.2R3} + \underset{(.23)}{77.83F34}$$

$$R^2 = .874$$

$$QD43 = -32541 - \underset{(1.60)}{344.9P34} + \underset{(1.13)}{202.6P14} + \underset{(7.20)}{807.7N4} - \underset{(1.27)}{713.3U4}$$

$$R^2 = .829$$

Market for Swedish Kraft Linerboard Shipped to Germany

$$QS32 = -10414 - \underset{(1.91)}{465.1P32} + \underset{(3.91)}{3372W3} + \underset{(1.85)}{88.47R3} + \underset{(1.68)}{408.1D3} + \underset{(2.05)}{610F32}$$

$$R^2 = .756$$

$$QD23 = -67480 + \underset{(1.76)}{287.4P32} + \underset{(2.59)}{386.4P12} - \underset{(4.25)}{520.3D2} + \underset{(4.59)}{217.2N2} \qquad R^2 = .830$$

The values of t are given in parentheses below the coefficients. The t value for 30 degrees of freedom is 2.042 at the 5 percent level and 1.697 at the 10 percent level. Definitions of the variables used in these equations are given in Appendix C with the quarterly data from 1961 to the second quarter of 1971.

Interpretation of Results

US Domestic Market

R^2 is very high in both equations. The signs are those expected according to economic theory except for B1(T-2) and D1(T-1). The minus sign in front of B1(T-2) and UO(T-1) can perhaps be explained by the fact that when favorable conditions (profits and unfilled orders high) exist in the industry, there is a tendency to restrain production, leading to higher prices, then higher profit and eventually to additional reduction of quantities produced. On the other hand, when unfilled orders and profit decrease, output is increased, leading probably to lower prices lower profit and a further increase in output. This represents a rather disrupting behavior, in the sense that in both cases the course of action leads to a sharp increase or decrease in prices. This helps to explain the collapse of prices in 1961 and in 1968 which occured in the pulp and paper industry.

The positive sign in front of D1(T-1) is probably due to an increase of output in spite of rising pulpwood costs. However, it should be remembered that pulpwood costs have increased slowly and have certainly been compensated by technological improvements in the manufacture of kraft linerboard.

In the supply relationship, the coefficient of the price of kraft linerboard exported to the United Kingdom is not significantly different from zero, and so the possibility that prices in foreign markets have no influence on the US domestic price should not be excluded.

Market for US Kraft Linerboard Shipped to the United Kingdom

Compared to the other equations of the system, it appeared that for these two equations R^2 is the lowest. This shows the difficulty of representing economic forces in the UK market. The curve QS14 has a downward slope, which is rather surprising for a supply curve. An interpretation is difficult to give as such a case might occur only in the presence of external economies (Henderson and Quandt, 1958, p. 93), that is, when the expansion of one firm's output lowers the total cost for other firms.

For the export of kraft linerboard such an explanation would not be justified as there is no real interdependence between companies, and another reason should be sought. Export is very often only part of the major activity of a domestic producer. Frequently, though, because of the oligopolistic character of the industry, prices are not lowered to allow the sale of unsold quantities. Thus US exporters might dump unwanted quantities of kraft linerboard in foreign markets, even when price is declining. Such behavior seems also to exist in the UK market for Swedish kraft linerboard. Indeed, the supply curve QS34 also has a downward slope, meaning that US exporters are willing to export even when prices are decreasing. This can also be interpreted as their desire to keep their share of the UK market.

The coefficient of the dummy variable (DV) indicates that quantities supplied and demanded during 1965 and 1966 have been reduced by about 20,000 short tons because of the import surtax imposed by the United Kingdom.

Market for US Kraft Linerboard Shipped to Germany

In the supply equation, as the coefficient of P12 is not significant, it appears that the export price does not influence export volume to Germany. The major factors appear to be inventory levels in the United States and pulpwood price in Germany.

In the demand equation, as expected, the price charged by Sweden affects adversely quantities of US kraft linerboard demanded by Germany. The sign of the coefficient of D2 is positive, indicating that increases in pulpwood prices in Germany lead to increased imports of US kraft linerboard.

Market for Swedish Kraft Linerboard Shipped to the United Kingdom and Germany

In these markets the supply equations have a downward slope indicating, as mentioned earlier, that Sweden exports greater amounts at a lower price to keep her share of these foreign markets.

The coefficients of D3 and W3 are positive, showing that quantities offered are growing in spite of cost increases. Unfortunately, productivity was not included to see the variation of output with rising or decreasing costs.

Testing the Model

"The only relevant test of the validity of a hypothesis is comparison of its predictions with experience" (Friedman, 1953, p. 8). A distinction should be made, however, between comparing prediction with experience inside versus outside the sample period, the latter being the real test. It is indeed possible to find hypotheses consistent with the evidence inside the sample period, but additional evidence should be introduced either to eliminate or confirm these hypotheses. This can only be done by using data outside the sample period.

Two methods can be used for prediction: (1) the estimated reduced form equation system or (2) the solved structural equation system. The estimated reduced forms are obtained by expressing each of the endogenous variables of the model in terms of all the predetermined variables. The coefficients of the resulting set of equations can be properly estimated by traditional least squares techniques since each endogenous variable is now a function of only predetermined variables. The second method consists in deriving algebraically from the structural equations another set of reduced form equations. The problem arises as to which forecasts to use, those from the least squares reduced form equations or those from the algebraically derived reduced form equations.

These two methods have been compared (Christ, 1956, p. 397-398). It appears, however, that for finite sample sizes, it is not known which method leads to less biased estimates. As the issue is unresolved, least squares reduced form equations were selected, requiring less computation. Half the equations were already computed during the first stage of the two-stage least squares method.

The coefficients of the least squares reduced form equations for the ten endogenous variables are given in Table 13. The results of the forecasts are given in the following sections. Before presenting the real test of the model, that is, the forecasts outside the sample period, the model's performance inside the sample period will be examined, as it is probable that a model forecasting satisfactorily outside the sample period will give good estimates inside the sample period.

Estimation of Export Values at Port of Shipment

Figures 13 to 17 give real and estimated price indexes of kraft linerboard in the United States and export values for the period 1961 to 1969.

For the four price trends P14, P15, P34 and P35, the reduced form estimates indicated the direction price would move 77 percent of the time. P11 was not considered in this test as the real values are for the most part constant.

The magnitude of estimation errors as a percent of real values never exceeded 3.6 percent except twice when it reached 5.3 and 5.6 percent for P14. These rather good estimations can be explained partly by the relatively small fluctuations of prices in absolute value.

Estimation of Quantities Exported and of US Production for Domestic Use

Figures 18 to 22 give real and estimated US production for domestic use and exports from Sweden and the United States for the period 1961 to 1969.

TABLE 17: COEFFICIENTS OF REDUCED FORM EQUATIONS

EXOGENOUS VARIABLES	FORECAST VARIABLES									
	Q11	P11	Q14	P14	Q12	P12	Q34	P34	Q32	P32
UO(T-1)	0	2.975000	36745.000	-9.88000	-685.290	19.51000	9206.200	-8.618000	1043.100	10.26900
B1(T-2)	-0.644880	-0.026960	-565.550	.45810	-53.243	.32040	132.490	-0.320100	-199.950	-0.09900
D1(T-1)	5.386300	-0.321900	2055.100	-0.46980	818.590	-1.73000	-543.260	.831000	-191.560	.32610
PC1	-0.279250	-0.029950	68.582	-0.03926	-53.694	-0.12170	67.690	-0.019990	103.730	-0.03853
N1	2.479200	.860300	-7650.500	1.14900	-1452.000	.32330	-805.980	.915300	1060.600	-0.28820
PF1	84.266000	3.797000	-27753.000	16.06000	-4079.600	1.58500	-230.930	2.340000	-4862.000	-1.63100
IB1(T-1)	-119.230000	6.608000	1432.300	-2.58900	-3345.900	6.73500	576.450	6.854000	9023.700	2.62900
D2	-0.082913	.065470	-369.450	-0.07718	-68.082	.02776	94.487	-0.058910	-19.714	.04978
N2	3.216100	-0.066950	-1116.400	-0.03525	255.150	.12250	-150.750	-0.125500	203.070	.22750
IM(T-1)	-21.774000	10.480000	-39108.000	3.80000	-6234.600	-11.50000	7076.900	-4.111000	11502.000	-2.08900
F34	4.433100	.225100	-1405.200	-0.16150	-309.970	.38610	-690.910	.934900	-915.460	-1.68000
F32	-2.126100	.406800	-5965.800	2.55300	-2455.100	-1.24400	-271.650	.254000	0	2.27000
N4	-2.874500	.491400	2998.800	-0.02980	1645.300	.10150	195.000	.621800	89.878	.01473
U4	13.094000	-0.915700	-2067.000	-0.47060	1019.000	-0.03207	-631.770	-0.871500	-1136.600	1.09200
R3	.907990	.030460	344.290	-0.02648	90.841	-0.16980	103.550	.082080	55.358	.06505
W3	66.042000	.187000	-1962.000	-1.04200	2479.500	-9.33700	-250.600	3.867000	-1359.200	2.12800
D3	3.956400	.283800	1298.700	-0.24430	-142.280	-0.28500	-18.704	.538000	82.371	.09457
t	5.197500	-1.221000	8852.200	-1.10000	652.410	2.43400	1946.100	-2.505000	-1215.600	-1.40400
CONSTANT	-1394.600000	-100.590000	929609.000	-207.70000	10283.000	249.80000	111703.000	-178.400000	-17267.000	6.10700

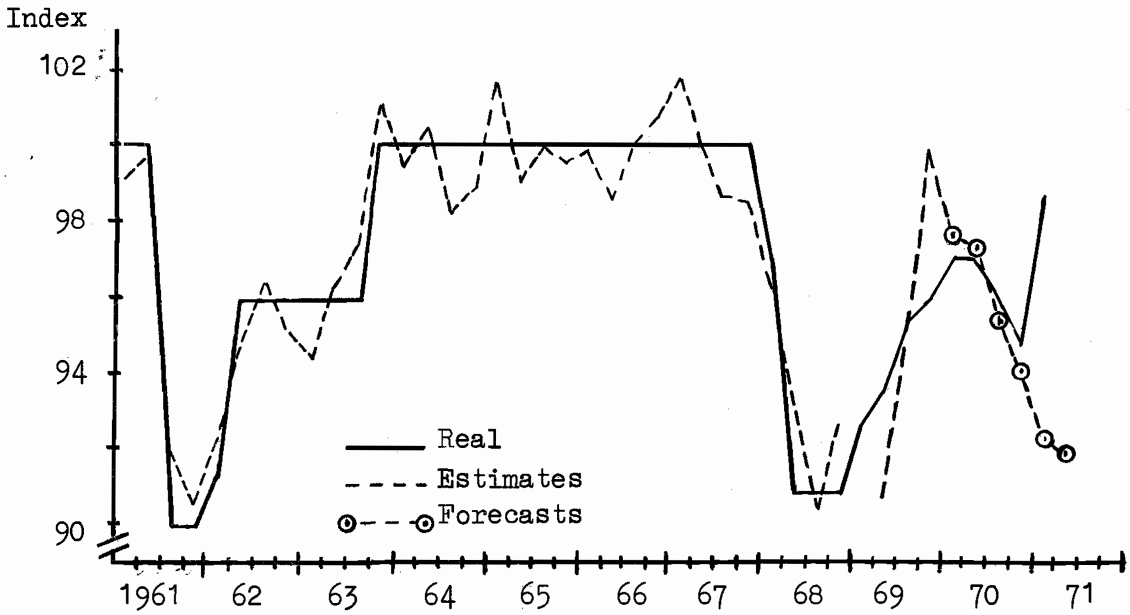


Figure 13. Quarterly price index (1963=100) of kraft linerboard in the United States (P11): real and estimated values (1961-1969), and forecasts for 1970 and the second quarter of 1971.

