

AN ABSTRACT OF THE THESIS OF

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Title: An Econometric Analysis of the Japanese Import  
Demand for U.S. Forest Products

Abstract approved:

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R. Donald Langmo

Japan is the largest market for U.S. forest products. Therefore, export of wood products to this country is critical to the economic life of the forest industry in the U.S. and particularly for the Pacific Northwest. Hence, economic conditions and developments in Japan may significantly affect the volume of trade for the products of concern and, in turn, the well-being of the U.S. lumber and log production-consumption system. Few studies have addressed forest product trade between the U.S. and Japan.

This study is designed to determine the effect of several selected market factors on the Japanese import demand for U.S. softwood lumber and logs and to estimate the influence of these factors on Japan's future trade. A numerical model was developed incorporating these selective factors, thought to be relevant, to determine their effects on the Japanese market for the U.S. forest products. The evaluation considers the effects of

variations in: Japanese income, domestic production of softwood logs in Japan, domestic prices of the products of concern, petroleum purchased by Japan, nominal interest rates in Japan, the exchange rates, and finally a weighted average of prices of the products from the Pacific Northwest (Oregon and Washington, only). Given the available resources, two empirical time series models for each commodity were estimated by OLS technique using annual data from 1961 through 1985.

The results indicate that the Japanese import demands for both products are inelastic. This finding, along with other evidence, suggests the distortion of the Japanese import demand for U.S. forest products by factors other than economic, mainly politics involved in trade restraint between the two countries.

The study shows that GNP per capita, housing starts, and the interest rates in Japan, significantly affect the Japanese import demand for lumber from the U.S. Housing starts is the only significant factor in the case of the Japanese import demand for U.S. logs. In the latter case, the exchange rates and log export prices to Japan (deflated by Japan's wholesale price index), are significant only when the log linear model has been applied.

An Econometric Analysis of The Japanese  
Import Demand for U.S. Forest Products.

By  
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Data Thesis is Presented    October 19, 1987  
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Typed by Zina Ben Miled for    Farhad Niami  
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DEDICATED TO

My wife, Laleh and my parents, Razieh  
and Youssef Niami without whose their  
love and support this task would not  
have been accomplished

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AN ECONOMETRIC ANALYSIS OF THE JAPANESE  
IMPORT DEMAND FOR U.S. FOREST PRODUCTS

CHAPTER ONE

INTRODUCTION:

The year 1979 has been considered as the banner year for softwood lumber exporters since 6 percent of the softwood lumber production in the U.S. was exported to other countries. The same year, the softwood plywood export in the U.S. accounted for 2.5 percent of the production.

Export of wood products is critical to the economic life of the forest industry in the U.S., particularly for the Pacific Northwest. The three largest export markets for the U.S. softwood lumber are Japan, Canada, and Europe. Japan is the largest among the three. During the 1970s, the United States lumber exports to all three markets accounted for 80 percent of the total exports. In the 1950s, lumber exported by the U.S. accounted for 0.60 BBF (billions of board feet) per year, whereas in the 1960s, 0.80 BBF per year were exported. Lumber exported by the U.S. since 1973 has averaged 1.5 BBF per year. The highest export during the data period was in 1979 when exports accounted for 1.78 BBF (1).

Exports to Japan became an important public policy issue in the mid-1960s. During the same period log exports accounted for a significant share of the timber harvest. As a result there was a rapid increase in the price of timber which to some extent put an increasing cost on the domestic lumber and plywood manufacturers who depended on an open market for logs. Basically, the concern was over the sale of the timber from public forest lands. The Morse Amendment to the Foreign Assistance Act in 1968 could be considered as the first public policy restriction on the log exports. Under this amendment, log exports from federal lands in the west were restricted to no more than 350 MBF (million board feet) per year, which was extended to all softwood log exports from federal lands in the west in 1974, with the exception of species specifically declared surplus to domestic needs.

"The export of unprocessed timber is restricted from lands managed by the Forest Service, U.S. Department of Interior, in the west". In addition, "...the export of unprocessed timber is also restricted from lands managed by the States of Alaska, Oregon, California, and Idaho. The States of Washington and Montana impose no restrictions on exports" (2). In general there are two groups that support the log export restrictions (3) :

1. Those whose incomes or jobs are threatened (workers employed by the domestic wood processors), and

2. The manufacturers who purchase logs or timber in the open market. Since they have to pay higher prices for logs, as a result of the demand for export logs, the profit margin of some mills may fall to the extent that some mills cease operation.

In contrast, the groups opposing log export restrictions include:

1. Those whose interests are protected through existence of free trade (government, businesses, and other economic interests), and believe that the log exports will improve the nation's balance of payments.
2. Those who benefit from higher prices paid for export logs.
3. Those involved in international transportation, such as shippers and longshoremen, whose benefits are served through free log trade.

Consequently, "Any change in the current restriction on log exports, in favor of either greater or lesser restriction, will probably involve legislative action at either the federal or state levels. So far, there are no restrictions on exports of logs that originate from private forest lands, although the federal government prohibits substitution of logs from federal land in processing plants for export logs from private lands" (1).

## The Problem

-----

"Japan is the focal point of Pacific-rim trade in timber products and provides the link between the timberlands of the Pacific Northwest and the remainder of the Pacific-rim" (4). For example, during the 1960s and early 1970s, Japan expanded the imports of forest products to beyond half of its domestic softwood consumption. It has intensified the competition within its suppliers of different wood products, especially in the area of softwood logs and softwood lumber. Moreover, "the volume of trade between British Columbia and Japan affects the trade between British Columbia and the United States, the United States and Japan, the Soviet Union and Japan, New Zealand and Japan, etc."(5). Japan's import increase of logs was the result of increasing construction activities, falling domestic production due to a small land base, a dense population, a timber resource that was severely depleted during World War II, and finally because of more favorable terms of trade between the U.S. and Japan. Today, Japan's forests, replanted after World War II, are approaching maturity so Japan probably could provide a greater share of its domestic consumption with domestic forests in the near future. However, Japan is still the primary customer of logs, purchasing on the average, ten million cubic meters of logs from the U.S. and seven million cubic meters from the Soviet Union.

There are a number of trade barriers and cultural factors hindering trade in Japan's lumber market. For example, the imposition of a ten percent tariff on sawn wood smaller than 160 mm (6.30") in thickness for the major species (fir, spruce, and pine) on the imports from the Soviet Union discourages the trade potentials for such lumber. In contrast, the major North American species are excluded from this tariff (Douglas fir and hemlock). However, all the exported lumber to Japan must be regraded (6). The cost (of regrading) amounts to up to 13 percent of the value of the lumber. The regrading also could be considered as a rationing device, when lumber imports exceed a desired level. The use of metric lumber size in construction methods in Japan is another hindering factor affecting trade with the U.S. Even the recent introduction of western construction methods (platform/frame), compatible with the North American lumber sizes, did not result in more than 0.1 percent of the new housing featuring this method. The import restrictions on the part of Japanese could influence prices and trade flows, both in log and lumber markets, such that (7):

1. As a result of these trade restrictions, the prices of lumber in Japan increase, while they decrease in North America. Also, Canadian lumber trade with the U.S. increases, but Canadian exports to Japan decrease.

2. There will be an increase in trade between the U.S. and Japan in the log market and prices either may increase or decrease.

In the past the Canadian log exports were almost eliminated through a permit system, such that, before a government permit can be considered for log exports, the timber should be refused by domestic millers, then the government must approve the log export. However, the permit system has changed since 1985.

There is a free trade of lumber between the U.S. and Canada. The developments in North American lumber economies on the supply side and Japan's lumber market on the demand side, reflect the trade between these two countries as well. But, unless Japanese trade restrictions are relaxed there may not be any connections between these two markets. The verification of existing free trade in some softwood markets is of importance while there are effective restrictions in other markets. The verification could be aided through time series data that spans housing market cycles. According to the results of a study done by Gallagher (4), the positive correlation of the price fluctuations for similar commodities are apparent in free trade markets, since the origin and destination prices differ only by a transportation margin. However, quotas and embargos insulate domestic from foreign prices, so correlation of the price fluctuation should be low or even

negative. Correlation of the annual price changes over the 1965 to 1975 period complies with the expectation. There is a high correlation between the price changes for U.S. and Canadian lumber (Douglas fir), ( $r=0.94$ ), whereas the correlation for the U.S. and Canadian sawn logs is low ( $r=0.58$ ). The correlation is even lower in the case of price differences between the U.S. and Japan (8). This is due to the quality differences in softwood species and adjustment in the exchange rates between the U.S. and Japan, but the relative magnitude in case of both log and lumber correlations are as expected. This correlation has been considered for log price changes between U.S. sawn log prices for Douglas fir (expressed in Yen) and an index of log wholesale prices for cedar and pine in Japan.

#### Assumption of the Study

The primary assumptions regarding this study are as follows:

1. Both the U.S. and Japan trade logs and lumber in a perfectly competitive market structure.
2. The commodities of concern are assumed to be homogeneous and therefore perfect substitutes for the products produced and supplied by other countries.

3. The estimated import demands and functions in this study are assumed to be derived demands simply because they are derived from the demand for the final product or products that the factors are used to produce.

From now on anywhere in this study that demand for logs and lumber is mentioned, it simply refers to derived demand for these two commodities.

### Objectives And Procedures

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The purpose of this study is to improve understanding of the factors affecting the Japanese import demand for U.S. softwood lumber and logs, and to estimate the influence of market forces in Japan on future trade. Specific objectives of this study are to analyze:

1. The effect of variation in Japanese income on the quantity of U.S. softwood sales to Japan;
2. The effect of variation in Japanese domestic production of softwood logs and lumber in Japan on imports from the U.S.;
3. The effect of variation in Japanese domestic prices on the quantity of U.S. lumber sales to Japan;

4. The effect of variation in imports of petroleum on imports of wood product, as an important factor in Japanese balance of payment;

5. The effect of variation in the interest rates in Japan, on imports of the wood product, as a primary concern in regards to the construction of new housing; and

6. To evaluate the effect of exchange rates on the price and quantity of U.S. softwood lumber as well as log sales to Japan.

In support of these objectives, the import demand functions of Japan for U.S. softwood lumber and logs are specified and empirically estimated. From the estimated coefficients, the reduced form coefficients are derived and used to evaluate the variation of the exchange rate and its effectiveness on the price and quantity of Japanese softwood imports.

#### Organization Of The Study

Chapter II provides a basic understanding of the forest industry in the U.S. and presents some information regarding the economy of the forest industry in the Pacific Northwest. Chapter III, includes a review of previous studies in the area of trade between the U.S. and Japan, and global trade models. Chapter IV, discusses the theoretical and empirical models, as well as the

analytical framework, used in this study. The results are discussed in chapter V. Finally, chapter VI presents the summary, conclusion, limitations and suggestions for further research that were derived from this study.

## CHAPTER TWO

## FORESTRY IN THE PACIFIC NORTHWEST

About 30 percent of the total forest lands in the U.S. are located in the Pacific Coast Region, mostly in the Pacific Northwest area. Thirty percent of the forest land in the Pacific Coast Region is in the form of commercial timberland (please, see table 2-1 ).

Also, table 2-2 gives a good comparison base for the forest land of the Pacific Northwest Region. As shown, the state of Alaska, with the largest total area has the smallest commercial forest land. British Columbia has the largest forest land, followed by the state of Oregon and then the state of Washington. Over 69 percent of the forest land in the Pacific Northwest Region is commercial forest land, capable of producing high quality timber.

Table 2-1 Characteristics by area and percent of forest land in the U.S. and Pacific coast.

