United States
Department of
Agriculture

Forest Service

Pacific Northwest
Research Station

General Technical
Report
PNW-GTR-210

Modeling Japan – South Seas Trade in Forest Products

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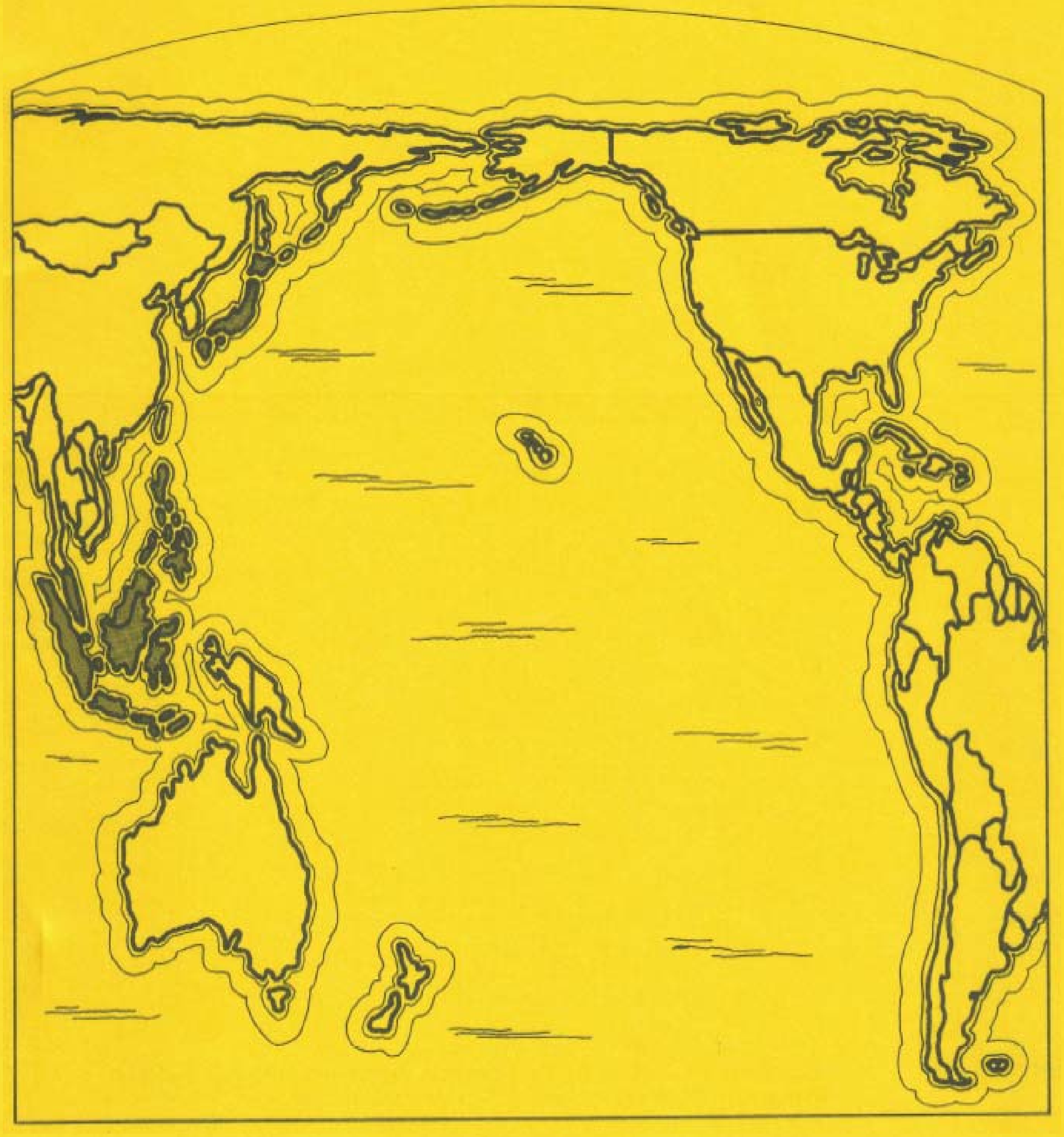

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Abstract

Vincent, Jeffrey R. 1987. Modeling Japan-South Seas trade in forest products. Gen. Tech. Rep. PNW-GTR-210. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station; 1987.28 p.

The international trade of forest products has generated increasing research interest, yet experience with modeling such trade is limited. Primary issues include the effects of trade barriers and exchange rates on trade patterns and national welfare. This paper attempts to add to experience by modeling hardwood log, lumber, and plywood trade in a region that has been mostly overlooked: East Asia, specifically Japan and the South Seas nations (Indonesia, Malaysia, and the Philippines). Japan-South Seas trade is important because of its significance in global forest-products trade and because of the large changes in trade barriers and exchange rates since 1970. In this paper, I describe the development of an economic model, JIMP, for investigating trade issues in the region. The model uses reactive programming to solve for a spatial equilibrium. Preliminary results suggest that: (1) restrictions on log exports will benefit South Seas nations only if the nations act together, and (2) relatively small fluctuations in exchange rates influence trade patterns as much as do large changes in tariffs.

Keywords: Trade modeling, Japan, South Seas nations, hardwood products, trade barriers, exchange rates, spatial equilibrium, reactive programming.

Contents

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Introduction

Awareness of the importance of understanding international markets for forest products is growing among forest economists both in the United States and abroad. Attention to issues such as the impacts of exchange rates and tariffs on trade patterns and the well-being of nations is increasing. The most common method for studying such issues is to build and simulate a computer-based model of the international economy. Modeling is attractive because it provides a structured, quantitative approach. Notable research efforts include the Global Trade Model developed at the International Institute for Applied Systems Analysis (IIASA) (Dykstra and Kallio 1984), Adams's (1985) African-European trade model, and the World Assessment Market Model being developed by the USDA Forest Service (Brooks, in press). Despite these efforts, however, knowledge of how to model international trade flows remains rudimentary.

Worldwide, solid-wood products (saw logs, veneer logs, sawnwood, and panel products) traded in 1983 had a total value of more than $20 billion. Hardwood products made up $8.6 billion, or 43 percent, of the total. Trade in hardwood products is concentrated in eastern Asia. In 1983, Japan-the world's second largest importer of forest products, after the United States-imported hardwood logs worth $1.6 billion, more than half the value of hardwood logs traded worldwide. During the past three decades, most of Japan's imports of hardwood logs, hardwood sawnwood, and hardwood plywood have come from the South Seas region: Indonesia, Malaysia, the Philippines, and several other island nations. This region is by far the world's most important exporter of hardwood products, especially hardwood logs. Japan-South Seas trade is subject to various tariff and nontariff barriers; Japan has sought to exclude the import of processed products, and the South Seas nations have sought to restrict log exports.

Japan is an increasingly important market for U.S. and Canadian forest products. In 1983, Japan was the largest importer of softwood logs and softwood sawnwood produced in Canada and the United States. Products from the South Seas nations compete in the Japanese market with products from North America, and there is evidence that direct competition will increase. Japan recently eased restrictions on domestic use of softwood plywood, and, because of log-export restrictions by South Seas nations, it has experimented with western hemlock *(Tsuga heterophylla* (Raf.) Sarg.) as a substitute for South Seas logs in the manufacture of plywood (Schreuder and Vlosky 1985).

This paper reports a study of the effects of log-export embargoes, tariffs, and exchange rates on trade between Japan and the South Seas nations. The study required the development of an economic model of the production, consumption, and trade of forest products in Japan, Indonesia, Malaysia, and the Philippines. Other nations in the South Seas region, such as Papua-New Guinea and the Solomon Islands, were not included in the model because they were much less important exporters during the period studied. The model is named "JIMP," an acronym based on the first letter of the name of each nation included in it. The products studied are hardwood logs, sawnwood, and plywood.

In this paper, I review historic features of the trade and discuss previous efforts to model it; I then describe how the model was assembled and how it is solved. Next I discuss the results of simulation exercises designed to throw light on major policy questions. Finally, I summarize the findings and point out ways in which the model could be improved. Results reported in this paper are preliminary. Nevertheless, they do indicate that a supply-demand analysis of forest-products markets in Japan and the South Seas nations is feasible and is useful for understanding the factors that influence trade flows in the region.

Trade Patterns and Price Trends: 1970-83

Log imports have constituted more than half of total log and hardwood log consumption in Japan. Both consumption and imports of hardwood logs have declined, however, registering sharp dips during the recessions that followed the oil shocks in 1973-74 and 1978-79 (fig. 1). Figure 1 also shows that imports from the South Seas nations have constituted nearly all of Japan's imports of hardwood logs. Plywood has been the most important (60-80 percent by volume) end use for Japan's imports of logs from the South Seas.