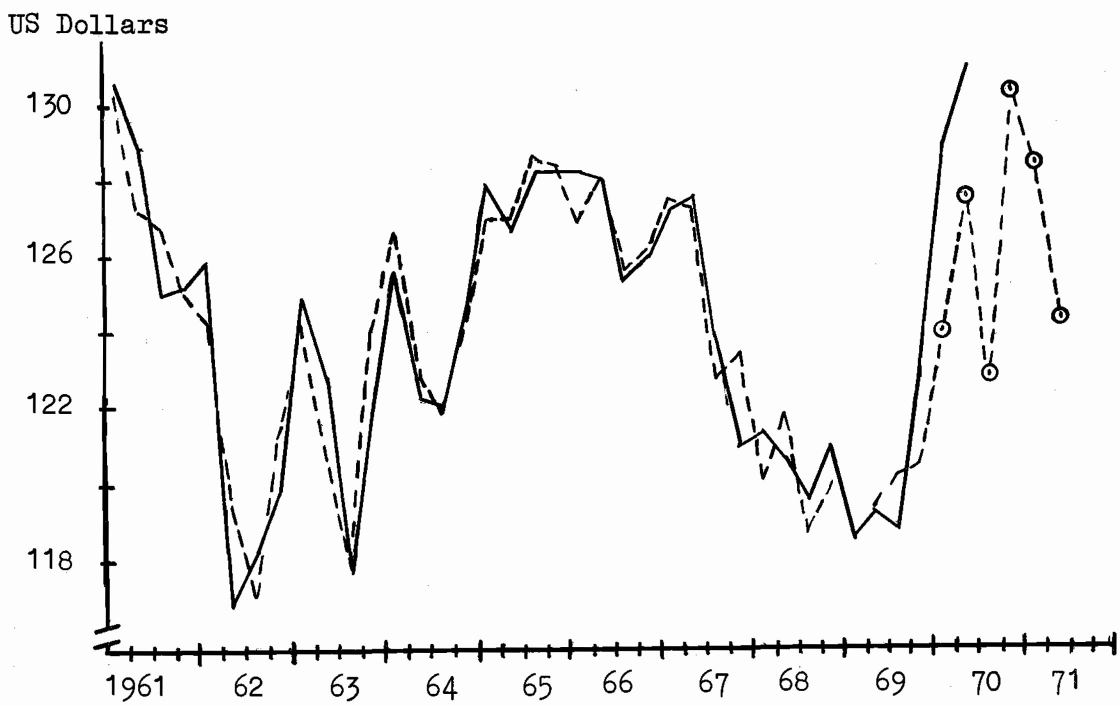


Figure 14. Quarterly average value at Swedish port of shipment of kraft linerboard for Germany (P32): real and estimated values (1961-1969), and forecasts from 1970 to the second quarter of 1971.

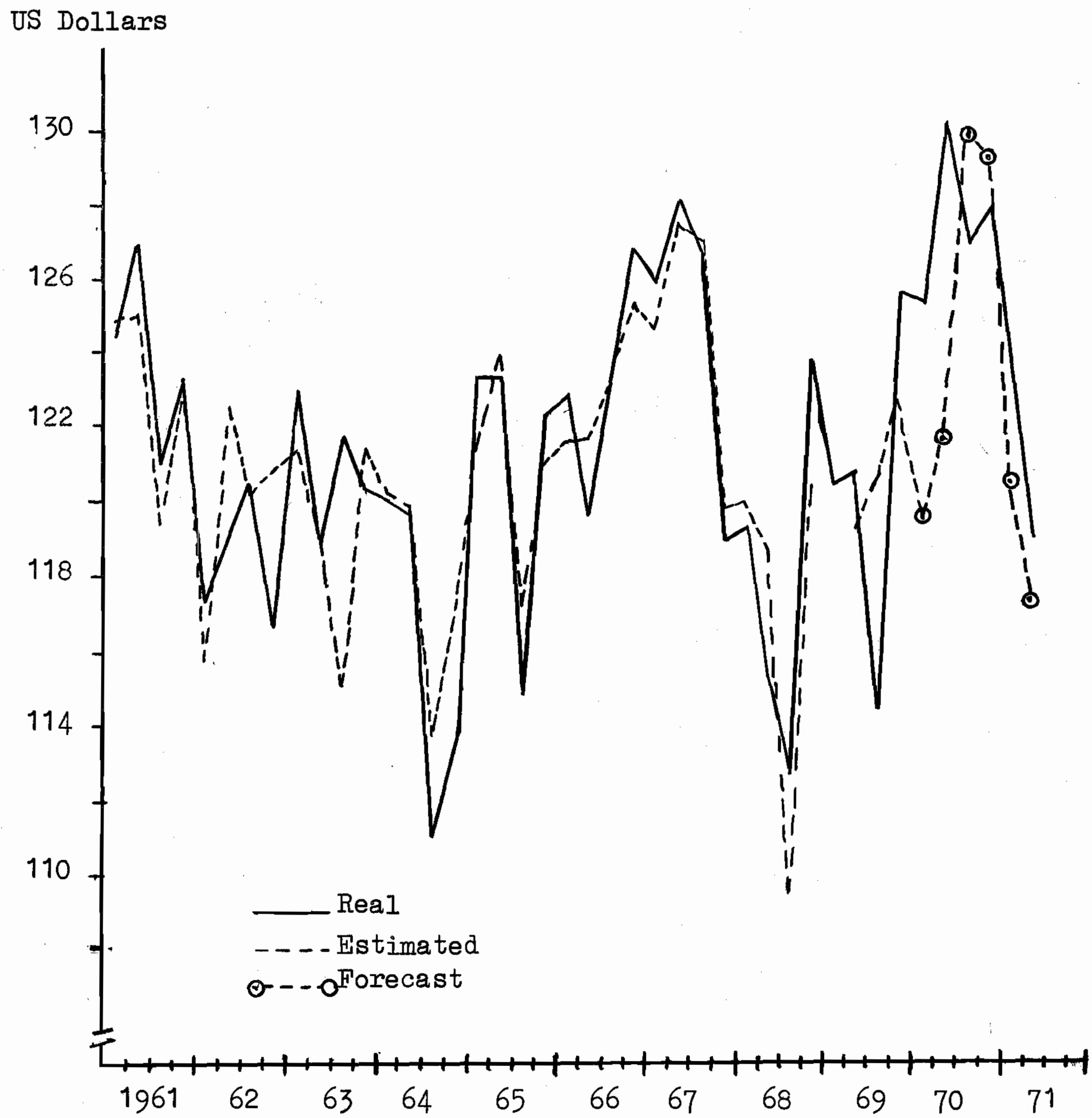


Figure 15. Quarterly average value at US port of shipment of kraft linerboard for the United Kingdom (P14): real and estimated values (1961-1969),and forecasts from 1970 to the second quarter of 1971.

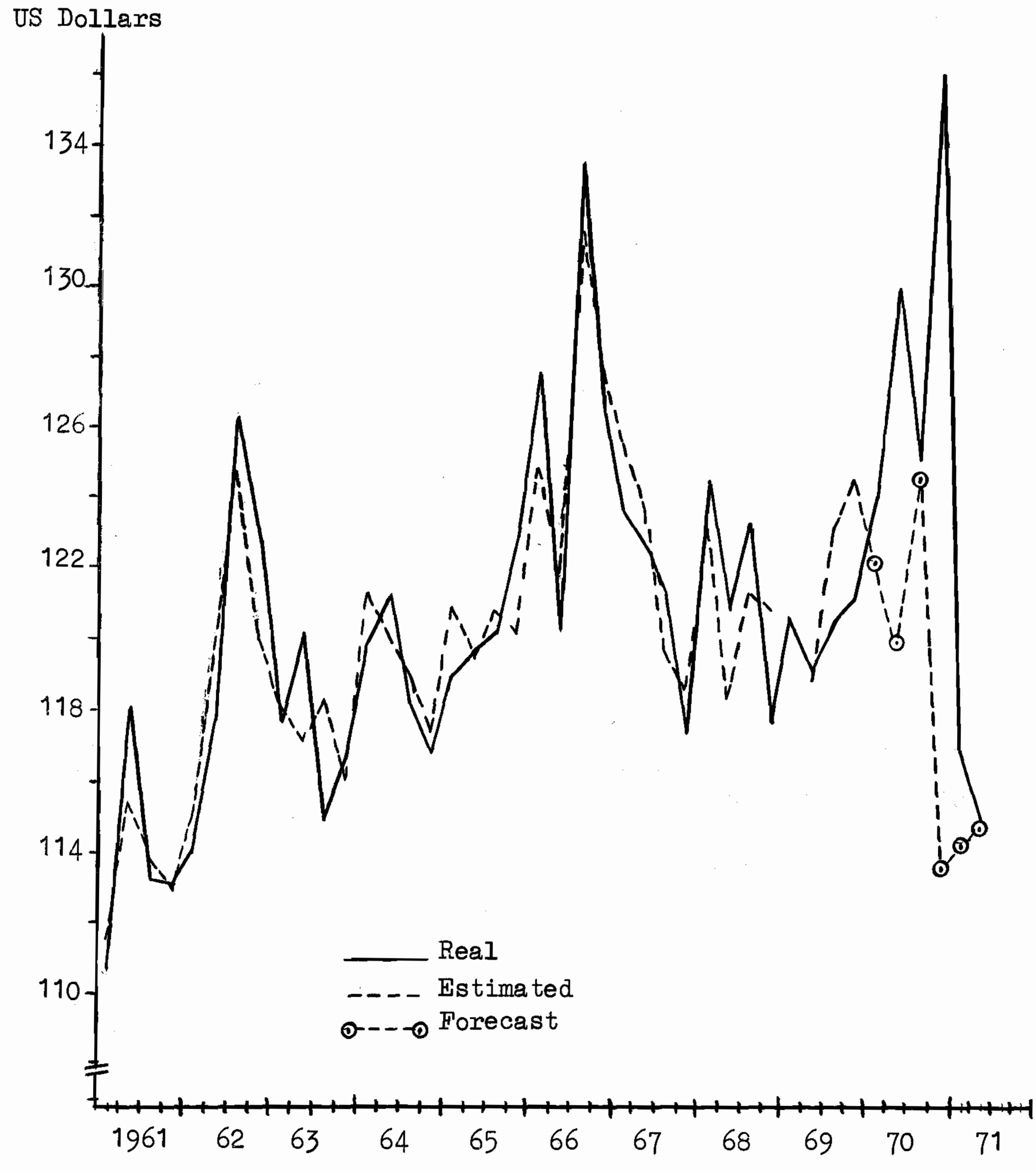


Figure 16. Quarterly average value at US port of shipment of kraft linerboard for Germany (P12): real and estimated values (1961-1969), and forecasts from 1970 to the second quarter of 1971.