Type of land	Total U.S.		Pacific Coast	
	Area million acres	Percent	Area million acres	Percent
Commercial Timberland	482.5	21.4%	70.5	12.36%
Production Reserved (5)	20.7	0.9	4.1	0.72
Production Differed (6)	4.6	0.2	1.2	0.21
Others	228.8	10.1	138.4	24.27
Total Non Commercial	254.1	11.3	143.7	25.20
Total Forest land	736.6	32.7	214.3	37.58
Other land*	1518.2	67.3	356.0	62.42
Total land area	2254.8	100.0	570.3	100.00

\* Includes rangeland, cropland, pasture, swampland, industrial to urban areas, and other non-forest lands.

Table 2-2 Area and percent of forest land in Pacific Northwest (area is in million hectar, Mha)

	Land Area	Forest Area	Percent Forest	Commercial Forest	
				Area	Percent Forest
Alaska	146.7	48.20	33	4.34	9
British Columbia	93.1	52.13	56	48.20	92
Washington	17.2	9.46	55	7.30	78
Oregon	24.8	12.15	49	9.80	81
Total of Pacific N.W.	281.8	121.94	43.27	69.64	57.1

Source: Based on the data collected in Pacific Northwest Timberlands, by David Darr (Renewable Resources in the Pacific). to convert to acres multiply by 2.471.

a. Alaska

About 48.2 Mha (million hec.) of the state of Alaska is considered as forest land which accounts for about one-third of all the land (146.7 Mha) in the state. Also, about 4.34 Mha which is about 9 percent of the total forest land accounts for commercial forest land. sixty seven percent of this type of land is covered by Hemlock

and about 23 percent by spruce. The federal government is the major owner of the land in the state Alaska.

The softwood inventory of Alaska has been estimated to be  $38.87 \times 10^9 \text{ ft}^3$  and in the case of the spruce inventory is about  $243.82 \times 10^7 \text{ ft}^3$  (1). Almost all the softwood logs, pulp chip, softwood lumber and woodpulp produced in Alaska is exported to Japan (1). Although Japan is an important market for Pacific Northwest wood products, it is currently the most important market for Alaska's wood products. Alaska does not contribute to the supply of timber in the mainland of the U.S. The main reason for this is the Jones Act which requires intrastate shipments to be made via U.S. registered vessels (9). The high cost of the U.S. carriers puts Alaska's wood products at a competitive disadvantage in the U.S. market.

b. Washington and Oregon

As much as 55 percent of the state of Washington (9.46 Mha) is forested and 7.3 Mha of the area which accounts for 78 percent of the total forest is considered as commercial forest land.

In Oregon, 9.8 Mha of the land is considered as commercial forest land which is 81 percent of the total of 12.15 Mha forested area.

For the two state area 51 percent of the commercial forest land is privately owned. This ownership accounts for 32 percent of the timber inventory. "To the west of

the Cascade Mountains  $95.41 \times 10^9 \text{ft}^3$  of the timber includes an inventory of 49 percent Douglas Fir, 22% Western Hemlock, and 29% other species (1). To the east of the Cascades  $38.87 \times 10^9 \text{ft}^3$  of timber with an inventory of 45 percent pine, 23 percent Douglas Fir and 32 percent other species provide all the forest resources in these two states" (1).

According to the study done by Maki and Schweitzer in 1973, about 40 percent of the economy of both states of Washington and Oregon depends on forest products. These two states are the major producers of timber products in the United States.

#### c. British Columbia

-----

In the province of B.C., 52.13 Mha of land which accounts for 56 percent of the total area is forested. With 48.2 Mha considered as highly productive commercial forest land with a total inventory of  $286.5 \times 10^9 \text{ft}^3$  of timber (1), it has about twice of the volume of Washington and Oregon, together. The major species of timber in B.C. include about 23 percent spruce, 23 percent hemlock, and 19 percent balsom fir.

As far as the timber harvest situation in the Province of British Columbia is concerned, a study by the Ministry of Forests of B.C. indicates that there will be a fall down in supply of timber in one region of the Province within 30 years, and within 60 years in several

other regions, if the harvest rates are continued at recent levels. Also the study suggested a five year program to consider harvesting, silviculture and forest protection. The final effects of this central program are not clear yet, but it has been suggested that more money be spent on insect and disease control, silvicultural practices and forest fire management.

According to the data collected by the B.C. Forest Services, in 1975, roughly one-fourth of the Province's population was at that time dependent upon the timber resources.

#### Forest Economy Of The Pacific Northwest Region

---

Based on the data collected by the U.S. Department of Commerce, Bureau of Census (10), during the year 1977 a total of 133,000 persons were employed in timber manufacturing in the Pacific Northwest, (excluding British Columbia). This included 79,400 workers employed in 3,574 lumber mills that manufactured a product value of \$6,698,500,000.

Plywood and Veneer manufacturing employed 2,700 people in 173 plants and produced a product value of \$2,338,100,000. Finally 7,300 workers were employed in 263 other primary timber manufacturing firms with a total value of shipments of \$456,800,000.

According to the available data, until 1977, about two-thirds of all the softwood plywood and veneer plants of the United States (1964 Establishments) were located in the Pacific Coast Region, mainly in the Pacific Northwest area (10). These plants provide over 60 percent of all the value of shipments of softwood plywood in the U.S. Availability of large-size, high quality timber from the old-growth forests has given this region an advantage. Also there has been a rapid increase in the price of timber in a short period of time, going from \$4.88/m<sup>3</sup> in 1960 to \$5.89/m<sup>3</sup> in 1970 and \$48.72/m<sup>3</sup> in 1980 (1). Because of these rapid price changes, there have been significant improvements in the areas of technology and utilization of forest land (1).

Figure 2-1 illustrates the amount of timber harvested between 1971 to 1981 in the states of Alaska, Oregon and Washington and the province of British Columbia. Figure 2-2 shows the employment in forest product industries in Alaska, Oregon and Washington during the same years.

The highest amount of timber harvest as shown in figure 2-1 occurred in the period of 1972-73, due to a high demand for new housing. Since that time there has been a declining trend caused by continuous economic fluctuation of the last decade.

Figure 2-2 which is based on the data available from the Oregon State Employment Agency, illustrates the employment in forest product industries of the Pacific Northwest. Excluding the Province of British Columbia, Oregon has the highest potential of employment in forest industry.

The number of timber industry employees in the state of Alaska compared to the other states is not very significant. Also, the degree of employment fluctuation in the states of Oregon and Washington is almost the same and parallels the quantity of timber harvested shown in figure 2-1.

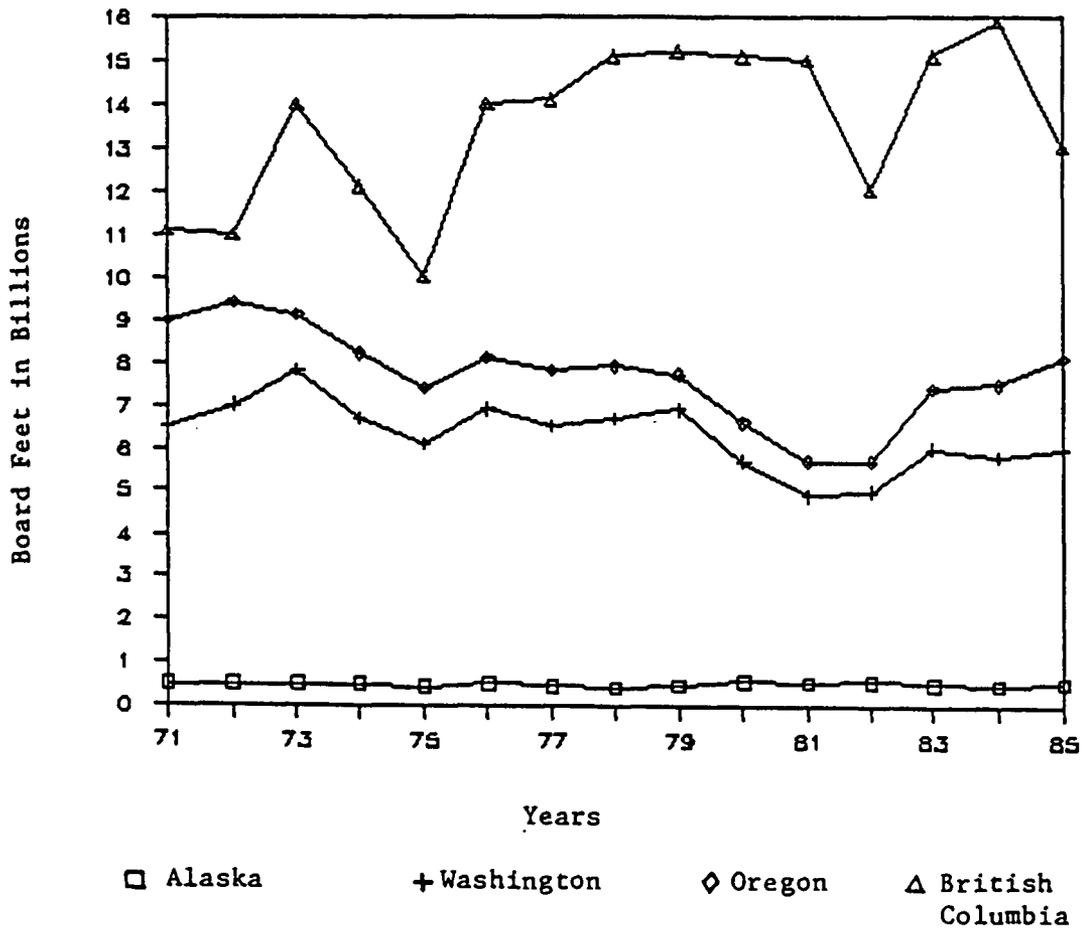


Figure 2-1, Alaska, Washington, Oregon, and British Columbia Timber Harvest, 1971-1985.

Source: Various issues of Production, Price, Employment, and Trade in Northwest Forest Industries. USDA, Forest Service, PNW-RB-145.

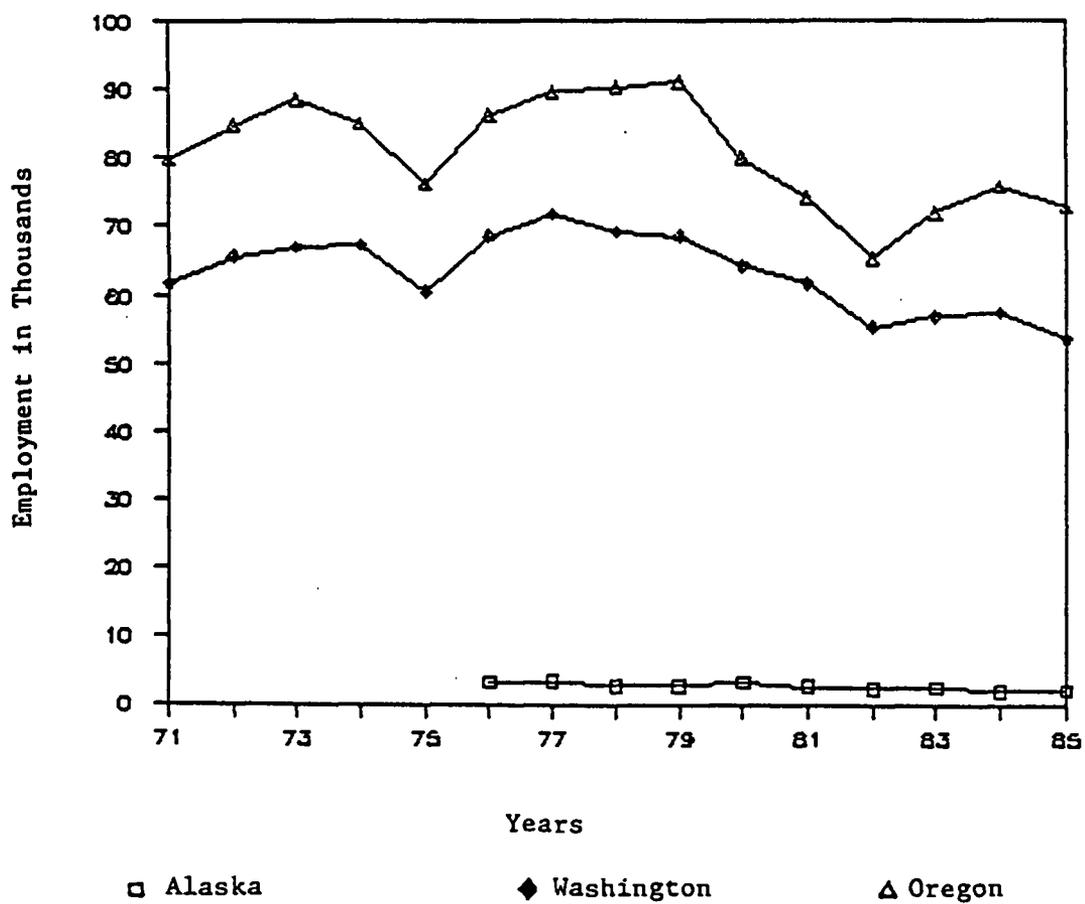


Figure 2-2, Employment in Forest Product Industries in the States of Alaska, Washington, and Oregon 1971-1985.

