International Price Transmission in the U.S.-Japan Softwood Trade

Paul Gallagher

This article explores the supposition that international price margins in the U.S. Pacific Northwest-Japan softwood trade are influenced by nontariff trade barriers and inelastic supplies of international transportation services. Furthermore, it pursues the hypothesis that a regime separation occurs in the log trade with the existence and extent of rent creation related to conditions in the export market. Estimated price spreads which depend on trade/volume serve as evidence. These factors magnify elasticities that measure the response of Japan's prices to changes in U.S. prices. Moreover, U.S. supplies on this market are more price-inelastic than its sheer size would suggest.

Previous research on international price transmission has emphasized the role of policies such as variable levies and of price-setting agencies, both of which are designed to stabilize prices in the importing country (Bredahl, Meyers and Collins; Collins; Gemmill; Meyers, Gerber and Bredahl). An important conclusion from this literature is that price transmission elasticities are reduced by price intervention policies. However, two fundamental assumptions of these studies were constant cost transportation, and the equivalence between international marketing costs and transportation costs. More recently, the relation between grain freight rates and trade volumes was established (Binkley and Harrer). Subsequently, Thompson suggested that international margin studies consider inelastic supplies of transportation services.

The possible existence of nontariff barriers (NTBs) to trade complicates application of this margin theory to the U.S.-Japan softwood trade. For example, Japan has its own set of grades and standards for lumber. Moreover, lumber graded in, and imported from, North America is reclassified according to Japanese standards upon arrival in Japan. This regrading could function as a phase of free trade, as a quota, or other policies. Also, the U.S. prohibits the export of logs harvested from federal lands. This policy may influence intercountry price spreads, because some participants might not have access to the export market. Moreover, some literature on forest-product transportation, discussed below, arouses suspicions of inelastic factor supplies.

In the study of price transmission in the U.S.-Japan softwood trade, the relation between international margins and trade volume provides a suitable measure for the combined influences of NTBs and transportation conditions. Estimates which build on this approach are presented for

Paul Gallagher is a Research Fellow at the College of Forestry, University of Minnesota, St. Paul, MN.

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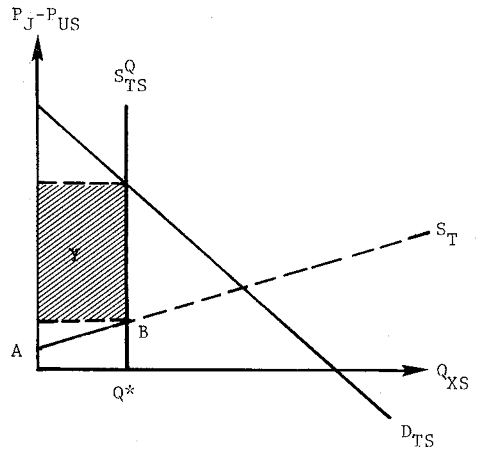

Figure 1A. Margin Formation with a Quota.

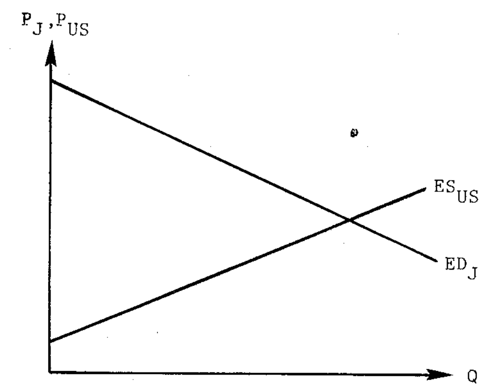

Figure 1B. Excess Supply (U.S.) and Excess Demand (Japan).