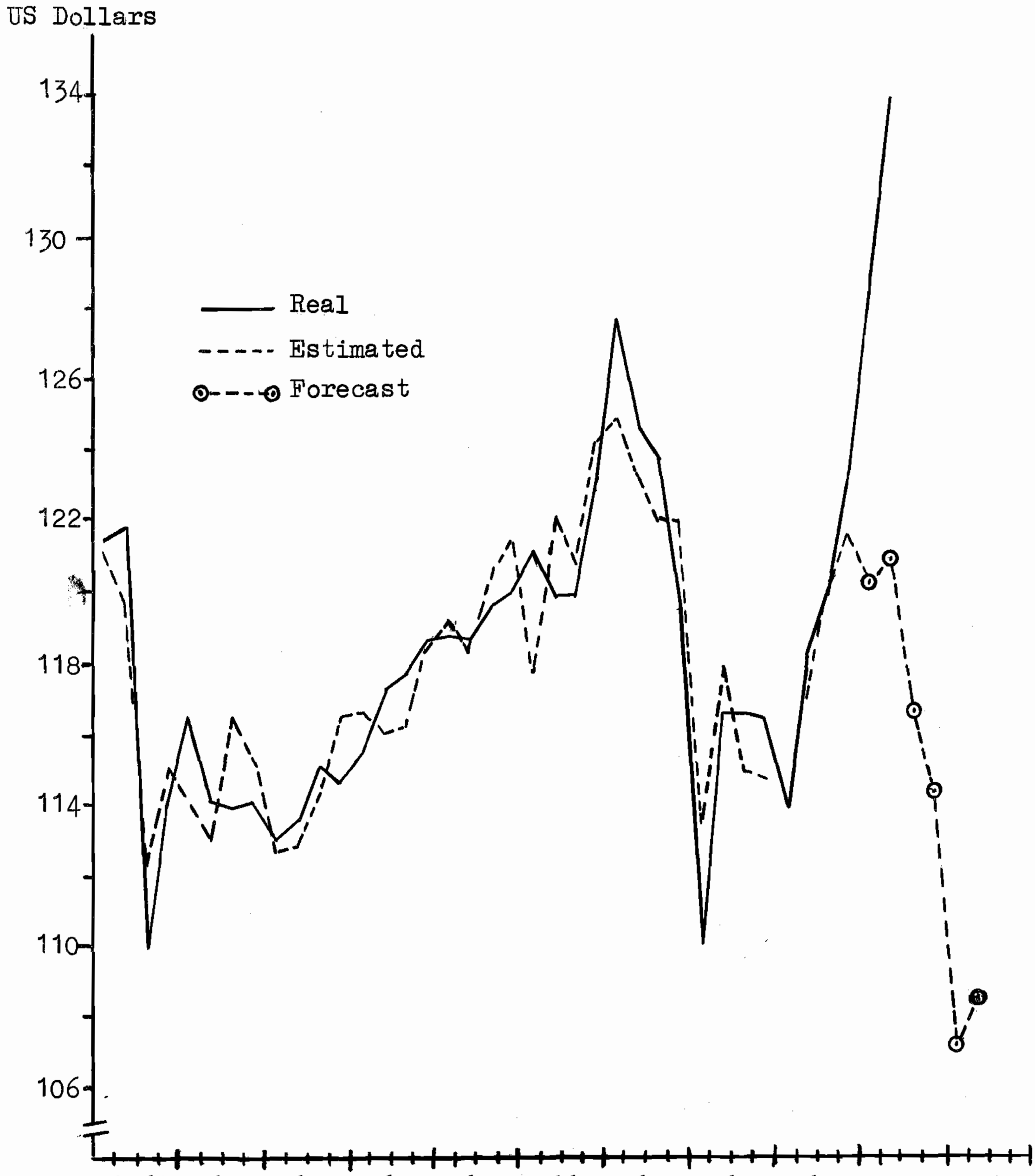


Figure 17. Quarterly average value at Swedish port of shipment of kraft linerboard for the United Kingdom (P34): real and estimated values (1961-1969), and forecasts from 1970 to the second quarter of 1971.

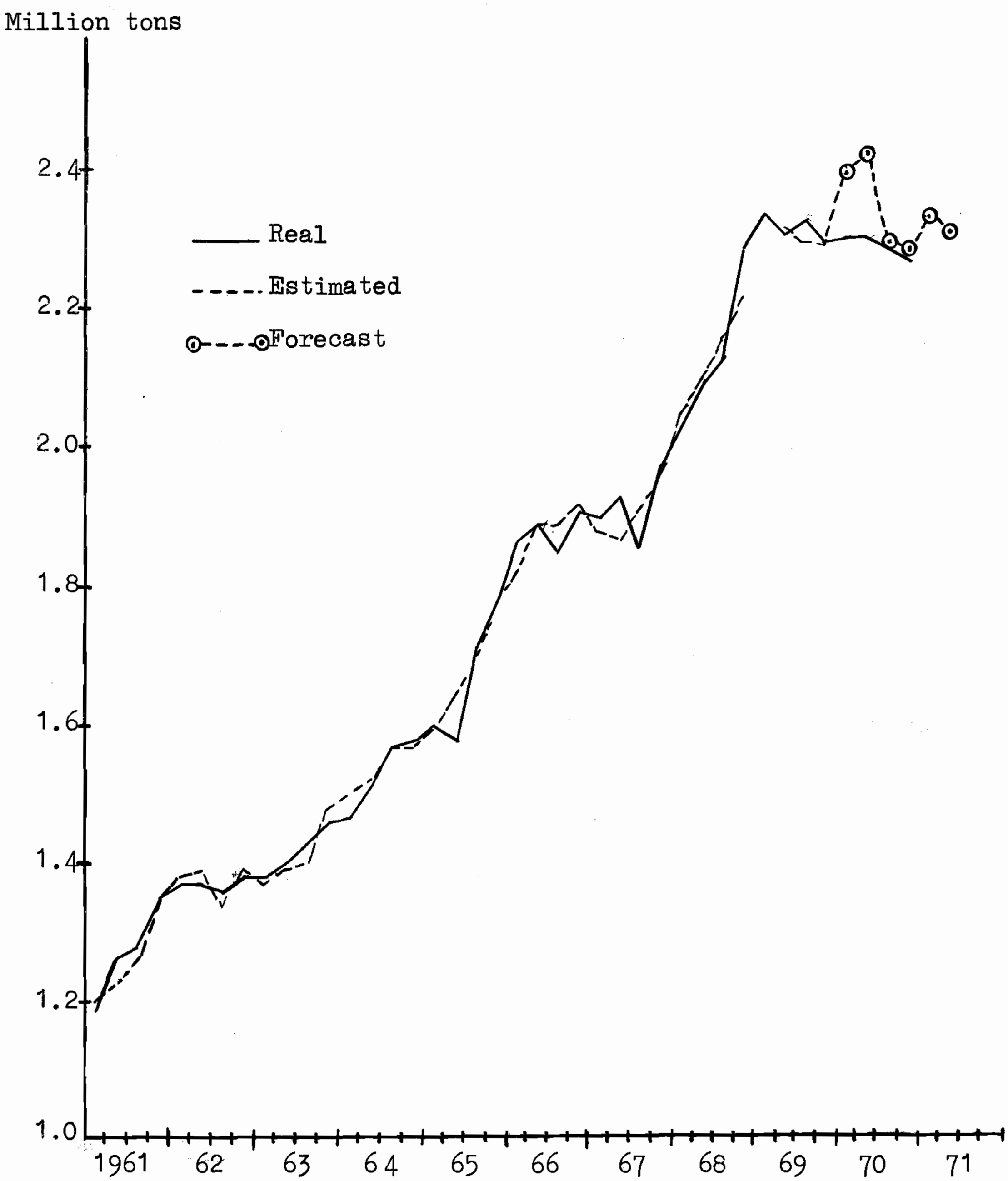


Figure 18. Quarterly US production for domestic use (Q11): real and estimated quantities (1961-1969), and forecasts from 1970 to the second quarter of 1971.

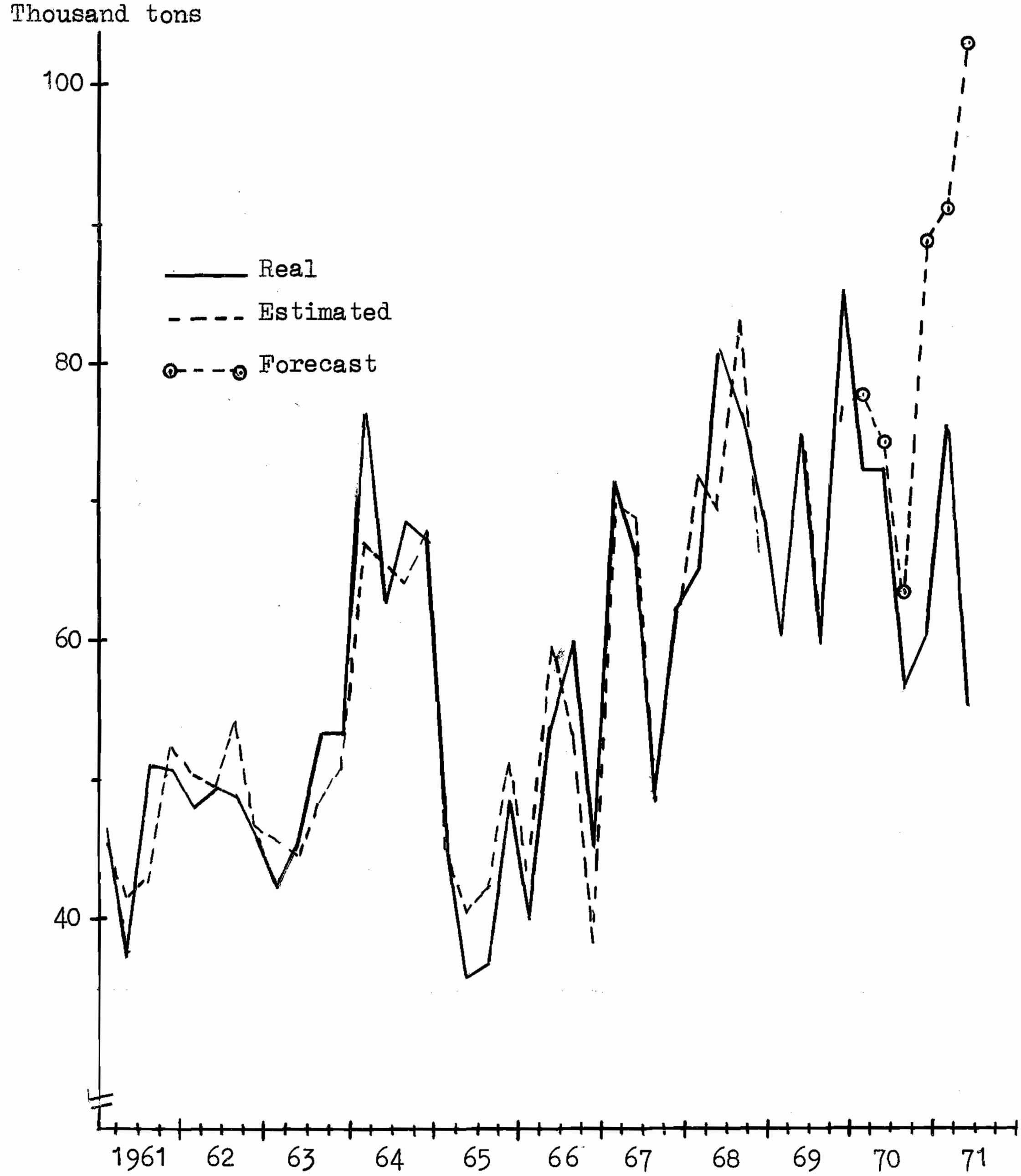


Figure 19. Quarterly exports of kraft linerboard from the United States to the United Kingdom (Q14): real and estimated quantities (1961-1969), and forecasts from 1970 to the second quarter of 1971.