Source: Various issues of Production, Price, Employment, and Trade in Northwest Forest Industries. USDA, Forest Service, PNW-RB-145.

## Export Projection

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The states of Washington and Oregon export 94% of the logs shipped from the West Coast. Most of the logs go to Japan (3). Their total annual value of \$1.4 billion in the late 1970's accounts for 22 percent of the total timber harvested in the western portion of Oregon and Washington.

The export of all lumber products from the United States in the year 2030 is projected to stay close to the level of total exports in 1976, or 1.9 billion cubic feet (11). Export of the softwood lumber is expected to increase to 1.8 billion board feet in 1990 which indicates a slow increase in response to the decrease in availability of high quality lumber which currently is being produced from the old growth timber of the Pacific Northwest (12).

In the case of hardwood lumber, a slight increase is expected due to the improvement of this type of timber supply. Both softwood and hardwood log exports are expected to remain at the current levels. Due to a projected increase in demand in Europe and Japan, the export of paper, woodpulp and board will continue to increase rapidly until 2030. All these projections are based on the normal behavior of the market, and do not consider the fact that any significant change in behavior

of the economy, such as any radical change in products demand, would occur.

## CHAPTER THREE

### REVIEW OF THE LITERATURE

This chapter facilitates the understanding of the empirical issues addressed in research literature and involved in estimating the import demands of wood products by Japan, and the potential export supplies of these products from the United States to Japan in general. Trade is particularly concerned with softwood logs and lumber. This is done primarily through the review of the previous studies regarding trade of wood products.

The chapter focuses on approaches to the formation of the models, choice of variables, estimation methods, relevant interpretation, and conclusions.

The literature review consist of three sections. The first section reviews studies concerned with the econometric analysis of supply and demand determinants for softwood lumber in the United States. The second section reviews the studies of the product trade between the U.S. and Japan. The third section reviews the general trade concepts in the world, especially the formation of global trade models.

The literature review plays a major role in development of the empirical model in the next chapter.

Analysis Of The Market In The U.S.

In 1974, Mills and Manthy, developed a Two-Stage Least Square (2SLS) econometric model consisting of both supply and demand equations for major softwood lumber product groups on the basis of available historical data for a period of twenty four years (1947-1970). They should be credited for the extensive description of the analytical tool used in validating models and their coefficients.

Contrary to the results of a previous study by McKillop in 1967, Mills and Manthy found that the variables included in the final demand equations are inelastic (elasticities of less than one), while in the case of the softwood demand equation, they found over half of the variations to have elasticities of more than one.

The estimation of the secondary demand variables showed higher elasticities on average ( $e=0.39$ ) than the primary one ( $e=0.26$ ). The relative importance of the individual variables are recognized through multiplication of the related elasticities by the average annual percentage change.

In the case of supply variables, the sawmill size has a low average elasticity ( $e=0.38$ ), in contrast with the results found by McKillop, who estimated that sawmill

productivity has one of the largest elasticities. Also, both tariff rates for the lumber imports to the United States, and log exports have low elasticities. The U.S./Canadian exchange rate has moderate elasticity ( $e=0.77$ ). The significance of serial correlation was tested, using Durban-Watson test and was found to be absent among the estimated residuals.

Multicollinearity was detected through sequential use of factor analysis, and simple correlation coefficient and equation test runs. Factor analysis was the best test of multicollinearity, whereas simple correlation was the worst single test. Due to the fact that it was impossible to separate the joint impacts of collinear variables it was difficult to interpret estimated elasticities for the measurement of the relative importance.

In 1980, Adams and Haynes proposed a spatial model for North American softwood lumber, plywood and stumpage markets with the idea of being able to project long-range price, consumption and production. The model consisted of a total of six demand and nine supply regions and data was evaluated for a twenty seven year period (1950-1976). The authors' attempts toward the improvement of the earlier assessment models resulted in a more flexible and comprehensive study structured to facilitate policy analysis. It would do so simply by identifying " the sectoral and geographic loci of policy impacts. " (13)

The imposition of a fifteen percent ad valorem duty on the imports from Canada was examined. As a result, the Canadian excess supply shifted upward and its slope increased. This projected an export reduction of Canadian wood product, lowering prices in Canada and raising prices in the United States.

A total ban on log exports, results in an equally divided market for both U.S. and Canada lumber exports, a reduction of the Canadian shipment of lumber to the United states, and an increase in production of lumber in the U.S.

In 1983, Darr emphasized in his article the role of excess supply and excess demand as the key factors involved in the interaction of domestic and export markets to determine both the volume of trade and prices. He considered promotional programs as a way to shift excess supply and excess demand.

The study covered a fifteen years, (1965-1979) quarterly data base period for price and volume of trade. The study showed a steady increase in the prices of both softwood and plywood. In the same period the volume of trade increased first then decreased sharply.

Policies influencing both excess supply and excess demand were evaluated. An increase in U.S. domestic supplies of roundwood was considered for the purpose of

reducing imports. This will in turn engender a decrease in the U.S. excess demand, which may cause an increase in the exports.

In another attempt to develop a world trade model for forest products, Mckillop (1984) introduced on the basis of quality classes, two alternatives approaches. One is referred to as the " GTM-linked analysis " in which the simple price and quantity relationship is applied to the existing or forthcoming estimates of world output, trade and consumption of sawnwood. The second one is referred to as " the grade-specific model " in which a spatial equilibrium model is formed. This latter model identifies different quality categories of lumber. The focus of the study is mainly directed toward the analysis of supply and demand of those species of softwood lumber for which sufficient data on both price and quantity by grade of product is available.

To estimate the supply and demand relationship, Mckillop used the Three Stage Least Squares and the logarithmic transformation of variables. He treated quantity as the dependable variable. Like in his first study of global model (1980), he found that the housing starts are generally dominant in the demand equation. He also found that the index of the industrial production is significant in the demand for Douglas fir, but not for

hemlock. Although the price of Douglas fir appeared to be a significant shifter in demand for hemlock, the reverse apparently was not true. However, lagged output plays a major role in case of supply relationship.

In 1983, Buongiorno and Chou conducted another study concerning the projection of demand elasticities for both imports and exports of forest products to and from the U.S.

Based on ordinary least squares and assumption of cost minimization in the U.S. housing industry a model was developed for U.S. softwood lumber and hardwood plywood imports with the use of general Cobb-Douglas. Monthly data for the period of seven years (1974-1980) were used. Results indicated a more responsive import of softwood lumber to change in domestic softwood lumber price in comparison to the import price, domestic price of all other commodities, and housing construction. The results also revealed more responsiveness of imported hardwood plywood to changes in import price and all other commodities' prices, in comparison with housing starts. For the forest products exported to the European Economic Community (EEC) from the U.S., a dynamic demand model based on pooled time series, for the period of 1961-1977, was developed. The results indicated similar elasticities for all the countries within the European Community, except for softwood lumber and newsprint. The study

concludes with the importance of the level of economic activity in the EEC and its great influence on demand for U.S. forest products.

In 1984, Buongiorno, Branman, and Bark conducted a study forecasting the United States softwood lumber imports through three different time series models consisting of an econometric, a univariate, and a bivariate formation. The purpose of the study basically was to compare the accuracy of each model on the basis of "either perfect knowledge of the future value of determining variables, or complete ignorance" (14) in short to medium term. As a result, the bivariate time-series model appeared to be the most useful as far as forecasting was concerned. The obvious advantage of the bivariate model over the econometric one was the need for much less information, and it was shown to be superior to the unilateral model. As far as the policy analysis was concerned, the econometric model appeared to be more suitable. The focus of the study in the case of the econometric model was over a thirteen year period (1965-1977) on one month and three month bases. To compare the accuracy of the forecasting in three alternative methods, data for the period of 1978-1980 were used. The criteria was on the basis of the smallest mean square errors resulting from each model. It was assumed that the cost of an error is proportional to the square of its magnitude, therefore the objective of the forecast was to

minimize the cost. Then several experiments were performed to test "the forecasting ability" of each method.

Darr in his 1981 study of interaction between domestic and export market for softwood lumber and plywood, discussed price formation in the export markets as well as the availability of data in both markets. Fourteen years of quarterly data (1965-1979) were used, consisting of information on volumes and prices in both markets. The policy implications were discussed throughout the study and possibilities of levying tariff, tax, and some other trade restrictions were considered.

Results of the study indicated a positive and significant relationship between prices in the export market and prices in domestic market. As far as the tests of the hypothesis were concern, the results suggested a major influence on price changes and exported volumes of dressed softwood lumber and plywood by a shift in excess supply, due to a shift in the product mix of exports. In the case of rough softwood lumber the traded volume and prices have been greatly influenced through the shift in excess demand. Generally, the study suggests that any shift in either supply or demand in one market is reflected in the other market.

Trade Of Softwood Lumber Between The U.S. And Japan

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McKillop (1973), studied the trade of forest products between Japan and North America in which he isolated major factors affecting this trade through the formation of an econometric model consisting of both supply and demand equations for the period 1950 to 1970, using quarterly data. The demand equations were for Japanese import demand for U.S. logs, import demand for U.S. lumber, and import demand for Canadian lumber. The supply equations were for U.S. supply of logs to Japan, supply of lumber to Japan, and finally Canadian supply of lumber to Japan.

McKillop found the price of competitive timber as well as stocks of logs and lumber, and construction in Japan to be the important factors affecting the demand equations. This indicated a very inelastic demand for North American wood products. He also found that the price of the commodity of concern is the most important factor in the U.S. supply equation, and the stock of lumber in British Columbia is the most important variable in the Canadian supply equation. McKillop criticized the handling of Japanese market by the U.S. producers, who treated Japan as a spot market and failed to guarantee a continuous supply of lumber of required specifications. He considered this as the major reason for the dominance of the Japanese market by Canadian suppliers. In the case

of logs supplied by the United States, the magnitude of the coefficient corresponding to the dummy variable used in the representation of the restrictions on exports of federal timber, also were suggested to play an important role in increasing the export prices by more than \$11.

McKillop did not include exchange rates in his model, due to their stability during the period of study. If this model was to be estimated today, then the exchange rates would be a major variable given the fluctuations in the last decade.

In 1980, Gallagher studied the market forces and policies involved in trade of softwood between North America and Japan. His analysis of the study is on the basis of the available annual data for a sixteen year period (1960-76).

The study implies the price responsiveness of excess demand for Japan and excess supply of the United States in the log market. Gallagher revealed that Japanese price responsiveness is in contrast with the earlier study done by McKillop, which used the quarterly data rather than annual (1950-1969), and trade units rather than wholesale prices (actually different price measurements were used). An econometric model consisting of eight functional relationships were developed in that regard. The relationships also cover the general position of both Japan and the U.S. in forest product markets, as well as

the equilibrium in both the U.S. and Canadian lumber trade.

Gallagher also discussed the policy considerations and issues regarding trade barriers.