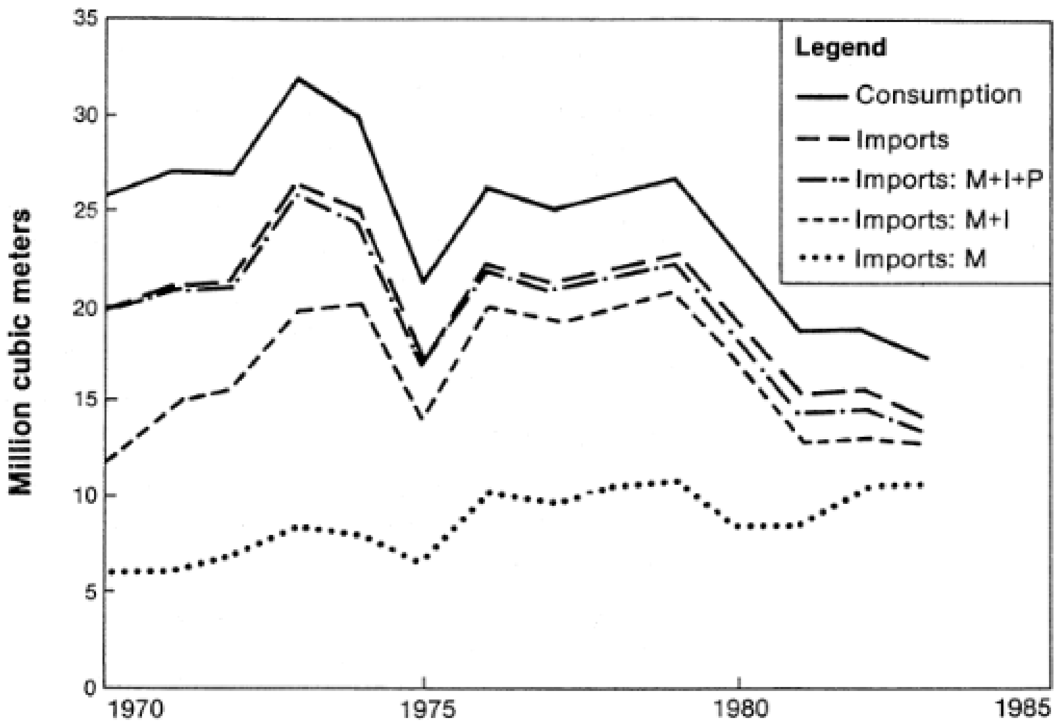

Figure 1—Hardwood-log consumption in Japan, 1970-83. M is Malaysia, I is Indonesia, P is Philippines.

Three points should be noted about the South Seas nations as log exporters. First, production of logs has increased in Indonesia and Malaysia but decreased in the Philippines (fig. 2), where harvesting began earlier. Second, exports to Japan have comprised more than half of total exports for each nation. Finally, figure 1 shows that exports to Japan by Indonesia and the Philippines have declined because of more stringent export restrictions. Data on export restrictions are summarized in table 1, which shows that South Seas nations have used both taxes and quotas to reduce log exports. Sabah and Sarawak are the two major log-exporting regions of Malaysia; for this reason, the restrictions imposed by Peninsular Malaysia have had little impact on Malaysia's log exports.

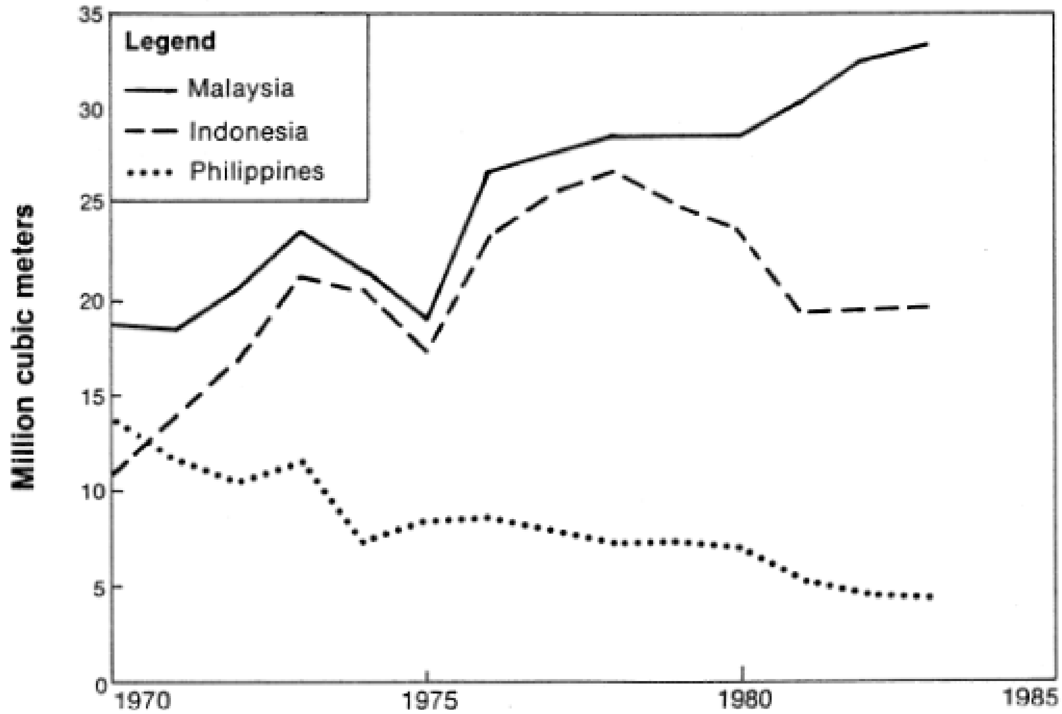

Figure 2—Hardwood-log production in South Seas nations, 1970-1983

Imports of solid-wood forest products by the South Seas nations have been virtually nil. The explanation is twofold: in the past, forest resources were abundant; and since the mid-1970's, log-export restrictions have helped maintain supplies for domestic processors, and import barriers against processed products have kept out competing products.

The story for Japanese sawnwood and plywood imports has been different from that for logs: Figures 3 and 4 show that imports have constituted a small portion of hardwood sawnwood and total plywood consumption in Japan. Although all three South Seas nations have increased production and exports of sawnwood and plywood (since the mid-1970's, Indonesia has constructed more than 100 plywood mills), they have exported little to Japan. Import barriers help explain this situation: Japan has a 10-percent tariff on South Seas sawnwood and a 17 -percent (19 .3-percent before 1985) tariff on South Seas plywood. These nominal rates translate into effective rates of protection that are several times higher because Japan has no import tariff on logs and because log price is a significant portion of production costs.[1]

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[1] An excellent exposition of the notion of effective rate of protection is given in Corden (1966). Essentially, the effective rate of protection is the ratio of value-added for a domestic industry to value-added for the same industry in the rest of the world. The rate increases as protection of final products increases, as protection of intermediate inputs decreases, and as the intermediate input comprises a larger portion of production costs.

Table 1—Trade barriers on products from the South Seas

Item	Logs	Sawnwood	Plywood
		Percent	
Export taxes: 2/			
Indonesia	10 (1971)	5 (1979)	0
	20 (1978)		
Malaysia--			
Peninsular	10 (1970)	5 (1970) 3/	5 (1970) 3/
	15 (1972)		
	20 (1980)		
Sabah	3 (1978)	0	0
Sarawak	5 (1974)	0	0
	10 (1980)		
Philippines	25 (1977)	0	0
Import tariffs:			
Japan	0 (1970)	10 (1972)	20 (1972)
		8 (1985)	17 (1985)
Indonesia	15	15	30
Malaysia	15 (1957)	15 (1957)	20 (1957)
	20 (1978)	20 (1978)	25 (1978)
			45 (1984)
Philippines	10 (1983)	20 (1983)	39 (1983)
Log export quotas:			
Indonesia	(4/) (1978)		
	(5/) (1980)		
	(6/) (1985)		
Malaysia--			
Peninsular	(4/) (1972)		
	(5/) (1976)		
	(6/) (1985)		
Sabah	(5/) (1975)		
Sarawak	(4/) (1979)		
Philippines	(5/) (1976)		

1/ All values are current unless otherwise indicated. Approximate dates when trade barriers were imposed are given in parentheses.
2/ Does not include royalties.
3/ Repealed 1974.
4/ Embargo on selected species.
5/ Quota.
6/ Total embargo.
Sources: Various. Major sources include country tariff schedules, Foreign Agricultural Service Attache Reports, Japan Lumber Journal (December 31, 1984), and Gillis (1980).

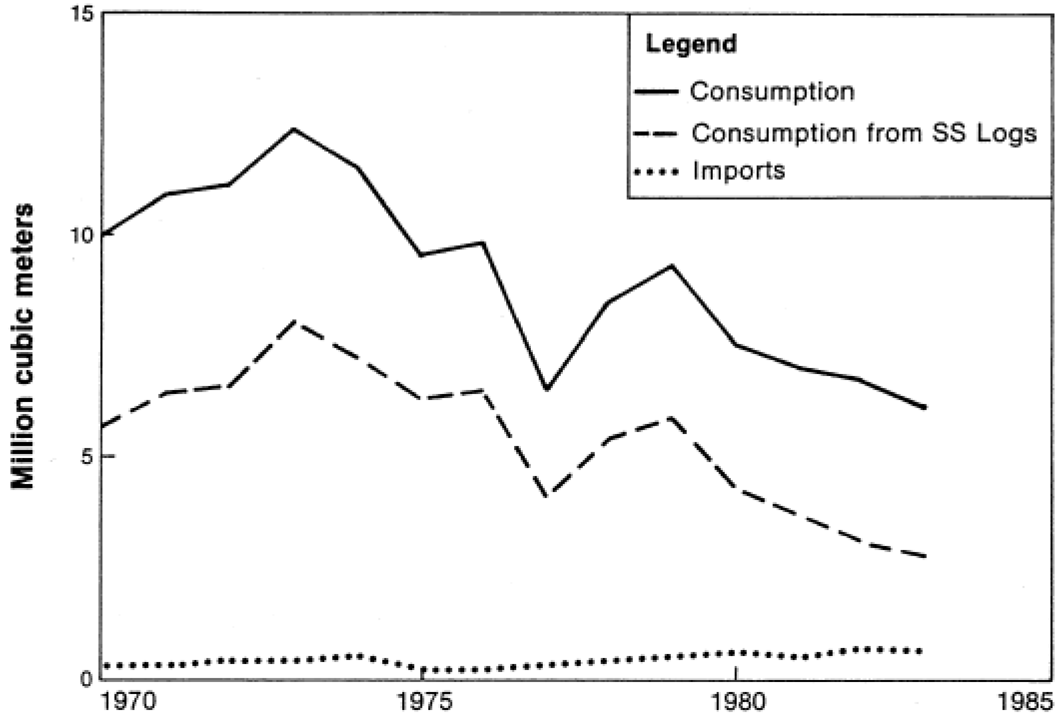

Figure 3—Hardwood-sawnwood consumption in Japan, 1970-83. SS = South Seas.