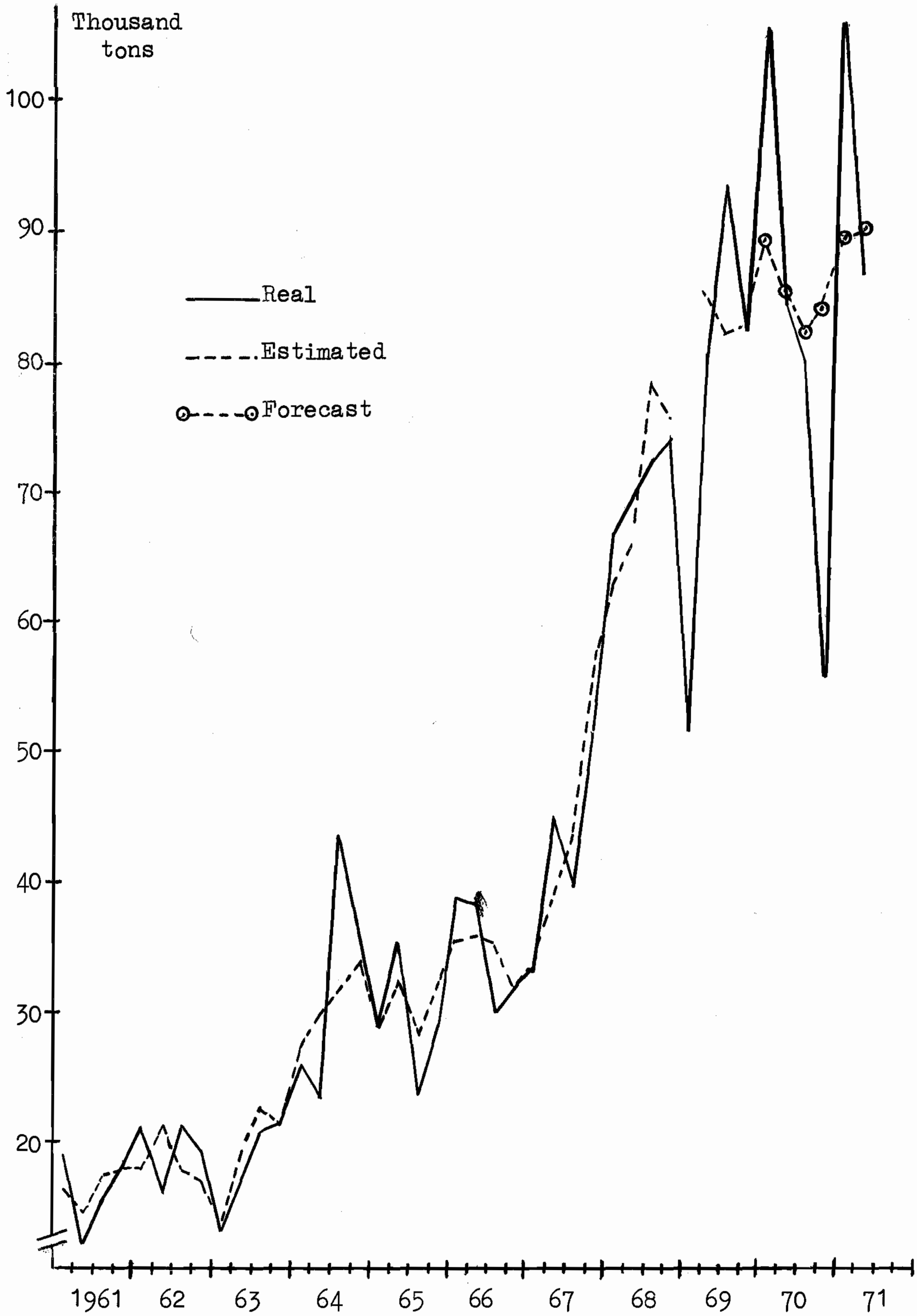


Figure 20. Quarterly exports of kraft linerboard from the United States to Germany (Q12): real and estimated quantities (1961-1969), and forecasts from 1970 to the second quarter of 1971.

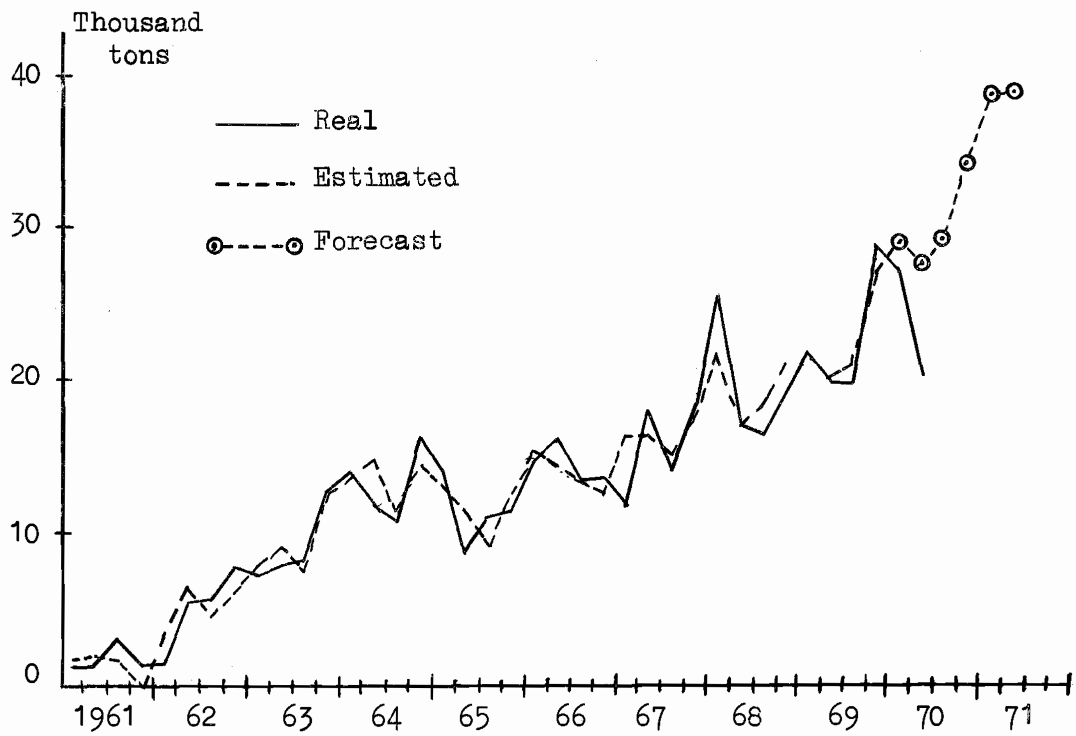


Figure 21. Quarterly exports of kraft linerboard from Sweden to the United Kingdom (Q34): real and estimated quantities (1961-1969), and forecasts from 1970 to the second quarter of 1971.

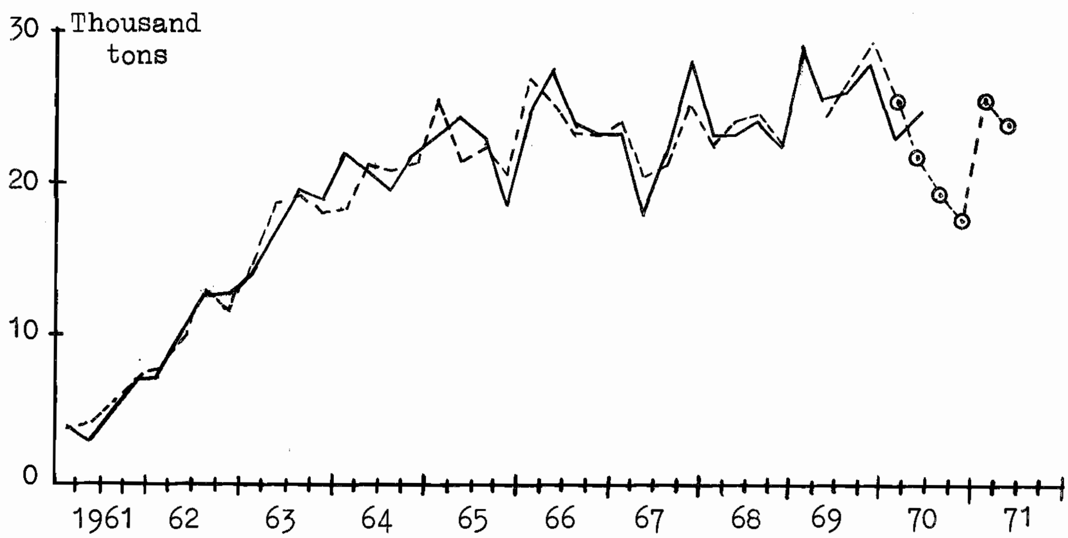


Figure 22. Quarterly exports of kraft linerboard from Sweden to Germany (Q32): real and estimated quantities (1961-1969), and forecasts from 1970 to the second quarter of 1971.

For the five time series predicting quantities produced and exported, the reduced form estimates indicated the direction in which quantities would move 74 percent of the time.

The magnitude of estimation errors as a percentage of real values are higher than those for prices. Estimates for Q11 were the best and did not exceed a 4 percent error for the sample period. For the other quantities, greater estimation errors occured. For Q32, 14 percent were higher than 10 percent; 28 percent of the errors for Q14 and 43 percent of the errors for Q12 and Q34 exceeded 10 percent.

Forecasts of the Model Outside the Sample Period

Comparison of the forecasts with real values, as mentioned earlier, is the best test of the model. Forecasts are given in Figures 13 to 22 and were obtained by keeping the same reduced form equations derived from the data for 1961 to 1969. Values of exogenous variables when not available were obtained by extrapolating any stable trends observed. The real values of exports from Sweden and value at the port of shipment were only available for the last two quarters of 1970. US production for domestic use was available only for 1970

A comparison of forecasts and real values is presented in Tables 18 and 19 together with percentages of errors. The average percentages were highest for quantities. The forecast errors for prices did not exceed 8.3 percent and in the case of P11 and P32 they were less than 3.1 percent.

For quantities, the average forecast error was lowest for Q11 at 3.7 percent and above 9.1 percent for other quantities, reaching 29.0 percent for Q34.

Table 18. Forecasts and real values of Q11, Q14, Q12, P11, P14 and P12 for 1970 and the first and second quarters of 1971.

Year Q	Q11 Fore-cast	Q11 Real	Q11 % of error	Q14 Fore-cast	Q14 Real	Q14 % of error	Q12 Fore-cast	Q12 Real	Q12 % of error
1970.1	2408	2305	4.5	78.0	72.5	7.5	89.3	106.0	-15.6
1970.2	2433	2302	5.7	74.7	72.2	3.5	85.3	84.7	0.7
1970.3	2308	2288	3.5	63.8	56.9	12.1	82.8	80.0	3.5
1970.4	2294	2271	1.0	89.1	61.2	45.5	84.3	55.3	52.8
1971.1				91.3	76.3	18.4	89.9	106.1	-15.3
1971.2				103.3	55.2	87.2	90.7	87.2	4.0
Average			3.7			29.0			15.6

Year Q	P11 Fore-cast	P11 Real	P11 % of error	P14 Fore-cast	P14 Real	P14 % of error	P12 Fore-cast	P12 Real	P12 % of error
1970.1	97.7	97.0	0.7	119.7	125.0	-4.2	122.2	124.5	1.8
1970.2	97.3	97.0	0.3	121.7	130.3	-6.2	120.9	131.1	7.8
1970.3	95.4	96.0	-0.6	130.7	127.0	2.9	124.5	125.9	1.1
1970.4	94.0	94.8	-0.8	129.5	128.0	1.2	113.5	136.0	16.5
1971.1	92.2	98.6	-6.5	120.6	123.1	-2.0	114.3	117.1	2.4
1971.2				117.2	119.1	-1.6	114.9	115.3	0.3
Average			1.8			3.0			4.98

Forecasts indicated the direction in which quantities and prices would move 56 percent of the time -- 70 percent in the case of prices and 43 percent in the case of quantities. Consequently, forecasts for prices were better than those for quantities in estimating absolute values but less efficient in predicting changes of direction.