In consideration of the relationships developed for the Japanese market, it became apparent that the estimation of the reliable coefficients was difficult, due to the collinearity among wage, lumber, and log price data. Also, the primary regression suggested correct signs of all the three coefficients, but the response of the lumber price was small compared to the input price elasticities. To develop an input price index, the input prices were combined.

Gallagher, considered low quality hardwoods (laun) and non-wooden building materials, as substitutes for softwood used in construction. Furthermore, both real prices and nominal prices were tested in the regression model. As a result, real prices showed lower explained variation in comparison to nominal prices.

Gallagher (1983), in "International Price Transmission in the U.S.-Japan Softwood Trade" addressed the influence of nontariff trade barriers and inelastic supplies on the international price margins.

For the purpose of the study, transportation cost has been considered as a constant. Also, both the

transportation cost and the international marketing costs are assumed to be equal. In developing the econometric model, it also has been assumed that the trade volume is the primary factor involved in explaining the intercountry margins which are the differences between the price in Japan and the price in the United States.

Gallagher's results indicate a more inelastic trade market compared to previous studies. Moreover, "The alternating presence and absence of a volume-related markup in the log market suggests the presence of a kink in the log-export supply function" (15). This could generate an alternating dependence on trade of log and lumber by Japan, over the course of a housing cycle, indicating a decreasing share of North American lumber in the Japanese market. The results suggest a more restricted policy toward export of logs, while undermining the influence of transportation.

#### World Trade Models In Forest Products

McKillop (1983), in a different study, estimated both supply and demand of forest products for a world model. In his study, he focused on a more general, larger scale and less complicated version of a global model. In this regard one aggregate supply function and one aggregate demand function per commodity for each region were formed.

The theoretical foundations of the proposed model were based on some modifications of the general theory of supply and consumer demand.

Five out of eight net import models showed correct signs for elasticity estimates, but only one net export model showed a correct estimated sign. McKillop stated that the persistence of a negative price coefficient in net export relationship indicates that important supply shifters, such as production capacity, have been omitted from the model. Therefore, as he also suggested, more complete models for both supply and demand are needed.

Blatner and Wisdom in 1983, published a study concerning the development of a general econometric model, estimating export demand function for sulphate pulp and linerboard. They used a pooled time series, cross-section model for which a traditional export demand function was assumed, and data were pooled across many countries in Europe, Far East Asia and Latin America, also across the custom districts to the east and west of the United States. Large differences between the two export regions were observed in regards to own-price, cross-price, and income elasticities of export demand, emphasizing the fact that there exists a product differentiation by type and place of origin. Blatner and Wisdom compared the two regions of eastern and western United States, exporting

sulphate pulp and linerboard. Interesting enough, they found different results.

Sulphate pulps exported from eastern U.S. to Europe and Latin America were slightly inelastic as a result of a price change. While exports of the similar products originated from western U.S., going to Europe and Far East Asia were inelastic. The exports of linerboard products originated from western United States were inelastic with respect to changes in own-price, while similar products were very elastic to price changes when they originated from eastern United States. The sensitivity and insensitivity of the export products to changes of own-price suggests that either there exist, or not, substitute commodities for the imported products in the importing country.

The flexibility of the model used in the above study makes the analysis of highly disaggregated and discontinuous trade flows very possible.

Buongiorno and Gilles (1983) described how different models for many countries could be linked to modeling the international trade for forest products. They emphasized the importance of this linkage as an assurance for the consistency of on imports and exports forecast and the corresponding prices between two trading countries.

Buongiorno, also mentioned several reasons for using a simple linkage mechanism. First, the diversity that

exists among the models used for each country. Second, the lack of a global linkage model developed to solve the individual country model simultaneously. Finally, the fact that only few countries are capable of developing a detailed forestry sector model during the period of the project.

### Conclusion

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The review of the literature in the preceding section indicates that little consensus has been reached with respect to the signs, as well as the magnitudes of the estimated demand elasticities. This could be the result of model and variable specifications, time differences, and the methods of estimation used in these studies.

The conclusions emerged from the preceding section are summarized below:

1- OLS technique as an estimation method has been used in most of the previous studies. There are some problems associated with OLS technique that need to be considered. If in the case of estimating import demand, the excess supply curve is not perfectly elastic, or in the case of estimating export supply, the excess demand curve is not perfectly inelastic, then the simultaneous equation bias is apparent. As a result, both import demand and export supply elasticities are underestimated.

There are serious limitations in using OLS technique, as far as estimating the effect of any change in trade policies on prices and quantities are concerned.

2- The demand for wood products in Japan is influenced by government intervention policies. That, certainly could justify its small responsiveness to any price change. Some previous studies have included such interventions in their model, through the use of dummy variable.

3- The commodities used as substitutes for the wood products imported from the United States, vary from study to study. Both, non-wooden construction materials and low quality hardwood have been considered as substitutes, and in each case the price of the substitute commodity has been treated as exogenously determined in the model specification.

4- The significance of the tariff, transportation cost, and export subsidy on the quantity of forest products traded were considered in the previous studies, however, no attempt toward the tariff inclusion in any model as an explanatory variable has been made. In the case of transportation cost, some studies have considered tariff as a variable in their import or export demand models.

5- Finally, the issue of exchange rate has been considered in the previous studies. Two versions were introduced in many trade models. One, considered exchange rate as a wedge between levels of prices in terms of the currencies of both importing and exporting country. The other, treated the exchange rate as a separate explanatory variable. The results are different in each case.

CHAPTER FOUR  
DEVELOPMENT OF INTERNATIONAL TRADE THEORY

The idea of international trade as a national issue was developed during the 1700's by mercantalists in Europe. Then each country's best interest was assumed to be expanding exports and reducing imports as much as possible. This would encourage the government to acquire more gold while discouraging imports by setting regulations to control the flow of goods into the country.

Adam Smith, often considered as the father of "modern economics" argued about the legitimacy of mercantilists trade theory offering instead the terms of absolute advantage, referring to the idea that goods produced more efficiently abroad should be imported in exchange for export of goods which are more efficiently made at home. The theory in a broader range suggests the efficient allocation of global resources. This proposed that all trading partners could benefit from this phenomenon because it would cost less in real terms to import certain goods than to produce them domestically. The capital needed to pay for imports will be provided by producing the goods in which the country has an absolute manufacturing advantage. On the contrary David Richardo who developed the theory of comparative cost advantage, questioned the accuracy of Smith's idea and cast some doubts about the benefit in trading with a country that

has no absolute advantage. Richardo showed that it is possible for two countries to gain from trade, even though one country has an absolute advantage in producing both goods. The benefit would take place, if the comparative advantage of one country in producing one good compared to the second country were such that it determined the international trade flow. There is also a shortcoming in regard to the theory of comparative advantage, such that there would be no trade if there is no difference in relative production costs between countries.

#### The Role Of Demand In International Trade -----

After Richardo, John Stuart Mill recognized the relative strenghts of demand as the determining factor in trade between two countries for each other's product. In fact, Mill added the intensity of demand to the cost analysis of Richardo. Later, Marshall and Edgeworth formalized the working of the demand intensity in the "reciprocal demand" or "demand and supply curve". Edgeworth emphasised the generality of this construction and rejected any assumption concerning the constancy of the marginal utility of money or of any commodity. "A movement along a supply-and-demand curve of international trade should be considered as attended with rearrangments of internal trade. accordingly, the marginal utility of import need not be supposed constant; nor the marginal disutility, the cost of production, of exports"(16).

Several classical economists tried to give a tighter mathematical approach to the existing international trade theory. In particular Pareto et-al, came up with models beyond their time. Unfortunately many of those were not recognized by English-speaking economists until the 1930's, and still most complete versions of these theories are in Italian (17).

### The Modern Theory Of International Trade

The twentieth century opened a new era in developing the new theories of international trade. In 1933 , Gottfried Haberler suggested that the comparative advantage of a country in every good it exports, compared to any good it imports, as the determining factor in trade in many commodity cases. This apparently was the idea behind the development of his opportunity-cost theory. During the same period, Bertil Ohlin, a Swedish economist who studied under Eli Heckscher, came up with the factor-proportion theory which expanded the idea developed earlier by his teacher. The theory frequently referred to as the "Heckscher-Ohlin (H-O) theory", is based on two necessary conditions responsible for comparative-cost differentials:

- (1) The existance of different factor endowments in the two trading countries, and

(2) The existance of different factor proportions for different goods. This suggested the existance of the comparative advantage in producing and exporting goods in which factors are greatly abundant in the country, and the lack of comparative advantage in importing goods in which factors are relatively scarce in the country.

#### The Economics of Interdependence Among Trading Nations

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Having the trade of forest products between the U.S. and Japan in mind, the following presents a general discription of interdependence among trading nations and its effect on quantities traded as well as price changes.

Figures 4-1a, 4-1b, and 4-1c illustrate the effects in the U.S. and Japan after opening-up international trade regarding any of the commodities of concern. It is apparent that a different quantity of excess supply in the U.S. (or excess demand in Japan) would be obtained as various prices in each market are in effect.

At the closed economy prices of  $P_1$  in the U.S. and  $P_2$  in Japan are observed, the quantity of excess supply in the U.S. and excess demand in Japan are both equal to zero. Now, in the presence of free trade between the U.S. and Japan and opening up the relationship both parties participate in trade to the extent that prices in the U.S. rise and fall in Japan, so they are equal to the price at

the world market level. At this stage the export quantities in the U.S. at price  $P_3$  exactly equals the import quantities in Japan at the same price level. The consumption in the U.S. falls from  $Q_1$  to  $Q_2$  level, while production increases to  $Q_3$  level. In Japan consumption increases from  $Q'_1$  to  $Q'_3$ , and production falls to  $Q'_2$  level. As a result, both the domestic market and world market would determine the internal market prices in each trading country.

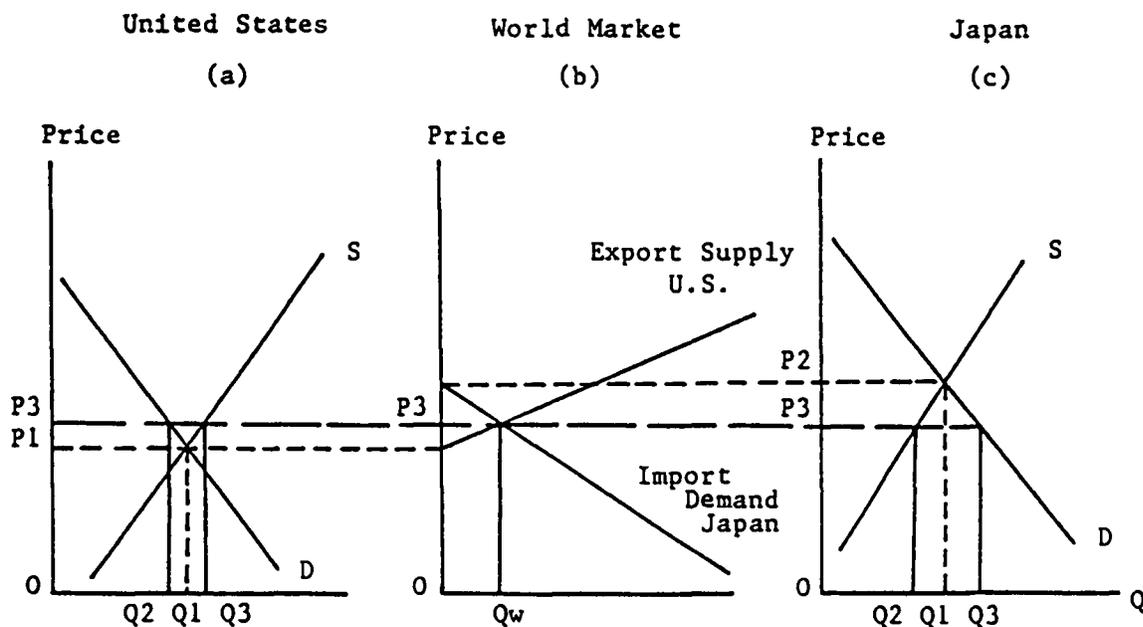


Figure 4-1, The Economics of Interdependence Among Trading Nations.