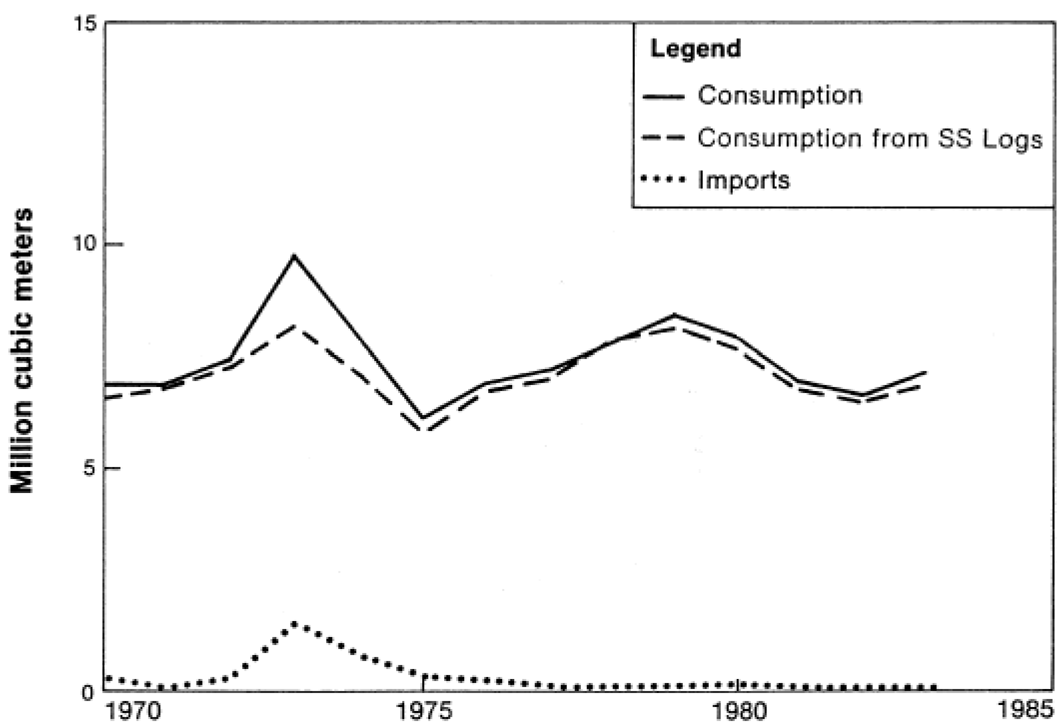

Figure 4—Plywood consumption in Japan, 1970-83. SS = South Seas.

Figures 3 and 4 show that Japanese consumption of plywood and especially sawnwood has declined from the 1973 peaks. These declines explain, by way of derived demand, the reduced log consumption noted above. The figures show that the major portions of plywood (>95 percent) and hardwood sawnwood (50-60 percent) consumed in Japan have been manufactured in Japan from logs from the South Seas.

Figure 5 shows that real prices of South Seas logs in Japan have been relatively constant and that real prices of plywood made from South Seas logs have declined markedly. Real prices of South Seas sawnwood, however, have increased steadily. This difference in relative price movements may explain why Japanese consumption of sawnwood has declined more rapidly than consumption of plywood: There has been less incentive to find substitutes for plywood than for sawnwood. Note that all three prices increased faster than the general price level during the 1973-74 and 1978-79 oil shocks.

Previous Modeling Efforts

Extant models of forest-products trade are too highly aggregated in terms of either products or regions for studying the factors that might influence trade between Japan and the South Seas nations. The Global Trade Model of IIASA has disaggregated forest products, but it treats the South Seas nations as a single region. Nomura and Yukutake (1982) presented a comprehensive model of the forest-products industry of Japan that included submodels of foreign supply, but they also treated the South Seas nations as one region.

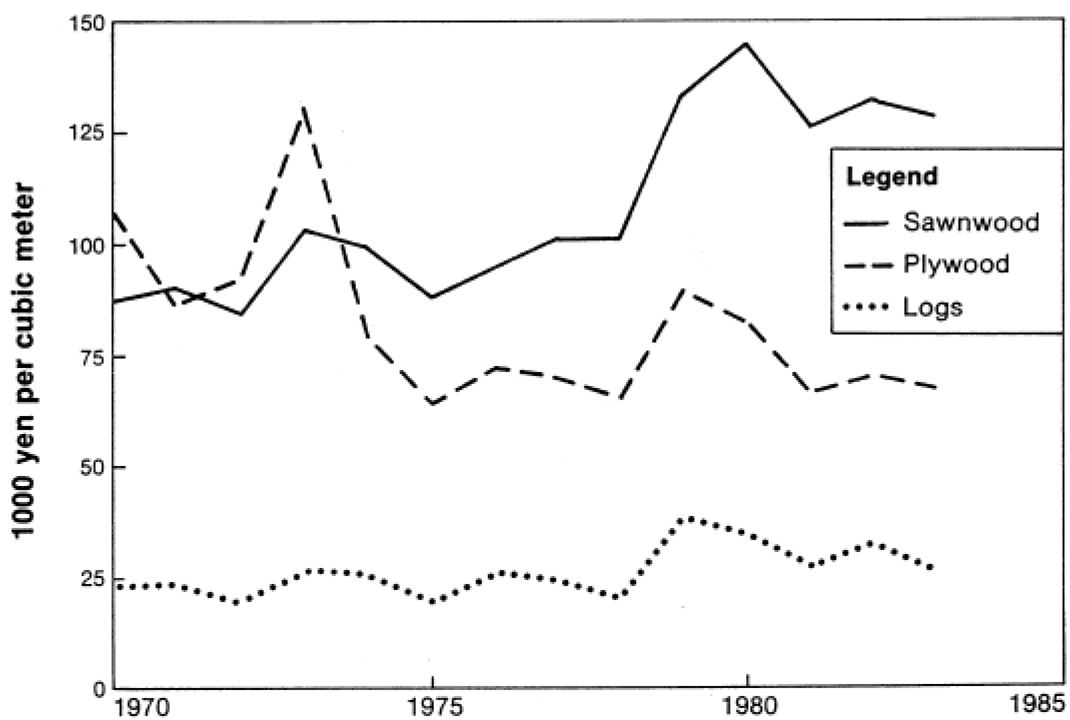

Figure 5—Real prices of South Seas products in Japan, 1970-83.

Treating the South Seas nations as individual regions is desirable for three reasons: Their forest resources and industries differ in important ways, they are not following identical trade policies, and their currencies have not been equally stable. The first two points were discussed above. Regarding the third reason, from 1970 to 1984 the strengths of the rupiah (Indonesia), ringgit (Malaysia), and peso (Philippines) all weakened compared with the yen. The exchange rates per yen increased about 325 percent, 10 percent, and 325 percent, respectively, and each currency had a change in annual value of as much as 25 percent at least once. We will see that simulation results support the hypothesis that these fluctuations in currencies have significantly influenced trade patterns.

The Model

Major Features of JIMP

Adams's (1985) model of trade between Africa and Europe was used as a guide for constructing JIMP. The two models share two major characteristics. First, both are spatial-equilibrium models, which means that: (1) They include more than one supply region and more than one demand region; (2) the supply regions and the demand regions correspond to real-world regions separated by geographic distances; (3) in equilibrium, prices for a given commodity are equal in all regions after adjustments are made for transportation costs, tariffs, and exchange rates; and (4) in equilibrium, the sum of quantities supplied by all regions equals the sum of quantities demanded. This type of model is useful for modeling trade because it allows study of how both domestic and export markets are affected by trade. Spatial equilibrium models are discussed in more detail by Adams and Haynes (1987).

Second, both models share the same method of solution-reactive programming. This algorithm is well suited for solving spatial equilibrium models, and it determines the bilateral trade flows that occur in equilibrium. That is, a reactive-programming solution tells us not only how much a particular region exports but also how much it exports to each of the other regions. Information on bilateral flows is useful for validating a model and is often of interest to model users. The reactive-programming algorithm was first described by Tramel and Seale (1959). The actual algorithm used in solving both models was the one developed by King and Ho (1972), which was modified by Adams (1985) to solve for an equilibrium when there are two market levels, logs and sawnwood.