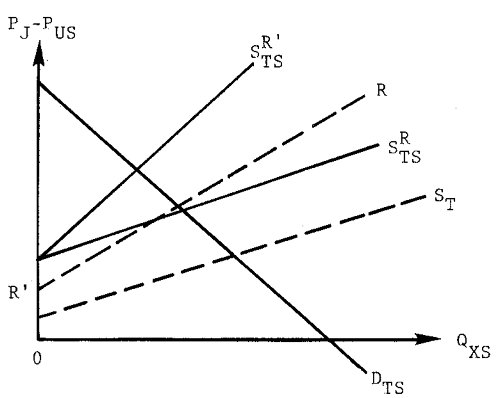

Figure 1C. Lumber Margin Formation with Regrading.

the log and lumber trade. It is shown that price transmission elasticities may exceed unity in both markets. Consequently, price-elasticities of U.S. supply to the Japanese markets are much smaller in the presence of NTBs and limited transport supplies than they would be with free trade and constant-cost transportation.

Theory and Implications for Empirical Analysis

The most familiar analysis of NTBs, quotas awarded by granting importing licenses, suggests that such policies create resources necessary for the conduct of international trade (Corden). To illustrate, consider Figure 1B, where trade volume (Q) is shown on the horizontal axis and prices in the U.S. (P_{US}) and Japan (P_J) are on the vertical axis. Schedules depicting willingness to pay for products on the import market in Japan (ED_J) and willingness to sell on the U.S. export market (ED_{US}), expressed in terms of prices on the respective markets, are shown in Figure 1B. In Figure 1A the quantity of trading services (Q_{TS}), which are used in fixed proportions with trade volume (Q), is shown on the horizontal axis, while the intercountry price difference (P_J-P_{US}) is shown on the vertical axis. The demand for trading services (D_{TS}) in Figure 1A is the vertical difference between ED_J and ES_{US} in Figure 1B. The supply schedule for international trading services is constructed on the assumption that import licenses are tradeable, so that a market forms. Then the supply of trading services (ABS^Q_{TS}) in Figure 1A is defined by fixed-proportion combinations or rate-responsive transport supplies (S_T) and a perfectly inelastic license supply (Q*). Finally the margin that equates the supply and demand for trading services defines intercountry equilibrium.

The effect is that economic rent (area Y) accrues to license holders because the policy affects the supply of trading services. Moreover, the existence of a license market is not crucial to quota-induced rent creation and resource allocation. Firms may amalgamate, be bought and sold at premiums reflecting license values, or pay commissions to other firms for a license and minimal service, if license trading is prohibited.

Corden's exposition focuses on the effects of implementing, or abolishing, a quota. This precludes discussion of market operation with the quota in effect. Specifically, the supply schedule for trading services (ABS^{Q}_{TS}) is not emphasized because its characteristics change with the policy. However, features of this supply schedule, with the potential NTBs of the softwood trade in place, are a central concern here. In particular, it is shown that restrictions in lumber and log markets may contribute to upward-sloping schedules for trading services. Thereafter, conditions favoring inelastic transport supplies are summarized. These points establish empirical margin analysis based on margin responsive supplies of trading services. Moreover, adjustments in (housing) market conditions within either trading country shift the demand schedule for trading services. Consequently, actual market outcomes should produce trade volumes and price spreads that identify the supply of trading services, provided that transport and policy structures are stable.

A. Lumber

Participants at the Tokyo Round of GATT (General Agreement on Tariffs and Trade) formally recognized that an international variance in product standards can function with quota-like properties. A recent discussion of these negotiations explained the quota function and summarized the signatories' resolutions (League of Women Voters). Typical restrictions caused by standards variance occur when "countries require their own officials, to certify compliance with standards during successive stages of a product's manufacture—yet refuse to send those officials to another country that is turning out the product for export" (Ibid., p. 3). GATT resolutions encouraged participants to "begin accepting export certification based only on competence and where appropriate specify standards in terms of performance (what the product must do) rather than design (what the product looks like)" (Ibid., p. 3).