## A Pragmatic Theory

Through decades of constant improvement of international trade theories, neither classical theories nor the modern version of Heckscher-Ohlin theory really represented global trade. In 1979, Gary introduced a theory in which all the basic forces involved in international trade among nations were included. In his theory, Gary retaining the two country model, stated that most of the problems occurring in trade relate to a single nation, viewing the rest of the world as "supplier or demander". Gary classified the traded good into three categories:

A- "Competitive goods" which are being considered as perfect substitutes and could be produced in both trading countries.

B- "Noncompetitive goods", and probably the most important of all, are the ones that must be imported because they either require specific factors of production unavailable in the importing country, or they are produced in a limited quantity. Hence, the element of competitiveness of these goods is lacking.

C- "Differentiated goods" which are different from the goods in the first category (competitive goods), but very

similar to them. The best example of these commodities are; televisions, radios, and autos.

Gary (1979) has specified the following different types of noncompetitive goods such as: " Type- A; noncompetitive good is one that the importing country is incapable of producing. It requires a specific natural resource for its production: copper deposit for copper ore, bauxite for aluminum..."(18). "Type- B; noncompetitive is an import labeled "gap filler" which fills the gap between domestic demand at the going world price and maximum domestic output".

Figure 4-2, demonstrates different types of noncompetitive imports. As illustrated,  $S_d$  represents the domestic supply schedual reaching its maximum at OB, at point H supply curve becomes perfectly inelastic. Gary suggests two reasons for inelasticity of supply curve throughout its length;

(1) A limited amount of natural resources that are essential in production of the good is available, thus by increasing the output a severe "diminishing return in terms of the cooperating inputs" would occur.

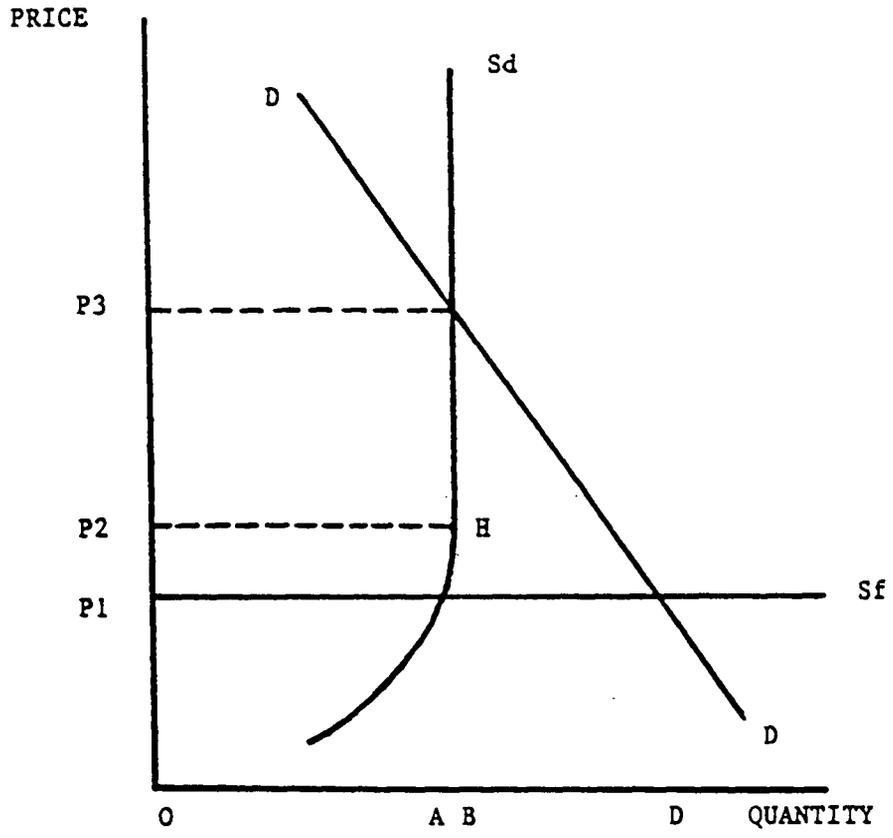


Figure 4-2, Non-Competitive Imports

(2) A quick deterioration in terms of the natural resources due to the exploitation and missuse of such resources.

In the same figure,  $S_f$  represents a perfectly elastic foreign supply schedule, indicating that perhaps unlimited quantities of the good is available at price  $P_1$ . At this price the country is both willing and able to produce  $OA$  and import  $AD$ . The quantity represented by  $AB$  is considered to be competitive, due to the fact that the maximum potential production is greater than  $OA$ , by  $AB$ .

In the case of an increase in domestic price up to  $P_2$ , all imports will be considered as noncompetitive, although  $OB$  is produced domestically. In an extreme case, such as severe restrictions on trade, if the domestic price increases to  $P_3$ , (a suicidal domestic policy), the entrepreneur would gain huge rents and the country becomes self-sufficient. "Type-C, noncompetitive good is one in which the technology of producing it is not available in the importing country" (19). The distinction between type-A and type-C is merely the question of availability of resources versus the technology, (e.g., type-C goods can be produced domestically, once the transfer of technology is possible, whereas type-A goods cannot be produced because for example of the climatical differences).

In the case of Japan, import of softwood lumber could be considered as type- B, a noncompetitive goods or "gap filler". Although Japan has a large source of wood its reserves can not satisfy the ever increasing domestic demands, at least in near future. This characteristic of Japan's forest industry, makes the consideration of the "pragmatic theory" more appropriate.

#### Theoretical Model

We could interpret a country's import demand for a particular good as its excess demand for that good. Therefore the import demand for a commodity ( $Q_m$ ) is the difference between the domestic demand ( $Q_d$ ) and the domestic supply ( $Q_s$ ) of that commodity, or mathematically we could write:

$$(1) \quad Q_m = Q_d - Q_s$$

It is apparent that factors affecting import demand will also affect both domestic supply and domestic demand.

In this regard, the classical theory of demand states that a consumer's income would be allocated among different goods such that it makes the consumer maximize his utility function subject to a budget constraint. Therefore, it makes the combination of all the purchased commodities, a function of their relative prices and of

course the available income. Knowing that the consumer always has the freedom of choice in how to allocate his income, thus the total domestic demand ( $Q_d$ ) could be driven as follows:

$$(2) \quad Q_d = f ( P_d, P_s, Y, POP )$$

Which means, the total domestic demand is a function of the price of the commodity of concern ( $P_d$ ), as well as price of its substitute ( $P_s$ ), income ( $Y$ ), and population ( $POP$ ).

By substituting the above equation into equation (3), we could derive the import demand for the quantity ( $Q_m$ ):

$$(3) \quad Q_m = f ( P_d, P_s, Y, POP ) - Q_s$$

By dividing the entire equation by population ( $POP$ ), consumer's price index ( $I$ ), we could have the relationship as:

$$(4) \quad Q_m/POP = a_0 - a_1(P_d/I) + a_2(P_s/I) + a_3(Y/POP.I) - a_4(Q_s/pop)$$

Where the  $a$ 's are parameters, and for the sake of convenience the error terms have been all excluded from the relationship. It is noticed that the per capita import demand for the commodity of concern is inversely

related to its own real price ( $P_d/I$ ), and per capita domestic supply ( $Q_s/I$ ) directly related to the real price of its substitute, as well as per capita real income. All indicated by minus and plus signs.

The above relationships are all in general forms assuming that both consumers and importers are demanding exactly the same commodity. While, this could be a typical case, it is not true in many other cases in which the commodity demanded by the consumer is very different from the imported commodity. The obvious example of such a case is the commodity of concern in this study, in which the final products are in forms of i.e., construction, both commercial and residential. In such cases, demand for the imported commodity is derived from the demand for final product. In this regard, we could come up with a price relationship which is in terms of commodity demanded by importers, as:

$$(5) P_d = b_0 + b_1 P_m + b_2 Z$$

Where b's are parameters,  $P_d$  is the price of the commodity paid by the consumer of the final product,  $P_m$  is the price of commodity paid by importer, and  $Z$  is the price of factors used in processing for the final product. It is also assumed that for maximization purposes, importers or millers use a factor in processing up to the point where

the value of marginal product of the good is equal to its price, i.e.,  $VMPZ = Z$

Once the price relationship is recognized, it could be applied to the linear formation acquired in relation (4).

Thus;

$$(6) \quad Q_m/POP = a'_0 - a'_1(P_m/I) - a''_1(Z/I) + a_2(P_s/I) \\ + a_3(Y/I \cdot POP) - a_4(Q_5/POP)$$

where;  $a'_0 = a_0 - (a_1 b_0)/I$ ,  $a'_1 = a_1 b_1$ , and  $a''_1 = a_1 b_2$ .

The price of an imported commodity paid by the importer ( $P_m$ ) is in the currency of the importing country and it is affected by several components.

$$(7) \quad \text{thus;} \quad P_m = @ ( P_x + C_t ) + T$$

Where @ stands for prevailing exchange rate,  $P_x$  is the price of the commodity sold in terms of the exporting countries currency,  $C_t$  is the transportation cost in terms of the currency of the exporting country, and  $T$  expresses a specific tariff imposed by the importing country in terms of its own currency.

As Edwards suggested in his paper titled " On The Role of Exchange Rates In The Analysis of International Trade ", the transportation cost may be defined as:

$$(8) \quad C_t = C_x + C_m$$

$C_x$  is per unit transportation cost payable in terms of the currency of the exporting country.  $C_m$  is per unit transportation cost payable in terms of the currency of the importing country. Both costs are independent of the volume of the commodity shipped. Now, both equations (7) and (8) could be included in equation (6):

$$(9) \quad Q_m/POP = a'_0 - a'_1 \frac{[ P_x + P_c + (C_m/S) + T ]}{I} - a''_1 (Z/I) \\ + a_2 (P_s/I) + a_3 (Y/I \cdot POP) - a_4 (Q_s/POP)$$

As may be seen in the above equation, all components presumably affecting the relationship such as; exchange rate, transportation cost, tariff and the exporters price of the commodity are included in the model. It is also assumed that the exporter's price ( $P_x$ ) is determined independently. Otherwise, in order to avoid downward bias in the parameters estimation the import supply equation of the importing country could be specified, then we could write the condition for the equilibrium such that;

$$(10) \quad Q_m = Q_x$$

So the total import demand ( $Q_m$ ) is exactly equal to the total export supply ( $Q_x$ ). Also, the export supply could be defined as;

$$(11) Q_x = [ QTS - QRW ] - QDX$$

QTS is the total supply of the exporting country, QRW is the commercial export of the exporting country to the rest of the world ( the importing country of concern, not included ), and QDX is the total domestic demand for the product in the exporting country.

Once more, the per capita domestic demand for the product in the exporting country may be written in a linear form as before:

$$(12) \frac{QDX}{POPX} = C_0 - C_1 \frac{PDX}{IX} + C_2 \frac{PSX}{IX} - C_3 \frac{YX}{IX.POPX}$$

Where  $\frac{QDX}{POPX}$  is the per capita domestic demand for the product in the exporting country considered as a function of; real domestic price of the product ( $\frac{PDX}{IX}$ ), real price of substitute ( $\frac{PSX}{IX}$ ), and per capita real income in the exporting country ( $\frac{YX}{IX.POPX}$ ). C's are parameters.

For the domestic price of product the relation is define as:

$$(13) PDX = PX + S$$

where S is considered as a specific subsidy given to the exporters in order to promote the exports. The following

relationship is derived by substituting the two equations (13) and (12) into (11).

$$(14) \quad QXS = QTAS - C_0 + C_1 (PX+S)/IX - C_2 PSX/IX + C_3 YX/IX$$

where  $QTAS = (QTS - QROW)$ .