The JIMP model includes four primary supply and demand regions—Japan and the three South Seas nations. It includes three products—tropical hardwood logs, and sawnwood and plywood made from tropical logs. To simplify modeling, I assumed that alllog5 are consumed in the manufacture of either sawnwood or plywood. This is not strictly true because some logs are consumed in the manufacture of other wood-based panel products, such as veneer. Products made from other hardwoods or softwoods are not included in the model. Such products are uncommon in the South Seas nations, and tropical hardwood products are more important than other hardwood products in Japan. A consequence of this product definition is that the model contains no log supply equation for Japan.

The model proper consists of a set of supply and demand equations for each product in each region. These are domestic supply and domestic demand equations, not export supply and import demand equations. Given exogenous values for transportation costs, exchange rates, and tariffs in a given year, the reactive-programming algorithm solves this set of simultaneous equations for spatial equilibrium. The price relation that must hold in equilibrium, described above, can be expressed by:

$$P(j) = [P(i) \times (1 + t(i)) + T(ij)] \times e(ij) \times (1 + t(j)) ; \quad (1)$$

where:

P(j) = demand region price;

P(i) = supply region price;

t(i) = ad valorem export tariff;

T(ij) = transfer cost from supply to demand region;

e(ij) = exchange rate;

t(j) = ad valorem import tariff.

If i=j, then "trade" is actually the portion of domestic production that is consumed domestically, and t(i)=t(j)= T(ij)=0 and e(ij)=1. The simple relation expressed by equation (1) is perhaps the most fundamental element of the computer code for the reactive-programming algorithm.

Trade flows to and from the rest of the world (ROW) —that is, imports from or exports to nations other than Japan and the three South Seas nations—must be taken into account too. These flows are modeled in two ways, depending on their size. Minor trade flows, such as imports by South Seas nations and exports by Japan, are fixed at historical levels by adjusting the intercepts of estimated supply and demand equations. This procedure assumes, of course, that equations are written with quantity as the dependent variable. Exports to the ROW by South Seas nations were frequently quite large, and these more significant flows were modeled by estimating individual ROW import-demand equations for each product of a given nation.

Data

Eight annual data series were needed for each product and region: domestic production, exports by destination, imports by source, domestic consumption, domestic producer prices, domestic consumer prices, f.o.b. (free on board) prices for exports, and c.i.f. (cost, insurance, and freight) prices for imports. Primary sources of data were the" Yearbook of Forest Products" ("Yearbook") published annually by the Food and Agricultural Organization of the United Nations, the "Japan Lumber Journal," and the "Monthly Report of Japan Timber Market" Not all data series were complete or available, especially for nations in the South Seas. I dealt with missing data by shortening estimation periods, by using other data series as proxies, or by constructing artificial data from other series. Additional details on data used in the model are given in appendix 1.

Transfer Costs—From equation (1), it is clear that the solution of a spatial-equilibrium model requires data on transfer costs, which are the sum of transportation and handling costs. The "Japan Lumber Journal" contains data on transportation costs for shipments of logs to Japan, but these data do not include handling charges. Instead of using these data directly and to estimate transfer costs for sawnwood and plywood, I calculated all transfer costs by inserting price, tariff, and exchange rate data into equation (1) and solving for the residual, T(ij).

Residual transfer costs were calculated only for trade flows from the South Seas nations to Japan. For flows from Japan to the South Seas and for flows between individual nations in the South Seas, transfer costs were set equal to an arbitrarily large number. This procedure prevented these flows from entering the model solution, reflecting the empirical fact that high actual transport costs and steep import barriers have forced trade flows in these directions to be essentially zero. This procedure is more acceptable for historical analysis than for forecasting because trade between South Seas nations appears to be increasing.

Trade Barriers—Available data on tariffs and quotas are summarized in table 1. Ad valorem tariff rates are incorporated directly into the model through equation (1). Per-unit (specific) tariffs are taken into account insofar as they are a component of the residually calculated transfer costs.

Quotas on log exports have become especially significant since 1980, the most extreme example being the embargo imposed by Indonesia on January 1,1985. Quotas can be included in spatial-equilibrium models as upper bounds on trade flows. Although they should be included if model solutions are to reproduce real-world behavior, they are not included in JIMP. The absence of upper bounds did not affect the simulation results reported in "Simulations," however, because JIMP has been solved only for 1980 values of exogenous variables and because the quotas that existed in 1980 were not binding for historical or simulated flows.

Estimation

Supply and demand equations were estimated in linear form for 1970-83. This period was chosen because F-tests indicated that the coefficients of supply and demand equations were significantly different for 1961-69 and 1970-83. Such structural change is to be expected in developing countries with large changes in processing capacity during the estimation period. Malaysian sawnwood supply and demand equations were estimated for 1965-78 because data were not available for the years after 1978.

Because the number of observations was small (14), the estimation technique used was ordinary least squares, not two-stage least squares. Quantity was regressed on price and other explanatory variables that economic theory predicts should shift supply and demand equations. Prices were in the domestic currency of each nation, not in a common currency such as the U.S. dollar. Consumers and producers were assumed to make decisions based on prices in their own currency. All equations were estimated in two forms, one with nominal prices and one with real prices. The decision between the two forms was based on goodness of fit (measured by R-squared), significance of coefficient estimates (measured by t statistics), and correctness of signs. Heaviest weight was given to coefficient significance and sign correctness.

A complete list of the estimated equations is given in appendix 2. Because of the preliminary nature of this research, the final set of estimated equations includes several specifications for equations that describe the supply or demand of the same product. The standard demand shifter was assumed to be current gross domestic product (GDP), although in some cases lagged GDP, change in GDP, or housing starts yielded better fits. Supply shifters that were tried included log price (for sawnwood and plywood equations), wage rate (available only for Japan and the Philippines), producer price index (the GDP deflator for Malaysia), and various measures of energy cost (oil price index, percentage change in oil price index, dummy variables for years after the 1973-74 and 1978-79 oil shocks). Lagged quantity was used in some equations to capture slowly moving changes not picked up by other variables. No measures of capital services were used in supply equations; lack of data on this crucial variable is a chronic problem in forest-sector modeling.

The use of an oil-price variable is perhaps unusual. On the one hand, energy costs constitute only a small portion of wood-processing costs. Worse, oil prices are a macro variable that might be collinear with demand shocks, and thus their inclusion in a supply equation might taint the equation with demand-side effects. On the other hand, energy costs, no matter how insignificant, are an element of wood-processing costs, and a supply equation would be misspecified if they were excluded. Moreover, oil price might be useful as a proxy for other costs, such as wage rates and costs of capital services, when data for such costs are missing. Indeed, wage rates were not available for Indonesia and Malaysia, and costs of capital services were not available for any of the nations. Finally, oil prices during the period studied were negatively correlated with GDP, and so their usefulness in explaining real and nominal price increases during the inflationary 1970's cannot be ascribed to their being a proxy for demand increases.

The estimated sawnwood supply equation for Japan lacks a log-price term because a satisfactory specification that included log price could not be found. Without a log-price term, the Japanese sawnwood supply equation is not sensitive to log-price changes, and this clearly biases simulation results. This equation is the one in the model that most needs modifying; one possible solution would be to restrict the log-price coefficient to be equal to some exogenously chosen value.

Single-period price elasticities for the equations are given in table 2.

Table 2—Own-price elasticities of estimated equations[1]

Equation	Japan	Indonesia	Malaysia	Philippines
Log supply	(2/)	0.51	0.37	0.32
Sawnwood supply	0.38	.73	.73	1.97
Plywood supply	.42	.53	.57	1.60
Sawnwood demand	-.49	-.58	-.38	-.59
Plywood demand	-.18 3/	-.22	-1.56	-1.44

1/ Own-price elasticity = percentage change in the quantity of a product produced or consumed divided by percentage change in the price of the product. Calculated from the mean (for the estimation period) values of the quantity and price variables and from the estimated coefficient on price.
2/ Not applicable.
3/ Exogenous estimate based on Wibe (1984).

Solution

The JIMP model has been solved for 1980 values of the exogenous variables, which include transfer costs, tariffs, exchange rates, and the shifters in supply and demand equations. Solving the model required rearranging each equation so that price was a function of quantity and exogenous shifters. Then, 1980 values for the shifters were inserted to produce reduced-form equations in which price was a function of only quantity and a constant term. I derived demand equations for logs by using processing-recovery rates to combine each region's sawnwood and plywood supply equations.

The final set of 27 equations—11 estimated supply equations, 12 estimated demand equations, and 4 derived demand equations for logs—was solved for prices, production and consumption quantities, and bilateral trade flows by use of reactive programming. Adams's (1985) interactive version of the reactive-programming algorithm was modified to include an additional product (plywood), to add export and import tariffs, and to add exchange rates.

Validation

Model validation relates to the behavior of the entire system of equations during solution. Since JIMP has been solved only for a single year, model validation is not yet extensive. As shown in table 3, however, baseline results were reasonably close to actual 1980 values. Only 5 of 35 prices or quantities deviated from historical values by more than 10 percent. Deviations were least for the log market, followed by sawnwood. The simulated Malaysian sawnwood price was too high by nearly 60 percent, and this was probably a consequence of lack of data after 1978 in estimating the Malaysian sawnwood supply and demand equations.