Controversies in the North American-Japanese lumber trade have echoed issues identified in GATT. In the late seventies, for example, the Japanese argued for design-based standards even though most posts and beams are not visible in finished homes, while North Americans favored performance-based standards (Forster, p. 18). During the same period, exclusive authority for regrading (in Japan) was granted to Japanese lumber associations (Ibid., p. 102). Currently, North American industry is less concerned with these problems (National Forest Products Association), but controversies could still arise in the future. Furthermore, analyses of margin history must allow for the possibility that regrading has a restricting effect.

Thus, limits on the availability of regrading services may make resources necessary for international trade more scarce. Three possible implementations of regrading are shown in Figure 1. At one extreme, the quota analysis discussed earlier (Figure 1A) may apply if regrading services are strictly fixed, even in the absence of explicit quotas and licenses. Second, regrading may be equivalent to a fixed-rate tariff, provided that the service is perfectly elastically supplied. In this case, the supply of trading services (S^{R}_{TS}) in Figure 1C is the vertical summation of transport supply schedule (S_T), and a horizontal line at height OR′; OR′ defines the magnitude of the regrading change.

A third case ensues when regrading availability varies systematically with the return to importing. Higher returns might evoke additional regrading services simply because importers are willing to devote more time to cumbersome procedures. Alternatively, procedures may be simplified in response to domestic market needs. In either event, the supply schedule for trading services becomes more inelastic, thus strengthening the relation between trade volumes and international margins. For example, an upward-sloping line indicating the availability of regrading services (R'R) is shown in Figure 1C. The vertical addition of R'R and S_T produces the supply schedule for trading services ($S_{TS}^{R'}$). This supply schedule is less price-elastic than the one produced with unlimited regrading services (S_{TS}^{R}). Thus, the presence of operating NTBs should increase the magnitude of margin adjustment which results from a given change in trade volume.

B. Logs

The log margin is separated into components defined by trade policy conditions in Japan and the U.S. Specifically, Japan pursues a free-trade import policy. Consequently, the Japan wholesale/U.S. export margin should reflect transportation charges, and subsequent discussion focuses on international shipping. In contrast, the U.S. restricts log exports from publicly owned lands. These restrictions may impinge on the relation between prices at export points and at domestic mills.

The regulation of log exports from public lands on the West Coast has a long and complicated history, as reported by other authors (Lindell, U.S. House of Representatives). Although some states (Oregon and California) prohibit exports from public lands, federal restrictions have been the dominant influence. In particular, annual exports of Forest Service and Bureau of Land Management timber were limited to 350 MMBF (million board feet), as of 1968.[1] More stringent controls, enacted at the end of 1973, banned the export of logs from federal lands. The substitution of private for federal timber in export sales was also reduced with the later restrictions; among other impediments, joint increases in exports and purchases of federal timber above historical benchmarks were prohibited.

This array of federal restrictions may also create resources necessary for the conduct of international trade. For example, export license recipients could have obtained higher returns than other federal timber buyers during the late sixties and early seventies. Moreover, logs from unrestricted lands in convenient locations may have commanded a premium attributable to both sets of restrictions. Finally, allotments based on a firm's history of joint participation in export and federal stumpage markets may result from the 1973 restrictions.

The influence of these restrictions on West Coast log and stumpage markets has been considered in previous research. One conclusion of this research is that there have been important effects of these restrictions on the margins and prices of high-grade logs only.[2] However, empirical work has not emphasized the likelihood that existence and extent of rent creation depend critically on market conditions.[3] The hypothesis pursued in this study is that regime separation occurs, with the existence and extent of rent creation re-

[1] This limit amounted to about 15 percent of the prevailing export volumes.

[2] Verification has focused on average log export margins before and after restrictions were imposed (Dowdle; Sedjo and Wiseman) or comparisons of average stumpage sale prices on restricted and nonrestricted parcels while restrictions were in effect (Haynes, 1982; Rickard). Several conceptual frameworks have been proposed which include price discrimination (Dowdle), Japanese unwillingness to substitute away from high-grade logs (Parks), and the fact that private log owners are residual suppliers to (1) domestic millers who depend primarily on federal timber, and (2) the export market (Sedjo and Wiseman).