It is interesting that for all forecasts, reduced form estimates of Q14 are all greater than the real values and the estimates of P12 are all less than the real values. This apparently persistent overestimation and underestimation suggests that biases may be present in these estimates. The implications of this comparison between forecasts and real values will be presented in the section concerning evaluation of the statistical model.

Marginal Analysis of Market Structure

The final step in the investigation procedure was the estimation and interpretation of demand and supply elasticities in the different markets. Price elasticities were calculated from the structural equations for the mean values of the time series considered. They are presented in Table 20. Price elasticities of demand are defined as the percentage change in quantity of a good consumed in response to a one percent change in price, all other factors being held constant. Cross elasticities and their definition are also given in Table 20. Basically, cross elasticity of supply for product A with reference to product B is the percentage change in the quantity of A supplied that would result from a one percent change in the price of B, all other factors being held constant. Cross elasticity of demand is defined in the same manner.

Table 19. Forecasts and real values of Q34, Q32, P34 and P32 for the first and second quarters of 1970.

Variable	1970: 1st Quarter Fore-cast	Real	% of error	1970: 2nd Quarter Fore-cast	Real	% of error	Average percent of error
Q34	29.6	28.0	5.7	20.7	28.6	-38.0	21.8
Q32	25.2	23.1	9.1	21.9	24.8	- 9.2	9.1
P34	120.2	129.0	-6.8	120.9	134.0	- 9.8	8.3
P32	124.3	129.0	-3.6	127.6	131.0	- 2.6	3.1

Table 20. Estimated price demand and supply elasticities and cross elasticities at the mean value level.

Market	Supply Elasticity	Demand Elasticity	Cross Elasticity	
US domestic market	0.45	-0.52	0.09	$\frac{dQS11}{dP14} \times \frac{P14}{QS11}$
Market for US kraft linerboard shipped to the United Kingdom	-1.45	-1.45		
Market for US kraft linerboard shipped to Germany		-1.52	-3.63	$\frac{dQS12}{dP11} \times \frac{P11}{QS12}$
			-3.65	$\frac{dQD21}{dP32} \times \frac{P32}{QD21}$
Market for Swedish kraft linerboard shipped to the United Kingdom	-4.25	-3.30	1.98	$\frac{dQD43}{dP14} \times \frac{P14}{QD43}$
Market for Swedish kraft linerboard shipped to Germany	-3.00	1.86	2.42	$\frac{dQD23}{dP12} \times \frac{P12}{QD23}$

In the US domestic market, supply and demand are inelastic, that is, a change of one percent in price leads to a change in quantities of less than one percent (0.45 percent for supply and -0.52 percent for demand).

In the market for US kraft linerboard shipped to the United Kingdom, supply and demand elasticities are both negative but about equal, meaning that in each point of the curve there is a possible equilibrium point. This can be interpreted as the dominance of the United States in the UK market, or the ability of US exporters to meet any price existing in the UK market, which is certainly a function of the price fixed by the Scandinavian countries. The cross elasticity of demand for kraft linerboard exported to Germany with reference to the domestic kraft linerboard (-3.63) shows that the price in the US domestic market has a great influence on quantities supplied by the United States to the German market and that a reduction of the US price, for instance, leads to a large increase of US exports to Germany. As the price P12 is not in the supply equation, it means that the amount of the quantity supplied to Germany will determine price. If for one quarter 50,000 tons are offered on the German market, the price will be the corresponding price on the demand curve (QD21) for this given quantity.

In the demand equation of the market for US kraft linerboard shipped to Germany, the cross elasticity of supply for US kraft linerboard to Germany with reference to the Swedish kraft linerboard supply indicates that the price charged by Sweden in the German market affects quantities of US kraft linerboard demanded by Germany. However, the minus sign indicates that US kraft linerboard and Swedish kraft linerboard are complementary rather than substitutes. This could be due to the fact that

Swedish kraft linerboard is of higher quality than that of the United States.

In the market for Swedish kraft linerboard shipped to the United Kingdom, demand and supply curves are both downward sloping with the supply curve being more elastic than the demand curve. This situation of a negative supply curve suggests again that the United Kingdom is a dumping ground for Swedish exporters. This depends, in fact, on whether the Marshallian rather than the Walrasian stability condition, as defined by Henderson and Quandt (1958, p.110-113), is the most plausible in reality. As Export Associations can, to a certain extent, control price by quantities offered, the Marshallian condition is assumed to be more relevant. The behavior assumption underlying this condition states that producers will tend to raise output when the price that buyers are willing to pay is higher than the price charged by the seller for a given quantity. Analogeous reasoning holds for the converse case. Under this condition, the intersection between the supply and demand curves is an equilibrium point. The cross elasticity of demand for Swedish kraft linerboard with reference to US kraft linerboard shows that Swedish and US kraft linerboard are substitutes. This corresponds to the fact that in the UK market, kraft linerboard is not differentiated. Such a characteristic was, in fact, revealed during the interviews.

Supply and demand elasticities in the market for Swedish kraft linerboard shipped to Germany are more difficult to interpret as the supply curve is downward sloping and the demand curve curve is upward sloping. If the Marshallian stability is applied to this situation, it means that this market is unstable. This may be considered plausible since the heavy collapse of price in 1961 and 1968 prompted an exchange of data among associations and eventual control of price by an export organization. The cross elasticity of demand for Swedish kraft linerboard with regard to US kraft linerboard suggests that the US product is a substitute for the Swedish one in the market for Swedish kraft linerboard shipped to Germany; this appears to be in contradiction with the findings for the market for US kraft linerboard shipped to Germany. Both conclusions can, however, be reconciled by observing that the traditional Swedish share of the German market has been eroded by US exports of kraft linerboard which has been, to a certain degree, a substitute for Swedish kraft linerboard. On the other hand, in the US share of the German market, Swedish kraft linerboard has not substituted but rather complemented US kraft linerboard, Swedish kraft linerboard having a higher quality.

Evaluation of the Statistical Model

In preceding sections, a statistical model of trade flows between the United States, the United Kingdom, Germany and Sweden was described. Those variables leading to a higher R^2 and making economic sense were included in the equations. The "student" t values for the various structural coefficients were reported. The t values give some indication of the relative significance of the variables in each relation, assuming that the true structural model was specified. Although some t values indicated the coefficients of certain variables were not significant, they nevertheless were included, being considered a priori as important to the model. Because of lack of time the test of autocorrelation among the residuals was not made.

Thus, for testing the hypothesis that this model is representative of the trade between the countries considered, attention is directed first to the results of predictions over the sample period, and more importantly, to forecasts for 1970 and 1971 outside the sample period. It is the degree of success with which a model explains actual market behavior that constitutes a critical test of the structural hypothesis.

From the information provided by analysis of the elasticities, a picture should emerge indicating the overall adequacy or inadequacy of the model in reflecting the true structure or process that is the object of the analysis.

In the present analysis, it appears that some deductions of the model are in conformance with a priori knowledge of the market, giving some confidence in the model. Prediction inside the sample period, however, and particularly forecasts outside the sample period did not give highly satisfactory results, although it is difficult to set acceptance or rejection criteria for the model on the basis of its prediction success. Additional comparisons between forecasts and real values outside the sample period would give a more conclusive test. The accuracy of forecasts for several years ahead can be adversely affected by structural changes. In such circumstances, a recomputation of the coefficients incorporating more recent data would be in order. In conclusion, it was decided that the model would be accepted until more data are available; in the meantime, the results will be reported to industry spokesmen for their reactions and comment.

Conclusion

In the event of oversupply of the world market which, according to the studies reviewed in Chapter IV, will probably be the case in the next few years, careful selection of export markets is particularly important. Oversupply leads, in fact, to a weakening of prices, making further investment in the Pacific Northwest or elsewhere less profitable.

The research carried out in this chapter has been an attempt to provide some answers concerning the effect on price of quantities offered in different foreign markets. For this purpose, price elasticity was calculated by developing an econometric model attempting to explain the US domestic trade and exports from the United States and Sweden to the United Kingdom and Germany. From these price elasticities conclusions can be drawn about the effect of additional quantities on different markets, quantity elasticities being the inverse of price elasticities.

In the US market both demand and supply quantity elasticities are rather high, close to 2.0, $(\frac{-1}{0.52}$ or $\frac{1}{0.45})$. Thus a quarterly increase of 2 percent (50,000 tons) in pulp produced for the US market, for instance in the Pacific Northwest, would lead to a decrease in price of 4 percent, that is about 5 dollars per ton, on condition that all other factors remain constant, and in particluar that there be no shift of the demand curve. It appears that the US domestic market is not influenced by the price charged to foreign markets, showing a certain independence of the domestic market from other markets in terms of price.

In the UK market, for any price there is an equilibrium. So in fact, price is determined by the quantities supplied by the United States to the United Kingdom. An increase of one percent in the quantity supplied to the United Kingdom at the mean point will lead to a decrease in price of 0.69 percent. As small quantities are involved, however, an increase in supply of 10,000 tons per quarter to the United Kingdom (a very plausible figure in view of the size of the new plants being constructed) would lead, ceteris paribus, to a decrease of 14.70 dollars per ton.

In the German market, an increase of one percent in the quantity supplied to Germany at the mean point would lead to a decrease in price of 0,66 percent. An increase of 10,000 tons in the quantity offered would lead, ceteris paribus, to a decrease in price of 21 dollars per ton. The drop is higher than in the UK market, in spite of a lower elasticity, because of elasticity change along the demand curve.

The above information can be used to decide an order of preference for export markets which would avoid an excessive price drop, making exports to certain foreign markets unprofitable.

These estimates of elasticities and of the parameter equations are preliminary and additional testing will be required to increase confidence in them. It should be remembered too that changes in quantities are likely to occur with change in other variables, such as costs and inventories, which would also affect price.

The effects of tariffs on trade can be considerable; for instance, the import surcharge of 10 percent reduced exports to the United Kingdom by 25 percent. Although tariffs have not been included in the other equations, their effect can be estimated by looking at the parameter of the cost coefficients or freight, as tariffs can be considered an additional cost in penetrating a foreign market.

In conclusion, the model presented provides information for planning marketing strategies. It can be used for forecasting export prices and quantities and for determining the effect on these of change in the level of an exogenous variable such as tariff, cost elements or freight. However, current estimates must be regarded as "best available" and subject to improvement. The model is important because of its immediate utility and because it provides a basis for future investigation.

VII. SUMMARY AND CONCLUSION

The aim of this study was to investigate those economic considerations that affect the ability of the Pacific Northwest's pulp and paper industry to compete with other regions producing pulp, paper and board.

A review of the literature on econometric models in international trade showed that international trade flows can be described by means of supply and demand curves. It was therefore decided to study factors affecting supply and demand of pulp, paper and board and to incorporate results in an econometric model.

The Pacific Northwest ships 23.6 percent of total US pulp, paper and board exports, which represents 10 percent of the pulp, paper and board production of this region. The Pacific Northwest's principal foreign markets are Asia, where Canada is the major competitor, and Europe, where the major competitors are Norway, Finland and Sweden. The major products exported from the Pacific Northwest are kraft linerboard, softwood sulfite and dissolving pulp.