Table 3—Deviations of baseline simulation results from 1980 data

Product and region	Price	Production	Consumption
		Percent	
Logs:			
Japan	-1.2	(1/)	-0.8
Indonesia	-1.6	-3.7	-2.0
Malaysia	-2.1	+.5	-8.6
Philippines	-1.4	-7.9	-13.4
Sawnwood:			
Japan	-2.3	+2.5	-8.4
Indonesia	-8.1	-.4	+4.0
Malaysia	+59.0	(2/)	(2/)
Philippines	-5.2	-16.0	-6.6
Plywood:			
Japan	-1.5	-2.5	-2.4
Indonesia	+41.5	-8.3	+1.0
Malaysia	+6.5	-2.1	+.5
Philippines	-2.3	-6.4	-40.9

1/ Not applicable because Japan does not produce tropical hardwood logs.
2/ Data for 1980 not available.

A final check is the similarity of actual and simulated trade flows to Japan. Table 4 shows that simulated flows of logs were close to actual values. Simulated sawnwood and plywood flows resembled actual flows in magnitude; both were very small.

Table 4—Actual and simulated trade flows to Japan

Product and region 2/	A	B	1	2	3	4	5	6	7	8	9	10
	Simulation 1/											
	Thousand cubic meters											
Logs:												
I	8905	7593	8292	0	14319	8136	0	7994	7591	8626	6367	7504
M	8373	9425	7906	14668	0	9942	0	9366	9651	8443	11017	9345
P	1166	1281	1609	2623	2894	0	0	71	731	1053	949	1132
Sawnwood:												
I	126	0	377	862	0	0	2440	130	262	349	0	0
M	198	0	0	0	902	0	1859	0	0	0	0	0
P	192	0	87	0	0	184	0	72	251	0	26	325
Plywood:												
I	20	0	0	291	0	0	2411	17	0	0	0	0
M	12	0	74	0	299	0	1276	62	0	0	0	0
P	0	41	191	18	27	119	2141	302	113	31	29	142

1/ A = Actual data; B = baseline simulation; 1 = free trade (no tariffs); 2 = Indonesian log-export embargo; 3 = Malaysian log-export embargo; 4 = Philippine log-export embargo; 5 = South Seas log-export embargo; 6 = 100-percent log-export surcharge by South Seas nations; 7 = Japanese yen 10 percent stronger; 8 = Indonesian rupiah 10 percent weaker; 9 = Malaysian ringgit 10 percent weaker; 10 = Philippine peso 10 percent weaker.
2/ I = Indonesia; M = Malaysia; P = Philippines.

Simulations

General Remarks

Ten static simulations were run with JIMP. These simulations are counterfactual in the sense that they predict the situation in 1980 as it would have been if the historical situation had been modified as in the simulation. Results of these simulations are given in tables 4 and 5. Table 4 shows actual and simulated trade flows to Japan. Table 5 shows direction of welfare changes for each nation under each simulation, compared with the baseline case. Welfare measures are defined in "Results: Log-Export Embargoes."

Table 5—Direction of changes in welfare [1]

	Simulation 2/									
Welfare measure	1	2	3	4	5	6	7	8	9	10
Consumer surplus:										
Sawnwood--										
Japan	+	+	+	+	-	+	+	+	+	+
Indonesia	+	+	-	-	-	+	-	-	+	+
Malaysia	+	-	+	-	+	+	-	+	-	+
Philippines	-	-	-	+	-	+	-	+	+	-
Plywood--										
Japan	+	-	-	+	-	-	+	+	+	+
Indonesia	-	+	-	-	-	+	-	-	+	+
Malaysia	-	-	+	-	-	-	-	+	-	+
Philippines	-	-	-	+	-	-	-	+	+	-
Producer surplus:										
Logs--										
Indonesia	+	-	+	+	-	-	+	+	-	-
Malaysia	-	+	-	+	-	-	+	-	+	-
Philippines	+	+	+	-	+	-	+	-	-	+
Sawnwood--										
Japan	-	-	-	-	-	-	-	-	-	-
Indonesia	-	+	-	-	+	+	+	+	+	+
Malaysia	+	-	+	-	+	+	-	+	-	-
Philippines	+	-	-	+	-	+	+	+	+	+
Plywood--										
Japan	-	-	-	-	-	-	-	+	+	-
Indonesia	-	+	-	-	+	+	-	-	+	+
Malaysia	+	-	+	-	+	+	-	+	-	+
Philippines	+	-	-	+	+	+	+	-	-	+
Total surplus:										
Japan	+	-	-	-	-	-	+	+	+	+
Indonesia	+	-	+	+	+	-	+	+	-	-
Malaysia	-	+	-	+	+	-	+	-	+	-
Philippines	+	+	+	-	+	-	+	-	-	+

1/ Increase (+) or decrease (-) compared with results of baseline simulation.
2/ A = Actual data; B = baseline simulation; 1 = free trade (no tariffs); 2 = Indonesian log-export embargo; 3 = Malaysian log-export embargo; 4 = Philippine log-export embargo; 5 = South Seas log-export embargo; 6 = 100-percent log-export surcharge by South Seas nations; 7 = Japanese yen 10 percent stronger; 8 = Indonesian rupiah 10 percent weaker; 9 = Malaysian ringgit 10 percent weaker; 10 = Philippine peso 10 percent weaker.

The changes to the model necessary for carrying out the simulations were easy to implement. The computer code for the reactive-programming algorithm includes a file containing input data. Within this file, data used in the price linkages represented by equation (1) were altered appropriately for each simulation. For simulation 1, export duties by the South Seas nations and import tariffs by Japan were removed. I will call this simulation the free-trade simulation, even though import barriers by the South Seas nations, which were represented by very large transfer costs, were not removed. For simulations 2-5, transfer costs for log trade were made prohibitively high to prevent log exports. For simulation 6, log-export duties by the South Seas nations were increased by 100 percent. For simulations 7-10, exchange rates were modified to represent changes in the relative strengths of the four currencies.

Results: Log-Export Embargoes

Log-export embargoes have been either contemplated or implemented by every nation in the South Seas. The consequences of single-nation embargoes, represented by simulations 2-4, followed very similar patterns. Changes in domestic prices and quantities are not shown but can be summarized as follows. Log prices decreased markedly in the nation erecting the embargo (the home nation) and increased elsewhere. The log-price increase in other South Seas nations was due to Japan's demand for logs being concentrated on fewer suppliers. Because of these price changes, log consumption in the manufacture of sawnwood and plywood increased in the home nation, whereas log production decreased; elsewhere, production increased, and consumption decreased. The lower log prices in the home nation induced its sawnwood and plywood prices to decrease, causing domestic consumption of these processed products to increase. Despite lower prices of sawnwood and plywood, domestic processing also increased because lower log prices offset the lower prices of processed products and led to higher profits for processors. In the other regions, prices of processed products increased because of higher log prices, and the higher prices made these products less competitive in the Japanese import market than the home nation's processed products. Comparing column B with columns 2-4 in table 4 shows that the home-nation's exports of processed products to Japan increased.

The welfare effects of the embargoes were studied by considering changes in consumer and producer surplus for each product in each nation. "Consumer surplus" is defined as the area under a demand curve and above the equilibrium price line. This represents the extra amount consumers would be willing to pay for the goods they purchase. "Producer surplus" is the area above a supply curve and under the equilibrium price line. This represents rents to the fixed factors of production. Because demand and supply curves in JIMP are linear, these surpluses were easily calculated from the formula for the area of a triangle. I calculated changes in welfare by subtracting the areas of the triangles in the baseline case from the corresponding areas in each simulation.

Results are given in table 5. A "plus" sign indicates that the value of the welfare measure increased in the particular simulation; a "minus" sign that it decreased. Consumer surplus for logs is not included in the total surplus because it is a component of consum_r surplus for the processed products. Table 5 shows that the nation imposing a log-export embargo suffered a loss in total surplus, as did Japan. The sole cause of the welfare loss in the home nation was the loss in log-producer surplus, which outweighed the gains in total surplus for sawnwood and plywood. These welfare changes represent a transfer of wealth from the government to the private sector because forests are owned by the governments of the South Seas nations, whereas processing facilities tend to be owned by the private sector. Note that this welfare loss is a static (single-period) result; over a longer period, an embargo might have positive welfare effects if, for example, it induced large increases in domestic processing.

In contrast, table 5 shows that an embargo imposed by the three South Seas nations simultaneously (simulation 5) produced a positive change in welfare for all three nations; Japan again lost. Production of tropical sawnwood and plywood in Japan dropped to zero because Japan could not acquire tropical logs. As a consequence, trade flows of processed products to Japan increased markedly (table 4). As might be expected, the South Seas embargo produced dramatic price changes, not shown. For example, the price of plywood increased 130 percent in Japan. In the real world, such a large price increase would probably induce substitution of plywood from other sources. At present, JIMP cannot measure this substitution because it does not include plywood made from logs other than from the South Seas.

Results: Changes in Exchange Rates

Simulations 7-10 in table 5 show the results of changes in exchange rates. These results must be interpreted with caution because exchange rates in JIMP, as in other forest-product-trade models, affect only the relative prices of traded goods. In the real world, however, exchange rates affect many elements of an economic system. They affect many of the variables treated as exogenous in demand and supply equations, such as gross domestic product, interest rates, and price index (which in turn affects wage rates). Simulation scenarios that modify exchange rates without also modifying other exogenous variables affected by them are inconsistent.