[3] Sedjo and Wiseman entertain the possibility that the effectiveness of restrictions may depend on export-market conditions. However, this idea is not carried forward in the empirical investigation.

lated to conditions in the export market.[4] Specifically, export deviations about trends serve as a proxy that identifies when restrictions exert a strong influence on log margins and measures the intensity of rent creation; the restriction should (1) have little or no effect when export volumes are low, but (2) contribute to a strong relation between margins and export volume when trade is strong.

C. A Note on Ocean Transport for Logs and Lumber

International shippers generally consider forest products a difficult cargo because of low density, awkward handling, and a preference for small parcels. Specialized carriers with improved cargo-handling equipment have therefore replaced the general-purpose bulk carrier in much of the forest product trade (Drewry, 1975, p. 29). The inkling of a positive relation between freight rates and trade volume arises when the volume of the U.S.-Japan trade is large relative to the capacity of a specialized fleet.

Log shipping is highly specialized. Carriers undertake round-trip voyages between the U.S. and Japan with one leg empty and rarely carry other cargos (Drewry, 1975). Furthermore, available mid-seventies estimates of fleet size and the range of ship capacities suggest that the record trade volumes of 1979 could have been handled by this fleet only if the ship-size distribution had been skewed towards larger sizes.[5] Then the possibility of upward-sloping transport supply schedules arises (a) with a fairly uniform distribution of ships by age, (b) when vessels of a given age have a break-even point that defines market participation, and (c) when the magnitude of break-even rates increases with a ship's age (Shimojo).

The potential for upward-sloping transport schedules is more difficult to assess in the lumber trade. In contrast to complete specialization in the log trade, for example, lumber-shipping vessels can range from exclusive lumber shipping with automobile backhaul to general-purpose carriers with a modest additional investment in handling equipment. Nonetheless, break-even points may be related to the degree of specialization, thereby defining entry and exit points as trade volume adjusts. Contracting practices may also contribute to a positive relation between freight rates and trade volume, as spot market transactions generally supplement long-term charters in high-volume markets. However, the substantial lumber trade between the west coast of North America and western Europe reduces the development of strong relations between U.S.-Japan trade and lumber freight rates (Drewry, 1979, p. 26).

D. Estimating Equations

The issues discussed thus far are explored empirically in this section. The central hypothesis is that trade volume (Q_X) helps to explain intercountry margins (M), where the margin is defined as the difference between the price in Japan (P_J) and the price in the U.S. (P_{US}). The following regression is appropriate when price

[4] Of course, other hypotheses could be advanced. Future research might show, for example, that variation in domestic-market conditions provides an equally satisfactory explanation, or that some combination of conditions in both markets improves the explanation.

[5] Kearney, Inc. estimated the size of the fleet at 75 ships, noted that sizes range from 16,000–30,000 DWT (dead weight tons), that round trips take 45 days and that a 16,000 DWT-class ship carries 3,000 MBF, l.s. (p. 27). Assuming a proportional relation between ship size and cargo limits, the annual capacity of this fleet is (a) 1,825 MMBF if all ships were 16,000 DWT, (b) 2,750 MMBF if ships were 23,000 DWT, and (c) 3,650 MMBF if ships were 30,000 DWT. These capacity estimates compare to a 1979 trade volume of 3,234 MMBF.

data for similar species, grades and sizes are available at both locations:

$$M = \alpha + \beta Q_X. \qquad (1a)$$

An alternative regression,

$$P_J = \alpha + \beta Q_X + \gamma P_{US}, \qquad (1b)$$

is useful when species, size or quality differences are present, or to establish that (1a) is valid for price data with similar commodities.