#### Derivation Of The Exchange Rate Elasticity

It is important to realize how the exchange rate elasticity of export (imports) is derived from the model since it is one of the major components of the model. It has been showed by Edwards that, the exchange rate elasticity of export (EX) or alternatively of import (EM) may be derived from the above system of equations, as follow:

$$(15) \quad EX = EM \left\{ \frac{[nx.nm.\theta]}{[nx.PM - nm.\theta.PX]} \right\} (PX + CX) < 0$$

Where (nx) is the price elasticity of excess supply of the exporting country, (nm) is the price elasticity of excess demand of the importing country. Further, it is assumed that all the transportation costs involved are constant. From the above relationship we realize that, if the price elasticity of excess supply (nx) is zero, then the elasticity of export is zero, regardless of the value of the other parameters. Also, if the price elasticity of

excess supply ( $nx$ ) is perfectly elastic, then the elasticity of export ( $EX$ ) is equal to the price elasticity of excess demand of the importing country ( $nm$ ). The magnitude of the exchange rate elasticity of export also depends on the per unit shipping costs payable in the exporting country's currency.

Figure 4-3 shows how equilibrium in the market of the commodity of concern could be affected, once, there is interaction in the related system of equations. As stated by Edwards, it is assumed that the import market of concern is relatively so small in comparison with the total trade sector as a whole that any development of such market would not in any way influence the exchange rates. Also there exists a perfectly competitive situation in the market shipping services. Figure 4-3 illustrates the effect of any change in the quantity traded and equilibrium prices, as a result of change in the exchange rate. For example any change in exchange rate from  $@_0$  to  $@_1$ , i.e. a devaluation of the currency of the exporting country, would shift the excess supply curve from  $Q_0XS$  to  $Q_1XS$  in terms of the currency of the importing country. Thus, it makes the price of the commodity in terms of the currency of the importing country cheaper than prior to the devaluation of the exporting country's currency. Therefore price would change from  $P_0M$  to  $P_1M$  and quantity from  $Q_0M$  to  $Q_1M$ . Also, both price and quantity will change in the exporting country from  $P_0X$ ,  $Q_0$  to  $P_1X$ ,  $Q_1X$ ,

resulting in an increase in exports of the exporting country.

Effects of the imposition of quota by the government of the importing country on both price and commodity traded could be different from the previous case. By setting the quota at the level of imports prior to the devaluation of the exporting country's currency ( $Q_0$ ), the quantity traded and the equilibrium price in terms of the currency of the exporting country still would be the same, but the importer would pay a lower price  $P_1M$  for the same quantity as before (in terms of its own currency), and therefore is able to make a profit (i.e. the difference of  $P_0M - P_1M$ ).



### Impact of New Suppliers on Japanese Market

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Under free market trade in logs and lumber products the impact of new supplier (i.e., Chile, or New Zealand) on the Japanese market for imported products is such that, the excess supply curve of the new supplier will be added to the U.S. excess supply curve. Therefore, the new supply curve (figure 4-4) will be in effect in the Japanese market. The result of this new addition would be a larger supply of products to the Japanese market and as a consequence, lower prices will be charged.

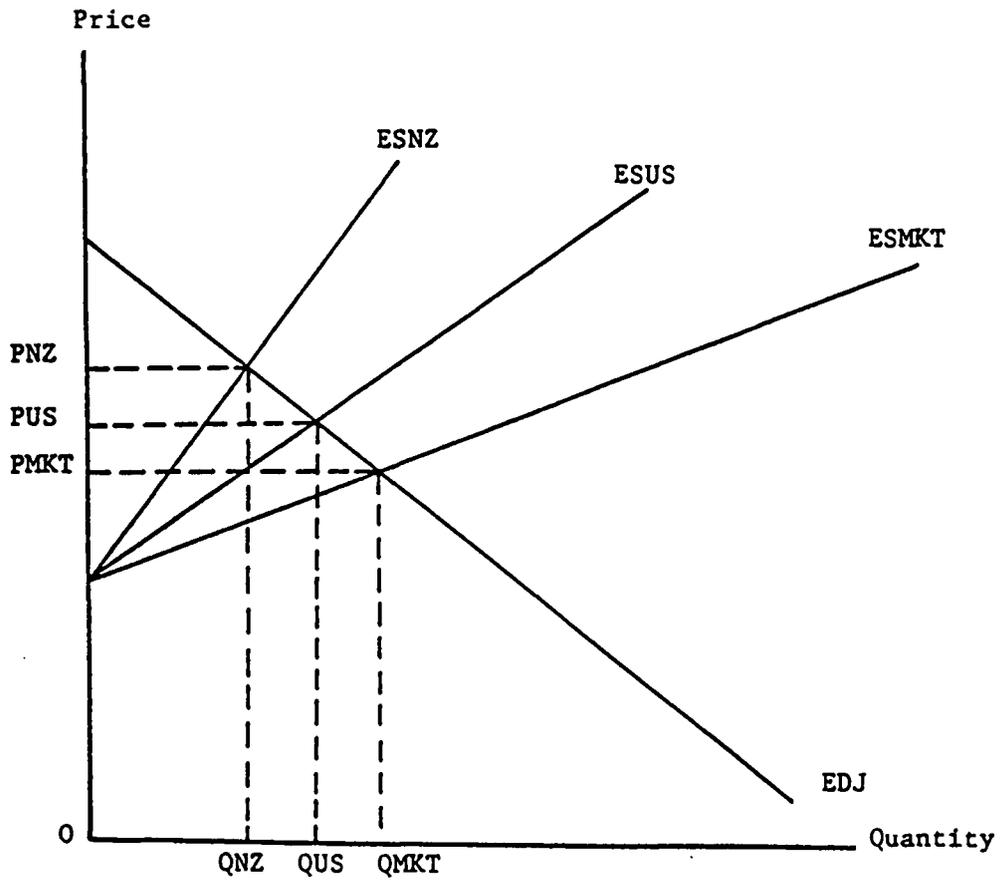


Figure 4-4, Impact of New Supplier on Japanese Market.

CHAPTER FIVE  
MODEL SUMMARY AND ASSUMPTIONS

The proposed models consist of two structural equations for each commodity of concern. These models are estimated in Log-Linear, and Linear functional forms.

The principle differences between a linear regression model as opposed to a log-linear model are as follow (20):

1- The linear regression model assumes that all the slopes are constant, while such an assumption does not apply to the log-linear model.

2- As a consequence of (1), the elasticities are constant under the log-linear model, but not under the linear regression model.

3- The choice of functional form also depends on the form of demand curve for the final product from which the factor's demand is derived therefore depending on whether the demand for final product is linear or not, we choose an appropriate functional form for the derived demand.

For each case two alternative specifications have been considered. One alternative considers the domestic price as a factor involved in the model, while the other disregards the domestic price as an influencing variable.

The variable definitions, equations, estimation procedure, and expected signs are summarized in table 5-1 below.

TABLE 5-1: Variable Definitions

Variable	Expected Sign	Definition
USLUMXJ	N.A	U.S. lumber export to Japan
PLUMPNWJ	(-)	An average price of lumber from the Pacific Northwest
JDEFLUMP	(+)	Japanese deflated lumber price
USLUMXJ1	(+)	U.S. lumber export lagged 1 yr
GNP/POP	(+)	GNP per capita
IMFXR	(+)	IMF exchange rate Y/\$
JPIP	(-)	Interest rate in Japan
JPPI	(-)	Japan's petroleum imports
STARTS	(+)	Total housing starts
USLOGXJ	N.A	U.S. log export to Japan
USXJGWPI	(-)	U.S. log price to Japan / WPI
JDEFLOGP	(+)	Japanese deflated log price
USLOGXJ1	(+)	U.S. log export price lagged 1 Yr
DLOGP	(-)	Japanese log, domestic production

Equations:  
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Lumber

$$(1) \log( USLUMXJ )_t = \log a_0 + a_1 \log( PLUMPNWI )_t \\ + a_2 \log( JDEFLUMP )_t + a_3 \log( USUMXJ1 )_t \\ + a_4 \log( GNP/POP )_t + a_5 \log( STARTS )_t \\ + a_6 \log( IMFXR )_t + a_7 \log( JPIP )_t \\ + a_8 \log( JPPI )_t + U_t$$

$$(2) \quad USLUMXJ_t = a'_0 + a'_1 PLUMPNWI_t + a'_2 JDEFLUMP_t \\ + a'_3 USLUMXJ1_t + a'_4 (GNP/POP)_t \\ + a'_5 STARTS_t + a'_6 IMFR_t + a'_7 JPIP_t \\ + a'_8 JPPI_t + U_t$$

Logs

$$(3) \log( USLOGXJ_t ) = \log( b_0 ) + b_1 \log( USXJGWPI_t ) \\ + b_2 \log( JDEFLOGP )_t + b_3 \log( USLOGXJ1_t ) \\ + b_4 \log( GNP/POP )_t + b_5 \log( STARTS )_t \\ + b_6 \log( IMFXR )_t + b_7 \log( DLOGP )_t \\ + b_8 \log( JPIP )_t + b_9 \log( JPPI )_t + U_t$$

$$(4) \quad USLOGXJ_t = b'_0 + b'_1 USXJGWPI + b'_2 JDEFLOGP_t \\ + b'_3 USLOGXJ1_t + b'_4 (GNP/POP)_t \\ + b'_5 STARTS + b'_6 IMFXR_t + b'_7 DLOGP_t \\ + b'_8 IPIP_t + b'_9 JPPI + U_t$$

Japanese Demand For U.S. Lumber And Logs  
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Statistical Results:  
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The following tables display all the estimated coefficients of the Japanese import demand function for U.S. lumber as well as logs. They also show that in the case of import demand for lumber three of the estimated coefficients; the lagged dependent variables, interest rates in Japan, and Japan's petroleum imports do not have the expected signs. Only in one case ( linear functional form with no domestic price of lumber included) the coefficient for the weighted average of lumber price in the Pacific Northwest, indexed for 1980 does not have the expected sign. In the case of import demand for logs, all the estimated coefficients, except for the U.S. log export price have the expected signs. Only in one case (import demand for logs includes domestic price of logs), GNP per capita does not carry the expected sign. In all four cases of import demand for lumber, the coefficients for GNP per capita, housing start, and Japan's interest rate are significant. Similarly, housing start in all four cases of import demand for logs has a significant coefficient, while the U.S. log export to Japan (deflated by WPI), and exchange rate are significant only in the log linear model. In case of both commodities, the rest of the coefficients are either not significant or

minimally significant under different trials (with the exception of lagged variable in the case of lumber under the log-linear model which is significant).

TABLE 5-2 : Estimated Elasticities (OLS) For Japanese Import of Lumber From the U.S., 1961-1985.

VARIABLES	LOG LINEAR MODEL		LINEAR MODEL	
	WITH DOMESTIC P	NO DOMESTIC P	WITH DOMESTIC P	NO DOMESTIC
PLUMPNWI	-0.7156 (-1.074)	-0.9325 (-1.524) *	- 0.0038 (-0.013)	0.0195 (0.066)
JDEFLUMP	0.0224 (0.862)	N.A.	0.1355 (1.439) *	N.A.
USLUMXJ1	-0.0070 (-2.157) ***	-0.0075 (-2.370) ***	-0.1306 (-0.869)	-0.0677 (-0.456)
GNP/POP	1.1170 (2.450) ***	1.3896 (4.264) *****	0.6401 (2.958) *****	0.5987 (2.702) *****
STARTS	0.0053 (1.836) **	0.0047 (1.701) *	0.3390 (2.695) ****	0.4612 (4.813) *****
IMFXR	0.0111 (0.012)	0.1306 (0.144)	0.4447 (0.812)	0.2654 (0.482)
JPIP	0.6810 (2.510) ***	0.7320 (2.787) ****	0.7445 (4.998) *****	0.7913 (5.270) *****
JPPI	0.0260 (0.793)	0.0316 (0.991)	0.0772 (0.919)	0.0590 (0.688)
DF	15	16	15	16
DW	2.60	2.39	2.26	2.26
R <sup>2</sup>	0.93	0.93	0.96	0.96

NOTES: 1. The numbers on the first row of each of the variables are the respective elasticities.  
 2. The numbers in the parenthesis are the t statistics associated with the original coeffs.  
 3. The level of significance are indicated by \* under t statistics  
 \* = %10 Level of significance  
 \*\* = %5 Level of significance  
 \*\*\* = %2.5 Level of significance  
 \*\*\*\* = %1 Level of significance  
 \*\*\*\*\* = %0.5 Level of significance

TABLE 5-3 : Estimated Elasticities (OLS) For Japanese Import of Logs From the U.S., 1961-1985.