Like simulations of other forest products trade models, simulations 7-10 are guilty of this charge.[2] Nevertheless, the simulation results have value as indicators of the potential magnitude of exchange-rate effects. Table 4 is most useful for studying these effects. Under simulation 7, strengthening of the yen, Japanese imports of logs decreased whereas imports of processed products increased. The size of the increased trade flows of processed products is comparable to that in simulation 1, free trade, and simulation 6, a 100-percent log-export surcharge. Table 5 shows that all nations gained in welfare as a result of the stronger yen. Japanese sawnwood and plywood producers lost, but the gains by consumers outweighed these losses.

The patterns observed in simulations 8-10, weakening of individual South Seas currencies, show some variation. Table 4 shows that devaluation of the Indonesian rupiah and the Philippine peso decreased log flows to Japan but increased flows of processed products. When the Malaysian ringgit was devalued, on the other hand, Japanese imports of products processed in Malaysia did not increase, but imports of logs did. Table 5 shows that in each case Japan and the nation devaluing its currency gained in welfare, and the other two nations suffered losses.

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[2] The IIASA model considers the effects of exchange rates on production costs, through the prices of imported factors of production. It does not, however, consider how exchange rates affect demand.

Conclusions

The estimation and validation of JIMP are preliminary. The research results presented in this paper do demonstrate, however, that trade in the Pacific basin can be analyzed in a supply-and-demand, spatial-equilibrium framework. This framework can be used to study policy issues such as trade barriers and changes in exchange rates.

Results of static simulations for 1980 indicate that South Seas nations will benefit from a log-export embargo only if they act together. A dynamic model might not produce this finding, however. Other results suggest that relatively small changes in exchange rates affect trade patterns nearly as much as does the dismantling of all trade barriers (except those between South Seas nations) or the imposition of very large export surcharges on logs. Model results indicate that all nations gain from a stronger yen.

Confidence in simulation results of JIMP would be increased by further research in the following areas. First, specification of several equations could be improved—the Japanese sawnwood equation, for example. Second, the model should be solved for additional periods to permit more extensive validation and investigation of dynamic effects. Third, the effects of changes in exchange rates on macroeconomic variables should be accommodated by developing sets of exogenous variables consistent with different exchange rates. Finally, data from sources other than the "Yearbook," specifically sources from within the South Seas nations themselves, should be sought. Better data exist, but they can be accessed only by doing research in the nations themselves or by establishing cooperative links with researchers in those nations. These data should be compared with the "Yearbook" and "Japan Lumber Journal" data to determine, for example, whether f.o.b. and c.i.f. prices are similar to domestic prices and whether residually calculated transfer costs approximate actual transfer costs.

A more ambitious goal would be to construct a model that includes both hardwood and softwood products, to study more readily the substitution possibilities between South Seas and North American products. If South Seas nations further restrict log exports, Japan's $4 billion (1983) market for products made from South Seas logs will probably become more open to competing products.

Acknowledgments

Richard Haynes, David Brooks, Darius Adams, and Don Flora provided helpful comments on drafts of this paper. The Pacific Northwest Research Station provided support for computer, travel, photocopying, and telephone expenses. A Graduate Fellowship from the National Science Foundation provided stipend support.

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Appendix 1. Data

This appendix gives more information on the data used in estimating and simulating the model. Tables 6-11 give the actual data series used. Headings of these tables are defined in "Abbreviations of Variables." Note that all prices in these tables are nominal.

South Seas Nations

The "Yearbook" was the primary data source for Indonesia, Malaysia, and the Philippines. It contains data on production, total exports, total imports, and f.o.b. and c.i.f. unit values. Apparent consumption of all products was calculated by adding production and imports and subtracting exports. All series for sawnwood and plywood were accepted without modification. Log-production figures were modified for Indonesia and the Philippines, however, for years in which recovery rates seemed abnormally high (>0.7) or low(<0.3). Recovery rates were calculated as:

$$\frac{\text{Sawnwood production + plywood production.}}{\text{Log production + log imports - log exports}}$$

Abnormal recovery rates were excluded from the calculated recovery rate series, and replacements were created from regressions of the remaining rates on a trend variable and a constant. These new recovery rates were then used with the data on log exports, log imports, and sawnwood and plywood production to solve for new log-production figures.

I used average annual exchange rates given in "International Financial Statistics," published annually by the International Monetary Fund, to convert unit values from U.S. dollars to domestic currencies. Producer prices were assumed to be equal to f.o.b. unit values. Consumer prices were calculated as weighted averages of f.o.b. and c.i.f. unit values; the weight for f.o.b. unit values was domestic production minus export quantity, and the weight for c.i.f. unit values was quantity of imports. The consumer prices calculated this way did not differ much from producer prices because the South Seas nations import only small amounts of forest products. The use of f.o.b. unit values probably introduced an upward bias into assumed domestic prices because the nations tend to export the more highly valued portion of production.

The f.o.b. unit values were, except for the Philippines, assumed to be net of tariffs. Because transfer costs for Philippines-Japan log trade calculated from the "Yearbook" values were too low, new f.o.b. unit values were created—the values listed in the "Yearbook" were divided by 1.25 to account for the Philippine's 25-percent export duty.

Japan

Data for Japan were gathered from a variety of sources. Because only tropical products were included in the model, Japanese log production figures were not necessary. Furthermore, exports of logs, sawnwood, and plywood could be ignored because they were less than 1 percent of consumption (logs) or production (sawnwood and plywood) for most years. Quantity data series were needed only for imports of all products, consumption of logs for sawnwood and plywood, and production and consumption of sawnwood and plywood.

Data on Japanese imports from the individual South Seas nations were taken from annual summary tables published in various issues of the "Japan Lumber Journal" ("Journal"). Data on log and sawnwood imports were used directly. The plywood data had to be converted from square meters to cubic meters by use of the ratio of aggregate plywood imports given in the "Yearbook" (in cubic meters) to the same series given in the "Journal" (in square meters).

The "Journal" import data differ from export data for South Seas nations given in direction-of-trade tables in the "Yearbook." That the volume of a bilateral trade flow should differ at point of export and point of import is not surprising because transport lags cause dates of export and import to differ and because both export and import figures suffer from reporting error. Reporting errors can be quite serious; official Philippine log-export figures have been estimated to understate true exports by as much as 300 percent (Foreign Agricultural Service 1985). Consistency, in the sense of imports equaling exports, was achieved in the JIMP data set by assuming that the import figures for Japan from the "Journal" and the total export figures for the South Seas nations from the "Yearbook" were correct. Trade flows to the rest of the world were then determined residually.

Japanese consumption of logs for sawnwood and plywood was given in the "Journal." These figures were measured by log arrivals at mills. Log arrivals did not always sum to annual total log imports, reflecting the lag time between unloading at the dock and delivery to the mill. The discrepancies were not great, and I eliminated them by adjusting the data on logs consumed for plywood. Production data for tropical sawnwood and plywood were created from log-consumption data and annual recovery rates for total sawnwood and total plywood production (based on "Yearbook" data). I assumed that the recovery rates for products made from tropical wood were the same as those for products made from other hardwoods. The production figures added to the sum of imports from Indonesia, Malaysia, and the Philippines determined consumption of tropical products.

Log price in Japan was assumed to be equal to the weighted average of log-import unit values from the South Seas, given in yen per cubic meter in the "Journal." Trade prices were not used for sawnwood and plywood. Sawnwood price was assumed to be equal to the wholesale price of lauan sawnwood boards of dimensions 3.0-3.4 cm by 30.0 cm by 4.0 m, given in yen per cubic meter and listed in various issues of the "Monthly Report of Japan Timber Market." Plywood prices were volume-weighted averages of Tokyo wholesale prices of plywood of various thicknesses. Plywood price and production data were taken from the "Journal" for 90-by-180-cm sheets that were 2.5, 4.0, and 12.0 mm thick. The aggregate price was converted to yen per cubic meter by use of "Yearbook" and "Journal" data on production.

Abbreviations of Variables

Most headings in tables 6-11 and most variables in the equations in appendix 2 are named according to a consistent system of abbreviations. The first letter represents the nation where production or consumption takes place:

J = Japan

I = Indonesia

M = Malaysia

P = Philippines.

The second letter represents the product being produced or consumed:

L = log

S = sawnwood

P = plywood.

The third letter represents the type of economic activity:

P = production

C = consumption

E = export

I = import.

The fourth letter represents the type of economic variable:

P = price

Q = quantity.

If the fourth letter is P, the addition of R as a fifth letter indicates that price is in real terms; the addition of the letter A indicates that price is in United States dollars. For example, MLEP denotes the Malaysian log-export price in nominal terms, whereas MLEPR denotes the same price series in real terms. For Japanese imports (that is, the first letter is J and the third letter is I), the addition of a fifth letter indicates the source of the import—I (Indonesia), M (Malaysia), or P (Philippines). For example, JLIQI denotes Japanese log-import quantity from Indonesia.