The successful application of methods used in analyzing the farm-retail price spread to the analysis of international margins has already been noted. The present extension, using trade volume as a measure of the extent to which scarce factors impinge on the supply of trading services, also utilizes previously developed methods (George and King, p. 57–9). This approach offers a convenient method for (a) gauging the combined influences of policy and transportation, and (b) assessing the implications for the international market structure.

Data

The standard problems in forest-product price comparisons, which include comparability owing to species, grade and handling differentials, are compounded in this case by the difficulty in obtaining long time-series from foreign markets. The prices in this study represent those of standard construction grades for major species. Indeed, margins comparing identical species and grades were employed wherever possible, but data with close-substitute species and similar grades were also used when necessary. The close substitution between the major West Coast species, hemlock and Douglas fir, is noteworthy; prices in the U.S. and Japan are often quoted in mixed parcels and these prices and the prices of separate bundles move together.[6]

In addition to the details of species and grade choices shown in Table 1, some general comments are in order. First, study of the West Coast log margin is unencumbered by difficulties associated with species and grade differentials, as data were available for standard-grade Douglas fir at both locations. However, a sufficiently long time-series of corresponding prices on Japan's wholesale market was not available. Thus, analysis of Japan's importing margin is based on a wholesale price index for the major domestic softwoods (cedar and pine). In the comparison of wholesale lumber prices, the dominant structural item was chosen from each country: Douglas fir 2 × 4s in the U.S., and hemlock "baby squares" in Japan. Japan's lumber price is a "spliced" series consisting of national averages for the last half of the sample and adjusted quotations from Tokyo in earlier years. Finally, all results are based on annual data.

Lumber Results

Satisfactory estimates of lumber price relationships resulted with direct application of ordinary least squares to equations (1a) and (1b).[7] These results generally confirm the importance of trade volume in margin determination. Moreover, statistical tests suggest that the margin specification (equation 1a) is suitable for these closely related lumber products. In equation (2a), for example, the U.S. price is expressed in Japan's units (Yen/

[6] West coast mill prices for Douglas fir and mixed hemlock/fir were compared over the 1963–80 period. The correlation coefficient between these two prices was 0.9997. Also, in regressions with the "mixed price" as the independent variable, the constant was insignificant. When the constant was suppressed, the slope estimate suggested that a $1 change in "mixed" price produced a $1.09 change in the "fir" price.

[7] Similar estimates based on real lumber prices, also confirm the importance of trade volume in lumber margin explanations. These results are discussed in an unpublished manuscript available from the author on request.

TABLE 1. Definitions of Variables and Sources.

Variable	Definition	Source
PJLUM	Japan wholesale price of hemlock lumber, in Yen/m^3 1970–80: Standard grade, National Average (dim: 9.0 cm × 9.0 cm × 4 m) 1963–69: Standard grade, Tokyo delivery (dim: 10 cm × 10 cm × 6 m)	Japan Forestry Ministry Japan Economic Journal
PUSLUM	U.S. west coast mill price of Douglas fir lumber, in $/MBF, lt. 25% std & btr. (dim: 2″ × 4″ random length)	U.S. Forest Service/ Bureau of Labor Statistics
PJLOG	Japan national average wholesale price of cedar and pine sawlogs, 1962 = 100	Japan Forestry Ministry/ Gallagher
PUSLOGX	U.S. west coast export price of Douglas fir sawlogs, in $/MBF, l.s., #2 sawmill logs, export sales from western Washington and NW Oregon	U.S. Forest Service/ Industrial Forestry Assn.
PUSLOGD	U.S. west coast domestic price of Douglas fir sawlogs, in $/MBF, l.s., (thousand board feet, log scale) #2 sawmill logs, water and inland sales	U.S. Forest Service/ Industrial Forestry Assn.
EX	U.S.-Japan exchange rate, in Yen/U.S. $.	International Monetary Fund
QIST	Japan imports of softwood lumber, in 1,000 m^3.	Food and Agriculture Organization of the United Nations
QXL	Softwood log exports from Washington and Oregon ports in MMBF, l.s. (million board feet, log scale)	U.S. Forest Service/ Dept. of Commerce