VARIABLES	LOG LINEAR MODEL		LINEAR MODEL	
	WITH DOMESTIC P	NO DOMESTIC P	WITH DOMESTIC P	NO DOMESTIC
USXJGWPI	1.2153 (1.658) *	1.2655 (2.039) ***	0.3737 (0.885)	0.5660 (1.497) *
JDEFLOGP	5.2277E-04 (0.142)	N.A.	0.3285 (0.349)	N.A.
USLOGXJ1	0.0038 (0.922)	0.0037 (0.944)	0.2298 (1.105)	0.3408 (1.803) **
GNP/POP	0.2077 (0.623)	0.2261 (0.762)	-0.0922 (-0.583)	0.1776 (0.915)
STARTS	0.0068 (1.932) **	0.0067 (2.060) **	0.5078 (3.038) *****	0.3175 (1.816) **
IMFXR	1.6254 (1.446) *	1.6961 (1.741) *	0.1260 (0.147)	0.3909 (0.505)
JPIP	-7.5421E-04 (-0.333)	-6.4501E-04 (-0.314)	-0.0680 (-1.043)	-0.1681 (-0.859)
JPPI	-0.3831 (-0.957)	-0.4002 (-1.083) *	-104.63 (-0.657)	-0.1819 (-2.039) **
DLOGP	-0.0457 (-0.911)	-0.0465 (-0.964)	-0.0680 (-1.043)	-0.0651 (-1.149) *
DF	14	15	15	15
DW	1.78	1.78	2.17	2.61
R <sup>2</sup>	0.86	0.86	0.90	0.92

NOTES: 1. The numbers on the first row of each of the variables are the respective elasticities.  
 2. The numbers in the parenthesis are the t Stat.  
 3. The level of significance are indicated by \* under the values.  
 \* = %10 Level of significance  
 \*\* = %5 Level of significance  
 \*\*\* = %2.5 Level of significance  
 \*\*\*\* = 1% Level of significance  
 \*\*\*\*\* = %0.5 Level of significance

The estimated import demand elasticities of lumber with respect to the per capita GNP indicate that, ceteris paribus, a one percent increase in the GNP per capita, increases the demand for softwood lumber by 1.12, 1.39, 0.64, and 0.60 percentages, if two separate forms of log linear model (domestic price included versus no domestic price included) are applied respectively. With the same token, one percent increase in housing start, increases the demand for lumber by only 0.0053, 0.00476, 0.34, and 0.46 percentages respectively. A one percent increase in interest rate in Japan, also influences a positive change in demand for lumber by 0.68, 0.73, 0.74, and 0.80 percentages respectively.

When the estimated import demand elasticity for logs with respect to one percent increase in the U.S. export price to Japan (deflated by WPI) is considered, the effect would be an increase in demand for logs by, 1.21, 1.26, 0.37, and 0.56 percentage respectively.

As far as the collinearity between the explanatory variables is concerned, the result of the coefficient matrices suggest the existence of a strong linear relationship among most of the independent variables, (see appendix II). The presence of multicollinearity in turn may have caused the value of the estimates of the coefficients to be unstable and imprecise, although

statistically unbiased. The signs of the parameters could have been affected as the degree of collinearity has increased, i.e., the lagged dependent variable and Japan's petroleum imports which do not carry the expected signs, show a strong linear relationship with most of the other variables. This latter effect may have caused problems regarding the important parameters in the model. On the other hand, multicollinearity could have caused the standard errors of the estimates to be large, which in turn may call for rejection of some important variables from the model. In short, misspecification of the variables may be the outcome of existing multicollinearity.

No attempt for correction of multicollinearity was pursued, due to the nature of this problem, and also, due to the existence of certain limitation on the part of this study, (i.e., availability of additional data and prior information).

Despite the results obtained by Gallagher (4), this study shows that the overall effect of domestic prices of lumber and logs produced in Japan is small in response to Japanese import demand. This view is suggested by comparison of the results in modified version of the models applied to the two products. Also, in the case of import demand study for logs, this study suggests that the

domestic production of logs in Japan has no influence on import demand for logs.

Finally, the inclusion of Japanese petroleum imports, as an influencing factor in the balance of trade, shows no direct effect on demand for concerned commodities and the exchange rate has minimum effect on the demand for logs only.

### Policy Implications

The results obtained in this study have the following policy implications:

While the Japanese import demand for both lumber and logs are affected by most of the domestic factors, and some of the outside variables such as exchange rate (in this case devaluation of the dollar), the import prices have little concern or no influence on the overall demand for these products. This phenomenon could be as a result of need for a steady flow of wood commodities used in growing housing projects, despite the increasing population with a decreasing rate.

Surprisingly, while the effect of the nominal interest rate in Japan in this study shows a significant positive influence on demand for lumber, it implies an insignificant effect on demand for logs in Japan. This could be viewed as the consumers willingness to borrow

money for purchase of new housing, although the contrary is suggested to be the case in the demand for logs. While the lumber directly used in housing projects shows a positive responsiveness with regard to the changes in the price of money, logs prove to be insensitive to the change in interest rates.

The following may suggest some clarifications concerning the logic of trade in terms of both a final product and factor on the same arc.

Although logs are the main factor input used in the production of lumber, they are not used solely for this particular purpose. The other uses of logs are in manufacturing of paper, pulp, and many products other than lumber. Therefore, export of logs to Japan is justified in this regard. Keeping in mind that paper production in Japan enjoys higher quality and standards in comparison with the papers manufactured in the U. S. Besides the justification provided here, considerations other than economical may have caused the exportation of both the final product, as well as the factor at the same time.

## CHAPTER SIX

### SUMMARY AND CONCLUSIONS

The introduction to this study provides a brief description of the Pacific Northwest reliance on the export of forest products to the Pacific Rim Countries. Japan, as the major market for the U.S. forest product is the primary concern in this study. As a result, new developments in Japan may significantly affect the volume of trade for many products including forest products, between the U.S. and Japan. In addition, very few studies in trade for wood products have been conducted between the U.S. and Japan.

The purpose of this study was to identify factors affecting the trade of wood products, (softwood lumber and log) between the U.S. and Japan, and to improve the understanding of the Japanese wood market, as well as the influence of the forces affecting the future trade between the two markets.

A free trade model under the basic principles of perfect competition and homogeneity of products were assumed. As a result, the products of concern produced in different countries and regions were assumed to be perfect substitutes for one another. Therefore, prevailing world market prices for these commodities must be in effect. But in reality, the imports from a given country as well as the quality of the products constitute "close, but not

perfect substitutes for imports from other countries or those produced domestically" (21). This constitutes the basis for product heterogeneity approach. If product heterogeneity is our concern, then the basic assumptions of the model are influenced by factors other than the ones already specified in this study. For instance, the price of imports from the alternative suppliers along with the domestic prices and price of imports from the country of concern (in this case the United States) would be included in the model. Alternatively, the model could include the approach originally introduced by Armington which considers multiple prices based on product heterogeneity condition. In this regard the quantity of imported product becomes a function of the price the product, relative to the average price of the ,products in the same market, as well as other relevant factors in the model. Moreover, the cross price elasticities, rather than merely price elasticities become relevant to the model. Therefore, if a model under product heterogeneity was performed in this study, the ratio of the commodity price from each country to the share of the market by each country must be considered.

An attempt was made to develop a model such that it would portray more relevant factors affecting the Japanese market for the U.S. forest products. Given the available resources, two empirical time series models for each commodity were estimated by OLS technique and using annual

data from 1961-1985. The empirical models consist of both a log linear, and a linear model for each of the products. Models differed from each other depending on whether or not the domestic price of the product has been included in the model. One draw back of the linear form is that the price elasticity tends to diminish as income grows, which could be very well reflected in the linear form adapted in this study. Under such circumstances the log-linear form which constrains the elasticities to be constant may be preferred.

The results of this study indicate that the estimated elasticities do not show a significant difference under alternative functional forms. Therefore, neither of the forms is preferred over the other one, i.e., GNP per capita, housing starts, and the interest rates in Japan significantly affect the Japanese import demand for lumber from the U.S. under both studies.

In the case of the Japanese import demand for U.S. logs, housing starts appear to be a significant factor, while the price of the U.S. log exported to Japan deflated by wholesale price in Japan and exchange rates were significant only in the log linear model.

The GNP per capita affects the estimated import demand of lumber by 1.12 in the log linear model when the domestic price of lumber was included in the model. The effect was 1.39 When the domestic price was excluded from

the model. When the linear model was applied and the domestic price of lumber was included in the model, the effect reduced to 0.64. When domestic price was excluded from the model, the effect was 0.60. These relatively inelastic results could be due to the increasing population in Japan at a decreasing rate. Therefore, although the national income has been increasing significantly during the period of concern, the number of housing start has been decreasing in the last decade.

Moreover, the study shows that the import prices of both products do not play a significant role in estimation of import demand for logs and lumber from the U.S. This may suggest that there is an interest in providing a steady supply of products to Japan's market even at relatively high import prices. This view also has been confirmed by some Japanese importers of different products from the U.S. The same line of reasoning might apply to the insignificant nature of exchange rate, and its effect on the import demand for wood from the U.S. It also could suggest a relative price change in the currency of the countries other than the U.S. that export wood products to Japan in favor of a strong Japanese Yen, which might imply a relative insignificance of the deflated dollar followed by a reduction in the U.S. prices of wood products, in its relation to trade with Japanese.

Though interest rates in Japan suggest a significant influence over the demand for imported lumber, the study shows that the same factor is very insignificant when it comes to the import demand for logs. This result could imply a strong willingness to pay higher prices for borrowed money by consumers of housing, which indirectly affects the demand for imported lumber in Japan. There is apparent unwillingness by importers to pay for increasing interest on capital to purchase logs for Japan. An alternative interpretation could suggest that unlike the nominal interest rate which is the factor introduced in this study, the real interest rate may be moving in opposite direction of the variable included in the estimate of lumber demand. Also, interest and the cost of capital in the decisions regarding housing starts may not be very significant since consumers in Japan enjoy higher saving rates and therefore may finance a large portion of the housing purchase. Moreover, a sizable portion of imported lumber would be used in renovation of older houses rather than construction of new housings.

Finally, Japan's expenditure on petroluem products has not significantly affected its imports of forest products from the U.S. In other words the change in petroluem expenditure of Japan due to the change in of the oil prices has not influenced the balance of payments in Japan to the extent that it affects the Japanese decision to import forest products from the U.S. This may suggest;

(1) a very high dependency of Japan to imported oil, almost regardless of the price, (2) a very strong balance of payments in favor of Japan which gives her an advantage in obtaining the essential products even at higher prices.

Due to the fact that the ratio of the Japanese import of U.S. logs and lumber to the total production of different commodities in Japan is not large enough to justify the use of general equilibrium model, as well as the simplicity of the partial equilibrium model, the latter approach has been adopted. Unlike the partial equilibrium model which focuses on a change in one market (no change in all other markets is assumed), in the general equilibrium approach we consider the adjustments that a change in one market could cause in each and every other market.