The literature on demand analysis for paper and board concerns both individual countries and wide geographical areas. Income was generally taken as the principal exogenous variable as it can be presupposed through economic theory. In most studies, an elastic long run supply curve, that is, a constant price, was assumed. In only two studies, by Åberg and McKillop, was this assumption removed, leading to estimation of a low demand elasticity and meaning that price, although not having an important influence on quantities demanded, should not be excluded from demand equations. Use of a linear relationship between dependent and independent variables is appropriate within a limited income range.

A need was seen for a better understanding of factors other than income to arrive at a more relevant specification of a demand equation. Several types of substitution phenomena were therefore reviewed which might favorably or adversely affect export or domestic demand for pulp and paper.

Information compiled from divers origins led to the following conclusions: increasing exports of chips from the Pacific Northwest are reducing the potential for exports of finished products such as wood pulp and other paper and paperboard products; different grades of pulp, in particular softwood and hardwood, are becoming increasingly substitutable or complementary, a fact that might affect Pacific Northwest exports which are based mainly on softwood pulp; kraft pulp has developed tremendously during recent years to the detriment of sulfite pulp, mainly because of water and air pollution regulations; demand for virgin pulp might be reduced if recycling continues to grow; synthetic paper could be a serious substitute for wood pulp, particularly in Japan.

None of these phenomena, however, seem to offer an imminent threat either to domestic demand for pulp, paper and board, or to export demand for these products from the Pacific Northwest.

Wood species used in the Pacific Northwest do not confer properties on pulp and paper that differentiate these products from those manufactured in other regions of the world from wood species giving equal or better paper properties. Such regions are the Southern United States, British Columbia and Northern Europe. The Douglas-fir pulp of the Pacific Northwest is, however, satisfactory for paper and board, though these products can only be differentiated through marketing practices.

In the review of international trade theories it was shown that determination of the competitive advantage of forested areas expressed in terms of returns or margin could replace a study of the comparative advantage of any world area.

The results of comparing the competitive advantage of the Pacific Northwest, Finland, Sweden, the Southern United States, East and West Canada, showed that the Pacific Northwest has a competitive advantage in the shipment of kraft linerboard to Japan and, if economies of scale are achieved, to Europe also. Comparison in the above world areas of total manufacturing costs for kraft linerboard, bleached kraft pulp and newsprint suggested that similar results would be obtained for these other two products. It was noted, however, that Sweden had a comparative advantage in the production of newsprint. From the standpoint of resource allocation and maximization of returns to the world pulp and paper industry, it would be to the best advantage of all producing areas if Sweden were to specialize in this product.

In order to compute the margin -- the difference between price and manufacturing and transportation costs -- cost elements were analyzed as well as the importance of scale economies and integration in the pulp and paper industry.

An alternative way of estimating whether a country has a competitive advantage is to analyze planned installations of capacity for meeting anticipated world demand. It appeared that in the immediate future the United States will have a lower rate of growth than other regions of the world and that the Pacific Northwest will attract less investment than the rest of the United States. This latter is justified by the fact that costs in British Columbia, although close to those of the Pacific Northwest, are lower, and the differential is sufficient to attract investment there. Another factor that may limit further increases in investment in the Pacific Northwest is the anticipated general price situation for pulp and paper which would make further investment unprofitable. Estimates of consumption and production capacities for all pulp grades and kraft linerboard from 1971 to 1975 were therefore compared. As consumption and production capacities appear balanced, it was concluded that further investments beyond those planned would lead to price decreases, making these investments less profitable. This pointed out a need to know more about the responsiveness of price to change in the industry's production of finished products such as pulp or kraft linerboard. This goal necessitated construction of an econometric model. More information was therefore needed on marketing practices in order to specify the model more precisely and to supply a basis for interpreting its implications.

A review of marketing practices showed that producers have some ability to control price by reducing production, that product differentiation exists based on brands and that integration is frequent between producer and foreign customers through foreign subsidiaries.

In the light of all these factors a quarterly econometric model was built to obtain quantity elasticity estimates and to explain trade between two major exporters, the United States and Sweden, and two major importers, the United Kingdom and Germany, kraft linerboard being used as an example of pulp and paper items. Results from the model could also be used to estimate the eventual profitability of investments in the Pacific Northwest.

The model was constructed in such a way that prices and quantities traded were the endogenous variables. Comparison of the forecasts of the model outside the sample period with real values, which is the test of the model, indicated that price forecast errors did not exceed 8.3 percent. On the other hand, errors for quantities forecast were higher in general. Additional comparisons with new data are needed to increase confidence in the model.

Analysis of quantity elasticities showed that a change of one percent in quantities supplied has the highest effect on price in domestic markets and a much lower effect in foreign markets. The size of the markets being quite different, the same quantities offered in each would have different effects. It is important, then, to consider choice of market and also quantities to be offered in it.

The supply curves were downward sloping indicating that exporters were willing to supply more kraft linerboard even when price decreased. However, markets for US kraft linerboard both in Germany and the United Kingdom were stable, meaning that an equilibrium point can be reached. Price in the United Kingdom, where kraft linerboard is rather undifferentiated, is determined by the price of Swedish kraft linerboard. Price in the German market is a direct function of quantities offered by the United States in this market. Swedish kraft linerboard is a complement to that of the United States in the German market.

Although the model brings some estimates into focus, these estimates should not be regarded as "true" but rather as the "best available".

Though they may be of direct usefulness they can be improved by specifying a better model to yield more precise forecasts. However, these estimates can be used for selection of markets and for deciding what quantities to offer without too greatly depressing prices.

Cost comparisons showed that the Pacific Northwest certainly does not have costs much higher than those of British Columbia, but probably the differential has been enough to attract the recent numerous investments in pulp and paper in this Canadian province. This does not mean, though, that expansion in the Pacific Northwest is not possible because of lack of material or water (Wall, 1969) or even know-how. It appears simply that given present conditions or location, other areas have been slightly more attractive than the Pacific Northwest for pulp and paper investments. Another factor of rising importance is the concern of the population for a clean environment. The State of Oregon seems to be a leader in the enforcement of laws limiting pollution (Oregon sets sulfur emission limits, 1972). The industry is a bit reluctant to move into an area where pollution control is so strict, bringing additional costs and a more uncertain future. Already, international pollution control agreements are under discussion by the OECD in order to put all producers of the same industry in different countries on equal footing in international competition.

As the Pacific Northwest cannot differentiate its pulp, paper and board products on the basis of product quality, other ways should be found to create a stable demand for these products. Marketing practices appear to be the key to differentiation. For increased export from the Pacific Northwest, exporting companies should therefore make particular marketing efforts in the following areas:

- planning of relevant channel of distribution (purchase of subsidiaries in foreign countries has been the most widespread practice but sales offices abraod and use of agents should not be excluded);
- differentiation of the product through use of brand names, advertizing (telling the reader about the company, its products and sales organization) and promotion, including willingness to meet foreign standards and sizes;
- improvement of physical distribution by reduction of transportation costs, by having buffer stocks here or abroad as a safeguard against shipping delays and for small orders because most customers like to have fresh pulp;
- above all, development of technical liaison with overseas customers involving free trial orders, liaison between research departments here and abroad (properties of pulp, alone or mixed, made of wood species of the Pacific Northwest, should be known and appreciated by overseas papermakers), follow-through by pulp salesmen to check pulp performance in overseas mills, first-class lectures by suppliers at technical meetings, close cooperation with machine and chemical suppliers, greater knowledge of end uses on the part of pulp suppliers.

To conclude this study, let us say that the model which has been developed is certainly preliminary. One major difficulty encountered was the selection or rejection of variables to be included in the model. The following suggestion can be made, however. An attempt was made to render the present model as complete as possible in terms of variables used, going from a complex to a simpler stage through elimination of variables, without, however, having valid screening criteria. Proceeding from a simple model to a more complex one would perhaps be more relevant and involve less computation, the criteria of selection for adding variables being (1) that a consensus between decision makers recognizes these variables as relevant and (2) that the predictive power of the model is increased. This latter criterion is the key to seeing if the model has been improved or degraded by additional variables.

Besides these problems of specification which should not be minimized, the major advantage of an econmetric approach has been to integrate scattered information, to direct collection of relevant data and to provide a framework for discussion.

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APPENDICES

APPENDIX A

Glossary of Pulp and Paper Terminology

GLOSSARY OF PULP AND PAPER TERMINOLOGY[1]

Pulp

Alpha and Dissolving Pulps Pulps used in products which involve a chemical conversion of the cellulose fiber into some cellulose derivative. These sulfite and sulfate pulps are generally made from softwood although hardwood is also used for some grades.. Some grades of pulp are: cellophane pulp, textile rayon pulp, staple fiber rayon pulps, tire cord rayon pulps and cellulose acetate pulps.

Groundwood Pulp The pulp is produced by forcing the pulpwood against a rapidly revolving grindstone. Groundwood is used in paper where permanence and strength are of minor importance, but where absorbing, bulk, opacity and compressibility are the chief characteristics desired.

Screenings Screenings are produced from the coarse fibers, fiber bundles, partially cooked chips and other materials removed from unbleached wood pulp in the screening operation. Screenings are used principally in the manufacture of coarse grades of paper and paperboard such as mill wrapper, and as a substitute for chipboard, corrugating material and insulation board.

Soda Pulp The cooking agent in the pulping process is caustic soda. Soda pulp is made principally from broadleaf woods, such as aspen, birch, maple, gum and tulip poplar.

Sulfate Pulp A term commonly used for all grades of pulp cooked by the process in which the make-up chemical is essentially sodium sulfate. Sulfate and kraft, where applied to pulp, are used generally today as interchangeable terms. Originally, sulfate pulps were used for the most part in the manufacture of various grades of paper and paperboard where physical strength was of primary importance. However, increasing amounts are being used for absorbent tissues, wadding, and for chemical conversion grades.

Sulfite Pulp Although some bleached sulfite is made from hardwood, it is usually manufactured from coniferous woods of low resin content such as spruce, balsam, fir and hemlock, by dissolution of the lignin and other wood components in one of several sulfite solutions. (a) The

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[1]Based on:
(a) American Paper and Pulp Association. 1965. The Dictionary of Paper. Third Edition. New York. 500 p.
(b) Libby, Earl C. (ed.), 1962. Pulp and paper science and technology. Volume I: Pulp. New York, McGraw-Hill. 436 p.

acid sulfite process utilizes a bi-sulfite solution with a large excess of sulfurous acid (H_2SO_3) at a pH of about 1.5. (b) The bi-sulfite process utilizes a solution of bi-sulfite alone, in which the base is commonly sodium or magnesium (magnetite). Cooking is done at a pH of about 4. (c) The neutral sulfite process utilizes a solution of sodium sulfite buffered with sodium carbonate at a pH of about 8.

Semichemical Pulp This is so-called because only a part of the ligneous part of the wood is removed during cooking, and consequently, high yields are obtained from this process. The term "semichemical" indicates a relatively mild degree of cooking, such as a quick-cook sulfite or sulfate cook, and is followed by a mechanically disintegration by a suitable refiner. This pulp yields a sheet of paper and board that has a dense formation and a high degree of stiffness and rigidity.

Paper and Paperboard

Boxboards Paperboards used for a wide variety of products such as book covers, food trays, plates, milk containers, and similar products. They are broadly classified as folding, set-up, and special food board.

Kraft Linerboard Paperboard made on a fourdrinier or cylinder machine in which the fiber furnish contains approximately 85 percent or more of virgin woodpulp, produced by the kraft (sulfate) process. It is used as a facing on a corrugated or solid fiber product.

Newsprint A generic term to describe paper generally used in the publication of newspapers. The furnish is largely mechanical wood pulp, with some chemical wood pulp.