m^3) through the use of exchange rates and a physical conversion factor (2.36 m^3 lumber per MBF):[8]

$$\begin{aligned} \text{PJLUM} = {} & 5173.6036 \\ & (1.65) \\ & + 1.06575(\text{PUSLUM}\cdot\text{EX}/2.36) \qquad (2a) \\ & (3.44) \\ & + 6.16973\text{QIST} \\ & (2.48) \end{aligned}$$

$\bar{R}^2 = .90753 \qquad \text{D.W.} = 1.045 \qquad \bar{S} = 3309.57$

Historical Period: 1963 to 1980.

In a test that showed the coefficient for adjusted U.S. lumber price (1.06575) not to be statistically different from 1.0, the t-statistic under the null hypothesis is 0.212, which suggests acceptance at any reasonable significance level. Thus, regressions with price differences as the dependent variable are appropriate. Equation (2b) displays the margin (MLUM = PJLUM − PUSLUM EX/2.36) specification:

$$\begin{aligned} \text{MLUM} = {} & 5929.1358 + 6.3560\text{QIST} \qquad (2b) \\ & (3.67) \qquad\quad (8.13) \\ & \qquad\qquad\quad [.662] \end{aligned}$$

$\bar{R}^2 = 0.7930 \qquad \text{D.W.} = 1.19 \qquad \bar{S} = 3203.54.$

Statistical properties are generally encouraging, as both estimates explain a high proportion of historical variation. However, Durbin-Watson statistics border on indications of positive autocorrelation.[9] The sources of this cyclical pattern might be uncovered through improved Japanese price data and information on international transportation rates. The potential causes are the use of a "spliced" lumber price, imprecise measurement of the relation between trade volume and trans-

[8] Numbers in parentheses are t-values for corresponding coefficients. Numbers in brackets below t-values are elasticities (flexibilities) for the corresponding independent variable. Definitions of variables are in Table 1.

[9] A definite indication of positive autocorrelation is given by the d_l statistic. With a sample of 18 observations and two explanatory variables the values of this statistic are 1.05 at the 5% confidence level and 0.93 at the 2.5% confidence level.

port costs, and cyclical adjustment of Japan's regrading policy. Until these measurement problems can be resolved, least-squares is a robust estimation procedure, even if autocorrelation does exist.

Log Results: U.S. Domestic to U.S. Export

Log prices were estimated by means of the margin formulation, equation (1a), since problems of species and grade comparison were not evident. Moreover, the focus on regime separation, where the restrictions alternately exert a moderate and strong influence on exporting margins, precluded other forms of hypothesis testing.

Regime separation was accomplished with "threshold" estimation procedures suggested by Hinkley. The basic assumptions are that (a) there are two linear functions governing the relation between the margin (MLOG = PUSLOGX − PUSLOGD) and the deviation of log export volume about trend ($\tilde{QXL}$), and (b) the two lines intersect at a threshold level of export deviation ($\tilde{QXL}^*$). This can be reduced to a regression problem with given $\tilde{QXL}^*$. Regressions are therefore calculated with various values of $\tilde{QXL}^*$, and the best estimate is the threshold assumption that minimizes regression residuals. An elaboration on these econometric procedures is presented in the Appendix.

Estimates of slope and threshold level should shed light on the effects of log restrictions. For example, results with modest slopes and thresholds at the highest export levels support the hypothesis that restrictions have little effect; this result approaches the constant margin model characteristic of free trade with fixed handling charges. In contrast, estimates with steep slopes and low threshold levels suggest that the restriction has an effect regardless of foreign-market conditions; this case approaches the margin under a quota (Figure 1A).