Exceptions to this system are names for the exogenous (shift) variables:

JGDP = Japanese gross domestic product in billion yen. IGDP, MGDP, PGDP, and ROWGDP are defined similarly and are in billion rupiahs, million ringgits, million pesos, and billion dollars, respectively. An R added as a fifth letter to a GDP variable indicates that the variable is in real terms.

JGDPC = absolute change in nominal Japanese GDP from one period to the next.

JHOUSE = Japanese housing starts, in thousands.

JPPI = Japanese producer price index (1980 = 1.000). IPPI, MPPI, and PPPI are defined similarly.

JOIL = Japanese oil price index (1980 = 1.000). IOIL, MOIL, and POIL are defined similarly. An R added as a fifth letter to an all variable indicates that the variable is in real terms. A C added as a fifth letter to an OIL variable or as a sixth letter to an OILR variable indicates that the variable represents the percentage change in the oil price index from one period to the next.

JAEXCH = Japan-U.S. exchange rate, in yen per dollar. IAEXCH, MAEXCH, and PAEXCH are defined similarly.

DUM79 = Dummy variable, equal to 1 in all years up to and including 1979 and equal to 0 in all years after 1979. Dummy variables for other years are defined similarly.

DUMX79 = Dummy variable, equal to 1 in 1979 and equal to 0 in all other years. Dummy variables for other years are defined similarly.

Table 6—Data on log imports in Japan[1]

	Quantity			Price		
Year	JLIQI	JLIQM	JLIQP	JLIPI	JLIPM	JLIPP
	Thousand cubic meters			Yen/cubic meter		
1970	5936	6018	7859	10687	10687	12021
1971	8531	5963	6292	10544	10563	12203
1972	8916	6903	5223	9141	8946	9698
1973	11331	8447	6136	14732	14169	14027
1974	12168	8050	4073	18830	17823	19926
1975	7424	6567	3071	14393	13231	15119
1976	9680	10108	1902	20788	19764	21576
1977	9615	9552	1664	19736	18013	22742
1978	9218	10518	1805	16162	15084	18629
1979	9977	10718	1400	33362	31514	32849
1980	8905	8373	1166	35342	32680	39958
1981	4507	8373	1467	29301	25774	30713
1982	2715	10261	1446	36243	31399	34631
1983	2217	10468	706	29596	25136	29574

1/ Headings are explained in "Abbreviations of Variables" in appendix 1.

Table 7—Data on products processed in Japan[1]

	Quantity				Price	
	Sawnwood		Plywood		Sawnwood	Plywood
Year	JSPQ	JSCQ	JPPQ	JPCQ	JSCP	JPCP
	Thousand cubic meters				Yen/cubic meter	
1970	5743	5981	6558	6560	42300	51721
1971	6408	6652	6819	6819	43000	41349
1972	6612	6834	7320	7325	40800	44618
1973	7982	8312	8164	8216	57400	72824
1974	7239	7678	7105	7114	73200	57891
1975	6314	6430	5796	5797	66800	48432
1976	6529	6694	6815	6815	76000	57313
1977	4117	4373	7143	7144	82200	57000
1978	5439	5717	7866	7872	79500	51291
1979	5894	6267	8200	8209	113300	75909
1980	4347	4863	7665	7697	144400	82461
1981	3686	4049	6756	6772	127700	66425
1982	3061	3642	6466	6476	135900	72371
1983	2816	3434	6949	6971	129400	67998

1/ Headings are explained in "Abbreviations of Variables" in appendix 1.

Table 8—Data for Indonesia[1]

	Quantity						Price		
	Logs		Sawnwood		Plywood		Logs	Sawnwood	Plywood
Year	ILPQ	ILCQ	ISPQ	ISCQ	IPPQ	IPCQ	ILEP	ISEP	IPEP
	Thousand cubic meters						Rupiahs/cubic meter		
1970	10700	2866	1662	1618	NA	NA	4015	12443	NA
1971	13705	2883	1662	1582	7	10	5945	13293	NA
1972	16821	3467	1662	1555	4	9	7094	8544	NA
1973	21190	2690	1380	1050	9	23	12591	20351	NA
1974	20377	3504	1819	1542	24	38	17289	32843	NA
1975	17212	4787	2400	2007	107	113	13066	33052	26560
1976	23200	5505	3000	2352	214	206	18421	31181	27677
1977	25368	6808	3500	2906	279	266	19491	35089	52167
1978	26620	7420	3500	2744	424	358	20502	50081	115767
1979	24860	7060	3400	2117	624	508	52439	114193	168929
1980	23637	8753	3975	2772	1014	771	62111	134523	142638
1981	19312	13111	5750	4579	1723	965	59022	101779	122947
1982	19394	16290	6798	5576	2487	1256	66511	99724	151536
1983	19544	16551	6296	4913	3138	1384	90084	140674	225397

NA = not available.
1/ Headings are explained in "Abbreviations of Variables" in appendix 1.

Table 9—Data for Malaysia[1]

	Quantity						Price		
	Logs		Sawnwood		Plywood		Logs	Sawnwood	Plywood
Year	MLPQ	MLCQ	MSPQ	MSCQ	MPPQ	MPCQ	MLEP	MSEP	MPEP
	Thousand cubic meters						Ringgits/cubic meter		
1970	18658	7328	3100	1773	197	58	57	148	354
1971	18457	7408	3098	1819	231	44	56	144	316
1972	20713	9372	3738	2037	330	68	56	155	316
1973	23599	10882	4293	2209	375	28	75	259	453
1974	21492	9345	4043	2131	311	101	85	249	498
1975	18972	8208	3851	2200	404	175	62	226	461
1976	26585	11102	5128	2266	525	122	93	290	466
1977	27579	11494	5654	2907	565	229	95	285	477
1978	28504	11821	5913	3286	465	70	99	289	478
1979	28516	12060	NA	NA	490	46	183	379	625
1980	28516	13370	NA	NA	601	149	173	404	620
1981	30317	14451	NA	NA	603	167	153	352	661
1982	32482	13192	NA	NA	787	417	175	373	599
1983	33300	14505	NA	NA	NA	NA	174	396	569

NA = not available.
1/ Headings are explained in "Abbreviations of Variables" in appendix 1.

Table 10—Data for Philippines[1]

	Quantity						Price		
	Logs		Sawnwood		Plywood		Logs	Sawnwood	Plywood
Year	PLPQ	PLCQ	PSPQ	PSCQ	PPPQ	PPCQ	PLEP	PSEP	PPEP
	Thousand cubic meters						Pesos/cubic meter		
1970	13836	4230	1341	1156	653	392	150	356	575
1971	11632	3189	861	630	642	364	170	327	631
1972	10446	3588	1412	1181	732	415	168	426	718
1973	11505	3746	1061	634	705	317	264	555	1028
1974	7332	2639	1292	1008	274	103	312	718	1093
1975	8441	3845	1470	1216	423	266	263	777	951
1976	8646	6315	1609	1116	416	156	431	1029	1235
1977	7873	5826	1567	1112	489	149	387	1084	1217
1978	7169	4969	1781	1208	490	107	388	1095	1436
1979	6578	5330	1626	711	515	98	683	1599	1994
1980	6212	5058	1529	787	553	186	775	1834	2400
1981	5280	3597	1219	672	463	65	682	1816	2352
1982	4462	2872	1200	609	434	185	710	1787	2377
1983	4283	3266	1222	494	469	166	835	2275	2877

1/ Headings are explained in "Abbreviations of Variables" in appendix 1.

Table 11—Data on exchange rates and price indexes[1]

	Exchange rates				Price indexes			
Year	JAEXCH	IAEXCH	MAEXCH	PAEXCH	JPPI	IPPI	MPPI 2/	PPPI
	Foreign currency/U.S. dollar				1980 = 1.000			
1970	358	365	3.08	5.91	0.484	0.185	0.506	0.213
1971	347	393	3.02	6.43	.480	.194	.504	.247
1972	303	415	2.80	6.67	.484	.181	.505	.284
1973	271	415	2.44	6.76	.560	.251	.596	.345
1974	292	415	2.41	6.79	.737	.370	.671	.521
1975	296	415	2.40	7.25	.759	.393	.651	.533
1976	296	415	2.54	7.44	.797	.433	.733	.586
1977	268	415	2.46	7.40	.812	.480	.784	.652
1978	210	442	2.32	7.37	.791	.527	.824	.702
1979	219	623	2.19	7.38	.849	.767	.938	.841
1980	226	627	2.18	7.51	1.000	1.000	1.000	1.000
1981	220	631	2.30	7.90	1.014	1.114	1.027	1.131
1982	249	661	2.34	8.54	1.032	1.188	1.047	1.252
1983	237	909	2.32	11.11	1.009	1.405	1.094	1.450

1/ Headings are explained in "Abbreviations of Variables" in appendix 1.
2/ Gross domestic product deflator, not producer price index.

Appendix 2. Estimation

General Remarks

The full set of estimated equations used in the model are listed at the end of this appendix. In general, coefficients were accepted if they were significant at the 10-percent level, although coefficients significant at higher levels were occasionally accepted. The Durbin-Watson statistic was used to test for autocorrelation, even in equations with lagged endogenous variables. Because this statistic is biased toward 2 under the latter conditions, sometimes autocorrelation may have been present but was not detected. When autocorrelation was detected (rejection of the hypothesis of no positive autocorrelation at the 5-percent level), the Cochrane-Orcutt correction was performed. If the correction produced coefficients with the correct signs and significant t-statistics, and the original equation was acceptable for reasons other than the low Durbin-Watson statistic, the original coefficients were accepted. This was done to preserve degrees of freedom: autocorrelation does not affect consistency of estimates, but the correction does use up one degree of freedom.