Paper and Paperboard The distinction between paperboard and paper is not sharp but broadly speaking, paperboard is heavier in basis weight, thicker, and more rigid than paper. In general, all sheets 12 points (0.012 inch) or more in thickness are classified as paperboard. There are a number of exceptions based upon traditional nomenclature. For example, blotting paper, felts, and drawing paper in excess of 12 points are classified as paper, while corrugating medium is classified as paperboard.

Sanitary and Tissue Paper A general term indicating a class of papers of characteristic gauzy texture and sometimes fairly transparent, made in weights lighter than 18 pounds (24x36 - 500). They include sanitary tissues,wrapping tissue, waxing tissue stock, twisting tissue stock, fruit and vegetable wrapping tissue stock, and crepe wadding. They are made on any type of paper maching and from any type of pulp, or sometimes from waste paper. They may be glazed or unglazed and are used for a wide variety of purposes.

<u>Semichemical Corrugating Medium</u> Paperboard used as the fluted member of a corrugated product, usually .009 or .010 of an inch thick.

<u>Writing Papers</u> Paper suitable for pen and ink, pencil, typewriter, or printing. It is made in a wide range of qualities from chemical and mechanical wood and rag pulp, or mixtures of rag and chemical pulp or chemical and mechanical pulp.

APPENDIX B

Fortran Program
to Compute Deseasonalized Data

```
      PROGRAM SEASON
C THIS IS A PROGRAM TO COMPUTE SEASONAL FACTORS. AVERAGES COVER THE PERIOD 1960-
C 1968. THE SEASONAL FACTORS ARE AVERAGES OF THE PERCENTAGES OF THE CENTERED
C FOUR QUARTERS MOVING AVERAGES.
      DIMENSION X(40,8),Z(40,8),Y(40,8),S(40,8),D(4,8),DX(40,8),TD(4,8)
  100 FORMAT(F5.0,26X,F5.0/5X,F5.0/3X,F5.0)
  101 FORMAT(1H1,25X,'ORIGINAL  DATA',/)
  102 FORMAT('    Q15      Q35      Q14      Q34',/)
  103 FORMAT(4F8.0/4F8.0/4F8.0/4F8.0/)
  106 FORMAT(1H1,20X,'SEASONAL INDEX')
  107 FORMAT(4F10.4)
      READ 100,((X(J,I),I=1,4),J=1,36)
      PRINT 101
      PRINT 102
      PRINT 103,((X(J,I),I=1,4),J=1,36)
C COMPUTATION OF MOVING AVERAGES
      DO 20 L=1,4
      DO 1 J=1,29
    1 Z(J,L)=(X(J,L)+X(J+1,L)+X(J+2,L)+X(J+3,L))/4.
      DO 2 K=3,30
      Y(K,L)=(Z(K-2,L)+Z(K-1,L))/2.
    2 S(K,L)=(X(K,L)/Y(K,L))*100.
      DO 4 M=1,4
    4 D(M,L)=(S(M+2,L)+S(M+6,L)+S(M+10,L)+S(M+14,L)+S(M+18,L)+S(M+22,L)+
     1S(M+26,L))/7.
      TD(1,L)=D(3,L)
      TD(2,L)=D(4,L)
      TD(3,L)=D(1,L)
      TD(4,L)=D(2,L)
      DO 7 N=1,4
      DO 8 I=1,33,4
      ID=N+I-1
    8 DX(ID,L)=(X(ID,L)/TD(N,L))*100.
    7 CONTINUE
   20 CONTINUE
      PRINT 106
      PRINT 102
      PRINT 107,((TD(J,I),I=1,4),J=1,4)
      PRINT 102
      PRINT 103,((DX(J,I),I=1,4),J=1,36)
      END
```

APPENDIX C

Definitions, Data and Data Sources

APPENDIX TABLE 1: LIST OF DATA, BY QUARTER, 1961-1971

YEAR	QUARTER	B1(T-2)	PC1	N1	PF1	D2	N2	F34	F32	N4	U4	R3	H3	D3	T	IM(T-1)	IB(T-1)	UQ(T-1)	DV
1961	1	111.6	70.83	83.40	14.80	49.87	93.00	23.64	32.44	95.00	35.50	125	6.07	66.50	1	.742	6.510	1.326	0
1961	2	120.0	70.05	87.40	14.47	50.30	92.00	23.69	32.20	96.00	35.50	124	6.07	70.80	2	.668	6.670	1.331	0
1961	3	117.1	94.09	90.10	14.18	51.14	93.00	20.92	31.33	96.00	36.20	109	6.32	68.30	3	.707	6.000	1.313	0
1961	4	109.1	93.99	92.30	14.45	51.14	94.00	21.37	26.67	95.00	36.60	132	6.17	67.70	4	.758	5.950	1.659	0
1962	1	100.0	93.64	93.50	14.62	49.87	95.00	20.00	29.93	95.00	36.10	127	6.23	69.30	5	.556	5.590	1.476	0
1962	2	108.3	95.59	95.00	14.96	46.07	97.00	18.16	28.33	97.00	35.40	126	6.25	70.70	6	.530	6.120	1.333	0
1962	3	102.3	93.43	95.90	14.94	43.53	98.00	18.05	28.42	97.00	34.00	108	6.40	72.10	7	.635	6.110	1.300	0
1962	4	104.3	91.13	96.10	14.74	39.31	99.00	19.76	30.35	96.00	36.10	133	6.53	70.70	8	.759	6.370	1.464	0
1963	1	102.3	91.11	97.20	14.63	32.36	96.00	17.92	31.03	95.00	36.70	135	6.62	69.30	9	.723	6.180	1.303	0
1963	2	95.8	89.27	99.90	14.46	33.81	100.00	18.26	30.91	99.00	35.30	137	6.74	65.80	10	.756	6.210	1.298	0
1963	3	88.1	90.72	101.00	14.42	33.81	101.00	18.85	30.71	102.00	35.50	117	6.89	66.50	11	1.092	5.890	1.305	0
1963	4	94.0	92.52	101.70	14.47	34.30	103.00	20.92	33.53	104.00	36.30	154	6.91	69.30	12	1.134	6.020	1.667	0
1964	1	95.7	92.12	103.50	14.48	34.38	106.00	18.67	32.99	106.00	36.20	156	7.09	70.70	13	.697	5.760	1.535	1
1964	2	103.9	95.70	106.00	14.33	35.74	108.00	18.26	31.99	107.00	36.00	157	7.08	72.80	14	.739	6.110	1.430	1
1964	3	95.9	101.99	107.70	14.22	37.19	109.00	17.99	31.62	108.00	37.10	133	7.51	74.20	15	.949	5.750	1.428	1
1964	4	96.4	101.39	108.60	14.12	36.71	111.00	19.53	33.58	110.00	36.70	167	7.49	69.30	16	.864	5.940	1.622	1
1965	1	96.1	99.01	112.50	14.06	36.23	114.00	18.66	34.71	111.00	36.70	162	7.54	70.70	17	.717	5.650	1.527	1
1965	2	101.9	93.92	114.20	14.15	36.23	114.00	18.65	34.50	111.00	37.40	161	7.84	67.20	18	.612	6.040	1.501	1
1965	3	83.3	93.76	116.20	14.25	36.71	114.00	18.89	34.97	111.00	37.20	139	8.13	68.60	19	.805	5.580	1.774	1
1965	4	86.2	102.80	118.30	14.42	36.71	115.00	19.00	35.04	113.00	37.30	168	8.17	68.60	20	.642	5.460	2.086	1
1966	1	88.9	116.35	122.50	14.57	37.20	118.00	15.03	32.59	114.00	37.30	164	8.34	69.00	21	.518	5.130	1.935	0
1966	2	94.7	126.34	124.90	14.78	37.20	118.00	14.80	32.35	113.00	36.80	167	8.34	72.30	22	.321	5.480	2.050	0
1966	3	94.6	116.73	126.90	14.92	37.20	116.00	14.50	31.59	114.00	37.10	142	8.68	71.60	23	.415	5.390	2.186	0
1966	4	94.9	93.13	128.20	14.92	37.20	114.00	14.88	31.97	111.00	38.00	172	8.87	70.00	24	.439	5.820	2.251	0
1967	1	92.6	74.43	126.40	15.03	34.90	111.00	11.20	31.63	111.00	36.00	165	9.06	74.60	25	.391	5.680	1.898	0
1967	2	98.2	67.98	125.40	15.08	34.90	110.00	11.80	32.18	112.00	37.60	166	9.06	70.30	26	.442	6.400	1.653	0
1967	3	98.0	64.43	126.50	15.13	36.10	114.00	10.60	30.47	112.00	37.20	149	10.05	65.30	27	.692	6.250	1.470	0
1967	4	94.2	63.97	128.30	15.02	39.70	120.00	9.60	28.93	115.00	38.70	170	10.05	65.00	28	.761	6.360	1.619	0
1968	1	95.7	64.46	130.40	15.16	38.70	119.00	7.70	27.15	117.00	39.50	173	9.77	38.70	29	.732	5.450	1.620	0
1968	2	90.4	79.53	132.50	15.14	32.40	126.00	8.80	28.13	118.00	39.90	178	9.77	32.40	30	.530	5.860	1.539	0
1968	3	88.0	97.91	133.40	15.16	31.90	130.00	8.50	25.77	121.00	41.80	167	10.29	31.90	31	.700	5.690	1.626	0
1968	4	98.1	96.12	134.80	15.23	31.70	136.00	10.50	27.93	122.00	41.20	194	10.29	31.70	32	.736	5.640	1.890	0
1969	1	91.8	86.70	136.90	15.27	32.10	143.00	8.70	25.83	122.00	41.50	211	10.49	59.00	0	.434	5.090	1.800	0
1969	2	96.2	87.96	138.90	15.35	27.90	144.00	9.20	26.39	123.00	38.90	211	10.49	27.90	33	.426	5.290	1.837	0
1969	3	95.9	90.46	140.20	15.50	31.20	144.00	9.90	14.49	124.00	38.70	195	11.35	31.20	34	.583	5.610	1.977	0
1969	4	102.0	91.97	138.30	15.61	37.20	150.00	9.60	27.34	125.00	37.60	224	11.35	37.20	35	.542	6.060	2.031	0
1970	1	102.2	87.90	137.30	15.72	40.60	153.00	10.20	27.20	125.00	40.80	228	11.89	62.30	36	.544	5.970	1.818	0
1970	2	100.0	86.30	136.20	15.71	41.20	155.00	12.10	29.80	125.00	41.70	226	11.89	64.60	37	.493	6.490	1.692	0
1970	3	105.0	84.80	135.10	15.73	42.00^{E}	152.00	12.00^{E}	29.10^{E}	126.00	40.00^{E}	209	13.49	60.00^{E}	38	.613	6.500	1.452	0
1970	4	100.0^{E}	73.50	130.90	15.60	43.00^{E}	152.00	11.90^{E}	30.30^{E}	126.00	39.50^{E}	225^{E}	13.50^{E}	59.00^{E}	39	.838	6.650	1.569	0
1971	1	95.0^{E}	94.00	133.10	15.50^{E}	43.00^{E}	159.00	9.50^{E}	24.50^{E}	126.00	39.50^{E}	220^{E}	13.50^{E}	59.00^{E}	40	.872	6.130	1.587	0
1971	2	95.0^{E}	91.10	133.10^{E}	15.30^{E}	43.00^{E}	157.00	11.20^{E}	25.90^{E}	127.00^{E}	39.50^{E}	218^{E}	13.50^{E}	58.00^{E}	41	$.950^{E}$	6.630^{E}	1.408	0