While Gallagher's study of "Trade Between the United States and Japan" in Softwood Log (4) played a significant role in development of this study, the results obtained here are very different from his. The major differences between this study and the study conducted by Gallagher are as follow:

- (1) Different factors are involved in each study.
- (2) The way in which these factors have influenced the trade between the countries are different.

Although the proposed models were developed under the assumption of perfect competition, the nature of the market, as well as the results of this study suggest that both logs and lumber are traded under an oligopolistic market structure (due to existence of several major suppliers to Japan with a significant market ratio), or even a bilateral monopoly, since both the U.S. and Japan exercise their influence in the same market.

While the trade theory tends to provide a simple understanding of the underlying forces in any trade activity, it does not necessarily guarantee the logical interaction of the factors involved in a trade model. In other words, trade models reflecting the economy in an abstract way, try to establish a reasonable relationship between the relevant factors, but in many instances considerations other than economical may influence the interaction of the concerned variables. Therefore, presence of results, sometimes contrary to the expected ones should not prevent researchers from conducting studies in this area.

#### Limitations and Suggestions For Future Research

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This study was the result of an attempt to analyse and evaluate models consisting of factors influencing the trade of forest products between the U.S. and Japan. To improve the effectiveness of the models, as well as their

marketability for potential policy analysis some further research is recommended.

Perhaps an improved model could specify a behavioral relationship between the concerned products imported from countries other than the U.S., and the same products imported from the U.S. The relationship pattern, if any, may suggest quite different result from the result obtained in this study. Also, inclusion of the shipping costs, rather than the money spent on energy in lieu of the transportation cost, might establish significant results concerning its effect on the demand for imported forest products. Moreover, inclusion in the model of tariffs, and other policy variables related to lumber and logs imposed by government of Japan and the U.S. is recommended, so the role of the price as well as the exchange rate affecting the U.S. forest products exports is clarified. Other consideration, involving the effect of devaluation in the U.S. dollar on U.S. lumber and log export, is the degree in which the devaluation lowers the U.S. prices in terms of the Japanese currency. Whether or not the lower prices, in turn, affects the quantity of the U.S. lumber and log exports depends on (1) if Japan has an import policy which requires maintaining certain proportion of imports from different countries, and (2) if countries other than the U.S. which export forest products to Japan would also devalue their currency following the U.S. devaluation of the dollar. Unless some additional

information of such conditions are provided, the effect of the exchange rates on the quantity and price of the U.S. lumber and log exports to Japan will not be well understood.

There are some limitations to the implementation of the noted modifications of the suggested model. These limitations are related to discrepancies existing between the reports and data provided by different sources of information which could be the result of a potential difference in specifications of the same commodities as well as the reliability of the sources. Also, there is a lack of literature on quantitative analysis of trade in forest products from the stand point of either the U.S., or Japan.

The proposed modifications imply time consuming research as well as expensive efforts in acquiring more recent and detailed information. Despite the barriers in investigating the matter any further, the new achievements could present us with an analytical tool capable of providing the policy makers in the related industry with helpful information in evaluating the market and advancing trade in the future.

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5. Ibid
6. Ibid., (a process in which the lumber is standardized).
7. Ibid.
8. The following assumption were made by Gallagher in his study of the softwood log trade between the U.S. and Japan:
  - A) Canada is considered to be the only exporter of softwood lumber to Japan. Also, the trade policies and cultural factors play an important role, functioning as quota on lumber imports to Japan.
  - B) There exists a free trade in logs between the U.S. and Japan. The supply of logs that the Soviet Union takes on the role of residual supplier for the Japanese market, expanding and contracting exports conditions in the Japanese market change.
  - C) There exists a free trade in lumber between the U.S. and Canada.
  - D) The export of Canadian logs is prohibited.
  - E) There exists a perfect substitution between domestic and foreign softwoods.
9. "Jones Act specifies that any cargo shipped between two U.S. ports must be transported on a ship constructed in the U.S. and operated by U.S. crews." See (3) under Alaska.

10. An analysis of the timber situation in the United States 1952-2030, Forest Resources Report no.23, Dec. 1982 PP.2, Table 1.1 .
11.  $35.336 \text{ FT}^3 = 1\text{M}^3$ , and  $2.36 \text{ M}^3 = 1000 \text{ BD Feet}$
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**APPENDICES**

## APPENDIX I

## DATA FORMATION

Variables	Definition and Sources
USLUMXJ	U.S. Lumber Export to Japan (PPE and T in PNW Forest Industries)
PLUMPNWI	Av. Price of Lumber in PNW, OR.& WA. (Pac. NW, West side )
JDEFLUMP	Jap. Lumber Price, Deflated for 1980 (Monthly Timber Market Report)
USLUMXJ1	U.S. Lumber Export to Japan Lagged For One Year
GNP/POP	GNP per Capita (IMF Inter'l. Finan'l. Stat. Yr.bk.)
IMFXR	IMF Exch. Rates, Y/\$, MKT.AV. (Main Economic Indicator, OECD)
JPIP	Nominal Interest Rates in Japan (IMF Inter'l. Finan'l. Stat. Yr.bk.)
JPPI	Japan's Petroleum Imports (IMF Inter'l. Finan'l. Stat. Yr bk.)
STARTS	Total Housing Starts, in 1000 (Main Economic Indicator, OECD)
USLOGXJ	U.S. Logs export to Japan (PPE and T in PNW Forest Industries)
USXJGWPI	U.S. Log Prices to Japan/WPI (PPE and T in PNW Forest Industries, Av. of OR & WA Prices/Japanese WPI)
JDEFLOGP	Jap. Log Prices, Deflated for 1980 (Monthly Timber Market Report)
USLOGXJ1	U.S. Logs Exported to Japan, Lagged For One Year
DLOGP	Japanese Log, Domestic Production (FAO Yearbook, (various issees).

## Notes:

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PPE and T stands for the "Production, Price, Employment, and Trade in PNW Forest Industry", issued by USDA, Forest Service, Pacific Northwest Research Station.

Various issues of the enlisted publications were cited for the collection of data.

Average prices of softwood lumber and logs from the States of Washington and Oregon were used in lieu of the export prices to Japan.

USLUMXJ and USLOGXJ are the softwood lumber and logs from the states of Washington, Oregon, Alaska, and California to Japan in 1000 bd ft.

All the prices have been adjusted for the year 1980 as the base year.

List of relevant set of data used in this study is provided in the following pages.

	PLUMPNWI	JDEFLUMP	USLUMXJ1	GNP/POP	STARTS	IMFXR	JPIP
1	27.78	.00	.00	201.41	.00	361.15	7.30
2	25.83	.00	108791.00	221.25	.00	360.82	6.57
3	26.63	.00	37975.00	252.81	.00	361.48	5.84
4	27.05	.00	104844.00	295.57	751.20	361.97	6.57
5	27.36	.00	122163.00	330.27	842.40	361.49	5.48
6	27.31	.00	99268.00	380.12	856.80	362.35	5.48
7	28.79	.00	161495.00	440.97	991.20	362.15	5.84
8	28.98	55730.86	263765.00	516.90	1201.20	360.55	5.84
9	34.76	55852.25	281343.00	601.12	1346.40	358.37	6.25
10	40.61	52657.02	304460.00	700.86	1484.40	358.07	6.00
11	33.45	50491.67	354152.00	761.80	1464.00	347.86	4.75
12	40.90	67836.77	267561.00	861.21	1807.20	303.17	4.25
13	48.52	84620.32	368959.00	1034.32	1905.60	271.70	9.00
14	65.14	60998.65	562702.00	1215.70	1316.40	292.08	9.00
15	61.54	56324.11	570851.00	1325.39	1356.00	296.79	6.50
16	56.76	58151.82	525558.00	1469.32	1524.00	296.55	6.50
17	72.46	59055.42	481926.00	1619.25	1508.40	268.51	4.25
18	83.99	58470.29	398769.00	1764.21	1549.20	210.44	3.50
19	99.53	69101.30	407082.00	1889.13	1492.80	219.14	6.25
20	109.91	61250.00	639048.00	2019.47	1268.40	226.74	7.25
21	99.96	45981.26	633541.00	2141.94	1152.00	220.54	5.50
22	95.34	46040.70	504940.00	2236.10	1146.00	249.08	5.50
23	82.07	46223.00	608260.00	2307.81	1136.40	237.51	5.00
24	97.75	44811.32	592560.00	2440.53	1187.30	237.45	5.00
25	93.41	.00	542234.00	MISSING	.00	238.54	5.00

	JPPI	USXJGWPI	JDEFLOGP	USLOGXJ1	DLOGP
1	266.00	175.37	.00	.00	.00
2	300.00	166.48	.00	355579.00	.00
3	368.00	146.87	.00	323977.00	59577.00
4	426.00	160.09	.00	676771.00	51713.00
5	481.00	187.52	.00	752971.00	59241.00
6	531.00	189.93	.00	787990.00	.00
7	647.00	182.65	.00	1045013.00	.00
8	756.00	189.82	.00	1574884.00	.00
9	827.00	257.39	.00	2105250.00	46217.00
10	1003.00	263.99	38202.04	2020987.00	45351.00
11	1265.00	259.69	35432.27	2319549.00	45253.00
12	1357.00	279.32	38282.65	1842528.00	43114.00
13	1827.00	462.39	45405.03	2521875.00	41534.00
14	6181.00	367.01	41601.48	2621710.00	38874.00
15	6231.00	415.47	39419.16	2073934.00	34154.00
16	.00	339.72	39399.55	2117368.00	35271.00
17	6925.00	375.44	36894.26	2664263.00	33793.00
18	5410.00	444.88	37331.30	2453037.00	32145.00
19	8320.00	555.97	41535.02	2638298.00	33270.00
20	13114.00	520.60	39008.00	3138417.00	34051.00
21	12940.00	470.12	34122.39	2527777.00	31370.00
22	12803.00	435.48	28991.42	1765858.00	31904.00
23	10855.00	405.85	25554.30	1966909.00	31990.00
24	10804.00	381.20	24404.21	1827299.00	31580.00
25	.00	MISSING	.00	1747858.00	.00

APPENDIX II  
CORRELATION MATRICES

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CORRELATION MATRIX FOR LUMBER, INCLUDING DOMESTIC PRICES

	PLUMPNWI	JDEFLUMP	USLUMXJ1	GNP/POP	STARTS	IMFXR	JPIP	JPPI
PLUMPNWI	1.00000							
JDEFLUMP	.55702	1.00000						
USLUMXJ1	.84996	.72864	1.00000					
GNP/POP	.96183	.59607	.89987	1.00000				
STARTS	.40718	.86471	.61505	.48107	1.00000			
IMFXR	-.95273	-.62487	-.81371	-.93975	-.48985	1.00000		
JPIP	-.11252	.05716	-.01156	-.20405	-.10991	.14407	1.00000	
JPPI	.94074	.40784	.80759	.91107	.25401	-.85608	-.11007	1.00000

CRITICAL VALUE (1-tail, .05) = + or - .33705

CRITICAL VALUE (2-tail, .05) = +/- .39521

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CORRELATION MATRIX FOR LUMBER, LOG TRANSFORMATION

	PLUMPNWI	JDEFLUMP	USLUMXJ1	GNP/POP	STARTS	IMFXR	JPIP	JPPI
PLUMPNWI	1.00000							
JDEFLUMP	-.17267	1.00000						
USLUMXJ1	.11209	-.56632	1.00000					
GNP/POP	.80566	-.61209	.29526	1.00000				
STARTS	-.49230	.83373	-.72856	-.74437	1.00000			
IMFXR	-.84586	.03557	.18254	-.66410	.20594	1.00000		
JPIP	.01067	.19676	.46513	-.13874	-.18938	.32450	1.00000	
JPPI	.68170	-.22800	.08772	.50787	-.46636	-.57013	-.23834	1.00000

CRITICAL VALUE (1-tail, .05) = + or - .33705

CRITICAL VALUE (2-tail, .05) = +/- .39521

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