Several preliminary hypotheses were considered under this general approach. For example, a wide range of estimates suggested that no volume dependence existed below the threshold level. Most other comparisons concerned several possibilities for structural change, since available data include periods of no restrictions (1964–67), the initial regulations (1968–72) and later extensions (1973–80). One potential problem, i.e. that associated with uncovering a volume-dependent margin during the no-restriction period, did not arise because the regime separated method failed to identify such a relationship for these early years. In fact, the constant estimate from these data may well represent export handling charges in the absence of restrictions. A second set of structural-change hypotheses concerned the possibility that the introduction and extension of restrictions could influence the margin regardless of market conditions. The reported result features a dummy variable (D73), which indicates an autonomous increase in the margin at the time restrictions were extended. Also, the stability of the threshold estimate and slope coefficients were considered with shortened time series. Specifically, the basic conclusions of threshold estimates moderately above trend and the absence of volume dependence below the threshold remained with 1968–80 and 1973–80 data sets. However, the threshold estimate did drift upward (from 70.8 to 94.4 and 141.6 million board feet above trend level exports), and the intensity of the volume dependence above the threshold strengthened (i.e., the slope of the estimated relationships increased from 0.20 to 0.23 and 0.472) as the historical period was shortened from 1964–80 to 1968–80 and 1973–80.

Equation (3) below is representative of results obtained with this method. The dummy variable, D_0 defines the regime separation, and the corresponding coefficient identifies the threshold level for export deviations.

$$\text{MLOG} = \underset{(0.52)}{-5.5904} + \underset{(4.90)}{59.30101}\text{D73} + \underset{(3.58)}{0.202367}(\text{D}_0 70.807 + \text{D}_1 \text{Q}\tilde{\text{X}}\text{L}) \quad (3)$$

$\bar{R}^2 = .7114$ D.W. = 1.745 $\bar{S} = 24.751$

$$\text{where } \text{D}_{0'} = \begin{cases} 0; \text{ if } \text{Q}\tilde{\text{X}}\text{L} \le 70.807 \\ 1; \text{ otherwise} \end{cases}$$

$$\text{D}_1 = 1 - \text{D}_0$$

$$\text{D73} = \begin{cases} 0; \text{ 1964–72} \\ 1; \text{ otherwise} \end{cases}$$

The estimated margin-volume relation is shown in Figure 2. A constant margin of \$68/MBF occurs until exports rise above 30% of a standard deviation about the trend. Beyond this point the margin increases rapidly with export volume. At two standard deviations above the trend, the margin is greater than two times the level for low export volumes: \$149/MBF.

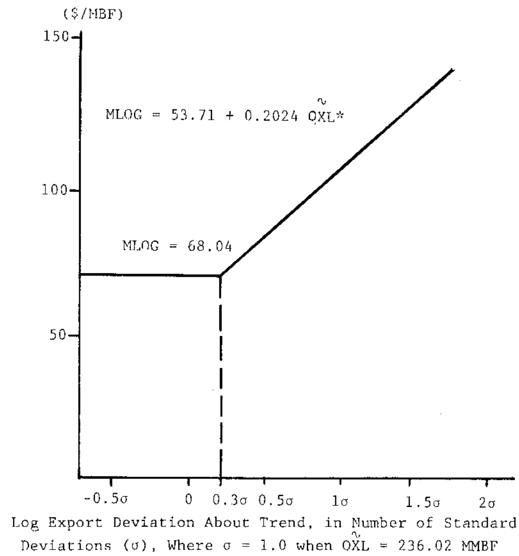

Figure 2. Estimated Relationships between the Log Exporting Margin (MLOG) and Export-Deviations about Trend Values ($\text{Q}\tilde{\text{X}}\text{L}$).