QUARTER	SEASONAL INDEX NUMBERS		
1	83.66	103.18	94.73
2	110.03	99.09	95.54
3	111.57	101.38	109.02
4	93.46	96.52	99.41

E : ESTIMATED

YEAR	QUARTER	O1(T-1)	H1	FR	T43	T23	E3	P12	P32	P14	P34	P11	Q11	Q12	Q32	Q14	Q34
		VARIABLES															
1961	1	100.00	100.8	115	10.00	16.00	19.3	110.70	677	124.40	628	100.00	1189.8	14794	3684	41347	1100
1961	2	100.00	99.5	115	10.00	16.00	19.3	118.00	669	126.90	630	100.00	1291.2	12563	2918	41439	1475
1961	3	100.00	99.8	113	8.75	16.00	19.3	113.20	648	121.00	569	89.90	1259.8	15970	5227	53896	3210
1961	4	100.00	99.9	114	8.75	16.00	19.3	113.10	649	123.20	591	89.90	1352.6	20144	7696	48492	1108
1962	1	100.00	100.6	98	8.75	16.00	19.4	114.10	649	117.30	601	91.20	1372.9	16335	6560	42432	1274
1962	2	100.00	99.8	96	7.50	16.00	19.4	117.70	603	119.10	588	95.90	1406.9	16582	10245	54950	6059
1962	3	100.00	100.5	95	7.50	16.00	19.4	126.30	610	120.50	588	95.90	1336.4	21998	12970	51699	6386
1962	4	100.00	100.4	112	7.50	16.00	19.3	122.70	621	116.70	592	95.90	1380.1	21474	13604	44000	6846
1963	1	100.00	100.1	110	6.12	16.00	19.2	117.80	651	123.00	588	95.90	1384.7	10169	12901	37546	6512
1963	2	100.00	99.7	113	6.12	16.00	19.3	120.20	636	118.70	590	95.90	1438.2	17968	16739	50562	8820
1963	3	100.00	100.2	118	6.12	16.00	19.2	115.00	614	121.80	598	95.90	1401.1	21554	20181	56385	9464
1963	4	102.71	100.2	139	6.12	16.00	19.2	116.70	638	120.40	596	100.00	1462.6	24063	20260	50978	11464
1964	1	102.71	100.3	129	5.00	16.00	19.4	119.90	647	120.10	595	100.00	1472.8	20136	19682	67710	12375
1964	2	102.71	100.0	124	5.00	16.00	19.4	121.20	630	119.70	603	100.00	1548.3	23926	20520	69378	13151
1964	3	102.71	100.6	121	5.00	16.00	19.4	118.20	629	111.00	607	100.00	1537.5	45264	20181	72478	12141
1964	4	106.64	100.6	136	5.00	16.00	19.4	116.90	643	113.70	611	100.00	1583.9	41003	23716	64287	14535
1965	1	106.64	100.9	142	3.75	16.00	19.4	119.00	659	123.40	611	100.00	1600.1	22145	21196	40502	12523
1965	2	106.64	101.9	142	3.75	16.00	19.3	119.80	657	123.40	615	100.00	1616.9	36638	24391	39716	9730
1965	3	106.64	102.6	144	3.75	16.00	19.3	120.40	665	114.90	619	100.00	1674.6	24399	23845	39021	12616
1965	4	113.59	103.4	145	3.75	16.00	19.3	123.00	665	122.40	622	100.00	1784.6	32318	20365	46430	10271
1966	1	113.59	104.6	120	2.50	16.00	19.3	127.70	665	122.90	626	100.00	1860.2	30158	22528	35649	13194
1966	2	113.59	104.8	118	2.50	16.00	19.3	120.30	664	119.60	620	100.00	1939.5	39902	27573	59905	18135
1966	3	113.59	106.0	115	2.50	16.00	19.3	133.60	650	123.60	621	100.00	1814.7	31146	24777	63421	15496
1966	4	116.31	106.2	118	2.50	16.00	19.3	126.60	653	126.90	638	100.00	1911.0	36015	25157	43173	12229
1967	1	116.31	106.0	112	0	16.00	19.3	123.70	660	126.00	660	100.00	1908.6	25845	21216	63619	10517
1967	2	116.31	106.2	118	0	16.00	19.4	122.70	658	128.20	644	100.00	1978.8	46561	17873	73264	20127
1967	3	116.31	107.1	106	0	16.00	19.3	121.40	642	126.80	640	100.00	1818.2	41433	22788	51090	16192
1967	4	119.93	107.4	96	0	16.00	19.4	117.30	624	119.00	617	100.00	1985.1	58098	30215	60030	16472
1968	1	119.93	108.6	77	0	16.00	19.3	124.50	629	119.40	569	96.90	2031.5	51715	20945	58170	22838
1968	2	119.93	109.4	88	0	16.00	19.3	120.90	625	115.40	603	96.80	2137.2	72304	23009	89887	19179
1968	3	119.93	110.3	85	0	14.40	19.3	123.40	620	111.30	603	96.80	2087.0	75737	24964	80735	18756
1968	4	126.28	110.3	105	0	14.40	19.3	117.60	627	123.90	603	96.80	2291.6	84038	24265	66452	17191
1969	1	126.28	111.8	87	0	14.00	19.3	120.60	615	120.60	594	92.60	2345.9	39890	26425	53745	19425
1969	2	126.28	113.0	92	0	14.40	19.3	119.20	618	120.90	612	93.50	2365.0	84401	25541	83607	22445
1969	3	126.28	114.3	99	0	14.40	19.3	120.60	616	114.60	621	95.20	2279.5	97802	26916	63686	22702
1969	4	122.28	115.8	96	0	14.40	19.3	121.30	637	125.80	637	96.00	2300.5	92816	30091	82259	25815
1970	1	122.00^{E}	117.3	102	0	13.60	19.3	124.50	670	125.50	670	97.00	2305.4	82265	23159	72577	28028
1970	2	122.00^{E}	117.2	121	0	13.60	19.3	131.10	683	130.30	700	97.00	2353.4	88159	24877	72298	20772
1970	3	122.00^{E}	117.9	120	0	13.60	19.3	125.90		127.00		96.00	2235.7	83473		56947	
1970	4	123.00^{E}	118.7	125	0	13.60	19.3	136.90		128.00		94.80	2267.1	62431		61223	
1971	1	123.00^{E}	120.2	95	0	13.60	19.3	117.10		123.10		98.60		82357		76367	
1971	2	123.00^{E}	120.7	112	0	13.60	19.3	115.30		119.10		100.00		90726		55242	

QUARTER						SEASONAL INDEX NUMBERS											
1													100.0	77.5	90.3	88.6	88.2
2													102.2	104.0	99.6	110.8	111.8
3													97.7	104.3	103.0	105.6	113.6
4													99.8	112.8	107.7	95.7	88.8

E : ESTIMATED

DEFINITIONS OF VARIABLES AND DATA SOURCES

Exogenous Variables

B1 Profits per dollar of sales in the paper and allied products industry as a percentage of profits per dollar of sales in all manufacturing corporations. Source: US Federal Trade Commission (1961-1967).

PC1 Deflated wholesale price index of old corrugated boxes. Source: US Bureau of Labor Statistics (1961-1971).

N1 Seasonally adjusted industrial production index for the United States, 1963 = 100. Source: Organization for Economic Cooperation and Development (1961-1971).

PF1 Quarterly averages of four-weekly seasonally adjusted basic prices per thousand square feet of corrugated board. Source: Fibre Box Association (1961-1971).

D2 Average price in DM per stere of spruce pulpwood, unbarked before loading, in state forests in Bavaria. Source: Food and Agricultural Organisation (1970).

N4 Seasonally adjusted industrial production index for the United Kingdom. Source: (Same as N1).

F34 Transportation costs from Sweden to England and tariffs on kraft linerboard imposed by the United Kingdom. F34 has been computed according to the following formula:

$$F34 = \frac{10.00 \times FR + T34 \times P34}{100}$$

where 10.00 US dollars is the estimated transportation cost per ton in 1959;

FR is the index of ocean freight rates for timber in charter trip. 1959 = 100. Source: Statistical Office of the United Nations (1961-1971);

T34 is the tariff rate imposed by the United Kingdom on Swedish kraft linerboard. Source: International Monetary Fund (1960-1971);

P34 is the average value in US dollars of kraft linerboad for the United Kingdom at the Swedish port of shipment. Source: (Same as P32 under endogenous variables).

F32 transporation costs from Sweden to Germany and tariffs on kraft linerboard imposed by Germany.

$$F32 = \frac{10.00 \text{ x } FR + T32 \text{ x } P32}{100}$$

T32 is the tariff rate imposed by Germany on Swedish kraft linerboard. Source: European Economic Community (1968);

P32 is the average value in US dollars of kraft linerboard for Germany at Swedish port of shipment. (Source: Same as P32 under exogenous variables).

N2 Seasonally adjusted industrial production index for Germany. 1963 = 100. Source: (Same as N1).

U4 Proportion of waste paper used in the manufacture of paper and board in the United Kingdom. Source: Department of Trade and Industry (1961-1970).

R3 Paper and paperboard production index for Sweden. 1959 = 100. Source: National Central Bureau of Statistics (1961-1970a).

W3 Average hourly earnings in Swedish crowns in pulp, paper and board products in Sweden. Source: (Same as R3).

D3 Average value of pulpwood in Swedish crowns per cubic meter at the Swedish port of shipment. Source: (Same as D2).

t Time trend. (See Appendix Table 1).

IM Week's supply of containerboard at millsites: inventory at the beginning of the quarter divided by the mill production of this quarter expressed as an average weekly tonnage. Source: (Same as PF1).

IB Week's supply of containerboard at box plants: inventory at the beginning of the quarter divided by the box plants' consumption expressed as an average weekly tonnage. Source: (same as PF1).

UO Ratio between weekly unfilled orders for paperboard and weekly production. Source: US Dept. of Commerce, Office of Business Economics (1961-1971).

DV Dummy variable taking the value one for the years 1965 and 1966 and zero for the other years. The United Kingdom imposed an import surcharge of 15 percent from October 1964 to April 1965 and 10 percent from April 1965 to November 1966 (World Review, 1966).

D1 Index of non-deflated pulpwood prices for southern pine in the Southeastern United States. 1961 = 100. Source: Dwight Hair, 1971, p. 68.

H1 Wholesale price index for the United States. Source: (Same as N1).

FR For definition see F34.

T43 For definition see F34.

T32 For definition see F32.

E3 Exchange rate between US dollar and Swedish Crown in Cents per Swedish Crown. Source: (Same as N1).

Endogenous Variables

P12 Average value at US port of shipment of kraft linerboard for Germany. Source: US Bureau of the Census (1961-1971).

P32 Average value at Swedish port of shipment of kraft linerboard for Germany. Source: National Central Bureau of Statistics (1961-1971b).

P14 Average value at US port of shipment of kraft linerboard for the United Kingdom. Source: (Same as P12).

P34 Average value at Swedish port of shipment of kraft linerboard for the United Kingdom. Source: (Same as P32).

P11 Price index for containerboard in the Eastern US market. 1957-59 = 100. Source: (Same as PC1).

Q11 Quantities in thousand short tons of kraft linerboard produced in the United States for domestic use. Source: (Same as Pf1).

Q12 Quantity in short tons exported from the United States to Germany. Source: (Same as P12).

Q32 Quantity in short tons exported from Sweden to Germany. Source: (Same as P32).

Q14 Quantity in short tons exported from the United States to the United Kingdom. Source: (Same as P12).

Q34 Quantity in short tons exported from Sweden to the United Kingdom. Source: (Same as P32).