In some equations, dummy variables were used to account for especially large residuals (outliers). These dummies were set equal to one for the year in question and zero for all other years. Dummies were used sparingly, no more than one per equation because their explanatory power is weak. If a data set is reliable, a correctly specified equation should have no dummy variables.

Special problems were confronted in estimating certain equations. In the Japanese plywood demand equation, a specification in which the coefficient on price was correctly signed and significant was not found. This indicated that plywood demand was totally inelastic with regard to price. Nomura and Yukutake (1982) and Yoshida (1982) encountered similar difficulties, reporting coefficients with correct signs but t-statistics of only 0.0682 (36 observations) and 1.0269 (25 observations). The solution adopted in JIMP was to restrict the plywood price elasticity to that reported by Wibe (1984) for panel products in nations with incomes greater than $2,500 per capita, -0.18.

Getting a satisfactory coefficient on log price was a problem with the Indonesian and Malaysian sawnwood and plywood supply equations. Without such a term, derived log-demand equations have no price responsiveness. The solution adopted was to restrict the log-price elastic ties in the Indonesian and Malaysian sawnwood and plywood supply equations to the values in the Philippine supply equations: about 0.94 and 0.59, respectively.

Estimated Equations

In this section, I list all econometrically estimated equations included in JIMP. Definitions of variables are given in "Abbreviations of Variables" in appendix 1. Coefficients associated with each variable are given, and the" t" statistic of each coefficient is given in parentheses under the coefficient. A missing" t" statistic indicates that the coefficient was constrained to equal an exogenous value. Standard information about each equation (period of estimation, A-squared, standard error of the regression, Durbin-Watson statistic) is also given.

Log Supply Equations

Indonesia: ILPQ = 0.223 * ILEPR + 0.628 * ILPQ(-1) - 6496 * DUM79
(3.73) (4.90) (4.48)

1970-83, R^2 = 0.843, S.E.R. = 1949, D-W = 1.55

Malaysia: MLPQ = 69.3 * MLEPR + 0.685 * MLPQ(-1) - 7429 * MOILRC
(2.49) (4.49) (2.68)

1970-83, R^2 = 0.879, S.E.R. = 1956, D-W = 2.13

Philippines: PLPQ = 5.92 * PLEP - 9094 * PPPI - 2680 * POILC 1845 * DUMX71 + 11912
(3.44) (8.21) (3.21) (4.11) (39.0)

1970-83, R^2 = 0.972, S.E.R. = 406, D-W = 1.62

Log Demand Equations

ROW for Indonesia:

ILEQROW = -74.8*ILEPA + 7.09*ROWGDP - 5.78*ROWGDP(-1) + 0.381 *ILEQROW(-1) + 3186*DUMX76
(3.46) (3.97) (3.12) (2.40) (2.86)

1970-83, R^2 = 0.924, S.E.R. = 1050, D-W = 1.65

ROW for Malaysia:

MLEOROW = -38.3*MLEPA + 1.23*ROWGDP(-1) - 1640*DUMX75 + 3067
(1.83) (4.11) (2.17) (6.31)

1970-83, R^2 = 0.843, S.E.R. = 689, D-W = 1.73

ROW for Philippines:

PLEOROW = -9.86*PLEPA - 821 *DUM74 + 689*DUMX80 + 2076
(2.78) (3.35) (1.92) (11.6)

1970-83, R^2 = 0.861, S.E.R. = 293, D-W = 2.69

Sawnwood Supply Equations

Japan: JSPQ = 0.0242*JSCP - 6104*JOIL - 1516*DUMX77 + 7150
(1.36) (3.41) (2.04) (11.2)

1970-83, R^2 = 0.843, S.E.R. = 717,D-W = 0.68

Indonesia: ISPQ = 0.0277*ISEPR - 0.0680*ILEPR + 1.32*ISPQ(-1)
(4.84) (NA) (8.53)

1970-83, R^2 = 0.891, S.E.R. = 853, D-W = 1.43

Malaysia MSPQ = 8.23*MSEPR - 30.4*MLEPR - 0.987*MSPQ(-1) - 1289*DUMX75 + 1201
(2.69) (NA) (6.42) (2.85) (1.78)

1965-78, R^2 = 0.948, S.E.R. = 429, D-W = 1.80

Philippines PSPQ = 1.72 * PSEPR - 2.01 * PLEPR - 166 * DUM79
(7.95) (3.86) (2.11)

1970-83, R^2 = 0.745, S.E.R. = 136, D-W = 2.24

Sawnwood Demand Equations

Japan: JSCQ = -0.0329*JSCP + 0.178*JGDPC - 2329*DUMX77 + 6095
(6.71) (4.05) (3.38) (8.05)

1970-83, R^2 = 0.859, S.E.R. = 644, D-W = 2.42

Indonesia: ISCQ = -0.0262*ISEP + 0.107*IGDP + 1454
(5.75) (11.2) (11.1)

1970-83, R^2 = 0.961, S.E.R. = 301, D-W = 1.45

Malaysia MSCQ = -2.38*MSCPR + 0.0830*MGDPR - 349*DUM74 + 544
(1.84) (7.60) (2.06) (1.96)

1965- 78, R^2 = 0.952, S. E.R. = 155, D-W = 2.27

Philippines PSCQ = -0.469*PSEP + 455*DUM74 + 1096
(4.02) (2.86) (10.5)

1970-83, R^2 = 0.595, S.E.R. = 186, D-W = 2.87

Plywood Supply Equations

Japan:

$$JPPQ = 0.0473*JPCP - 0.0704*JLIP - 2646*JOILC + 0.862*JPPQ(-1) - 1113*DUMX75$$

(2.41) (2.59) (2.79) (6.99) (2.17)

1970-83, R^2 = 0.683, S.E.R. = 459, D-W = 1.53

Indonesia:

$$IPPQ = 0.00437*IPEPR - 0.0134*ILEPR + 1.46*IPPQ(-1)$$

(4.04) (NA) (10.2)

1975-83, R^2 = 0.930, S.E.R. = 340, D-W = 1.19

Malaysia:

$$MPPQ = 0.393*MPEPR - 1.93*MLEPR + 0.983*MPPQ(-1) + 175*DUM79$$

(3.78) (NA) (5.26) (2.66)

1970-82, R^2 = 0.856, S.E.R. = 86, D-W = 2.23

Philippines:

$$PPPQ = 0.370*PPEPR - 0.458*PLEPR - 228*DUMX74$$

(9.85) (3.51) (6.02)

1970-83, R^2 = 0.929, S.E.R. = 37, D-W = 2.70

Plywood Demand Equations

Japan:

$$JPCQ = -0.0159*JPCPR + 3.45*JHOUSE + 0.467*JPCQ(-1) + 570*DUM78 - 1195*DUMX75$$

(NA) (8.05) (4.66) (2.16) (2.93)

1970-84, R^2 = 0.857, S.E.R. = 364, D-W = 2.27

Indonesia:

$$IPCQ = -0.000998*IPCP + 0.0242*IGDP - 130*DUM74$$

(2.09) (16.0) (3.35)

1971-83, R^2 = 0.987, S.E.R. = 60, D-W = 1.72

Malaysia:

$$MPCQ = -0.417*MPCP + 0.0138*MGDP - 292*DUM78$$

(2.56) (4.34) (3.54)

1970-82, R^2 = 0.732, S.E.R. = 60, D-W = 1.96

Philippines:

$$PPCQ = -0.136*PPEPR - 309*DUM74 + 739$$

(1.94) (5.86) (3.88)

1970-83, R^2 = 0.851, S.E.R. = 49, D-W = 2.76

ROW for Indonesia:

$$IPEQROW = -0.978*IPEPA + 0.192*ROWGDP(-1) + 1.07*IPEQROW(-1) - 210*DUMX80 - 568$$

(2.72) (6.31) (14.1) (2.97) (5.29)

1975-83, R^2 = 0.996, S.E.R. = 59, D-W = 3.00

Vincent, Jeffrey R. 1987. Modeling Japan-South Seas trade in forest products. Gen. Tech. Rep. PNW-GTR-210. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station; 28 p.

The international trade of forest products has generated increasing research interest, yet experience with modeling such trade is limited. Primary issues include the effects of trade barriers and exchange rates on trade patterns and national welfare. This paper attempts to add to experience by modeling hardwood log, lumber, and plywood trade in a region that has been mostly overlooked: East Asia, specifically Japan and the South Seas nations (indonesia, Malaysia, and the Philippines). Japan-South Seas trade is important because of its significance in global forest-products trade and because of the large changes in trade barriers and exchange rates since 1970. In this paper, I describe the development of an economic model, JIMP, for investigating trade issues in the region. The model uses reactive programming to solve for a spatial equilibrium. Preliminary results suggest that: (1) restrictions on log exports will benefit South Seas nations only if the nations act together, and (2) relatively small fluctuations in exchange rates influence trade patterns as much as do large changes in tariffs.

Keywords: Trade modeling, Japan, South Seas nations, hardwood products, trade barriers, exchange rates, spatial equilibrium, reactive programming.

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