Log Results: U.S. Export to Japan, Wholesale

The relation between U.S. export and Japanese wholesale log prices is shown in equation (4). Trade volume was initially included as an explanatory variable. The coefficient had the correct sign, but including this variable did not increase the $\bar{R}^2$ value. Consequently, volume dependence was excluded.

$$\text{PJLOG} = \underset{(6.25)}{60.655361} + \underset{\substack{(12.70)\\ [.642]}}{0.0094368062} \cdot (\text{PUSLOGX} \cdot \text{EX}/4.53) \quad (4)$$

$\bar{R}^2 = .8990$ D.W. = 1.653 $\bar{S} = 19.87$

Historical Period: 1962–1980

This estimate suggests that scarce log shipping resources do not influence the relationship between prices at U.S. export points and prices on Japan's wholesale markets.

Implications for the U.S. Elasticity of Supply to the Japan Market

Price transmission elasticities are often combined with import demand elasticities in the importing country as a method of gauging the structure of demand in the exporting region. Nonetheless, it is equally valid to combine supply elasticities in the exporting region with price transmission elasticities to assess the structure of foreign supply in the importing country. The latter approach is taken here, as it illustrates conveniently how price-elastic U.S. markets, combined with volume-dependent margins, produce an inelastic structure in the trade market.

It is straightforward to demonstrate that the elasticity of U.S. supply to the Japan market ($E_{Q_X \cdot P_J}$) is the ratio of the elasticity of U.S. exports from the U.S. market ($E_{Q_X \cdot P_{US}}$) and the price transmission elasticity ($E_{P_J \cdot P_{US}}$):

$$E_{Q_X \cdot P_J} = E_{Q_X \cdot P_{US}} / E_{P_J \cdot P_{US}}.$$

The presumption that the supply to Japan is more price elastic than supply from the U.S. follows with a constant margin ($M = P_J - P_{US}$); the price transmission elasticity is the ratio of export and import prices ($E_{P_J \cdot P_{US}} = P_{US}/P_J$), which is less than unity. However, the volume-dependent margins of this study point to larger price trans-

TABLE 2. Elasticities of Price Transmission and U.S. Export Supply.[a]

Commodity and Margin Assumption	Parameter: $E_{Q_X \cdot P_J}$	$E_{P_J \cdot P_{US}}$	M/P_J	$E_{Q_X \cdot P_{US}}$	$F_{M \cdot Q_X}$
Lumber					
Constant Margin	30.92	0.47	—	14.53	—
Volume-Dependent	2.61	5.57	0.53	14.53[c]	0.662[e]
Logs[b]					
Constant Margin	3.78	0.71	—	2.70	—
Volume-Dependent	0.37	7.22	0.29	2.70[d]	8.32[f]

[a] All elasticities based on sample means for 1964–80 period.
[b] Domestic mill to U.S. export points only.
[c] Source: Gallagher. This is a direct estimate of the elasticity of North American supply (U.S. + Canada) wrt. U.S. lumber price.
[d] Source: Adams and Haynes. This is the implied export supply elasticity at the mill level on the West Coast, calculated as a weighted average of stumpage supply and domestic proceeding elasticities for the western portion of the Pacific Northwest.
[e] Source: equation (2b).
[f] Source: equation (3).

mission elasticities and a more inelastic structure in Japan. The price transmission elasticity also depends on the flexibility of the margin with respect to trade volume ($F_{M \cdot Q_X}$), the margin and the elasticity of supply from the U.S.:

$$E_{P_J \cdot P_{US}} = \frac{P_{US}}{P_J} + \frac{M}{P_J} E_{Q_X \cdot P_{US}} F_{M \cdot Q_X}.$$

Table 2 shows some estimates of these elasticities for logs and lumber. Previous research suggests large export elasticities at West Coast mills (2.7 for logs and 14.5 for lumber). Moreover, this elasticity is magnified at export points and in Japan (3.78 and 30.92 for lumber) when relative prices define the price transmission elasticity. In contrast, elasticity magnitudes shrink when volume dependence is included; estimates show an inelastic log market (0.37) and a moderately elastic lumber market (2.61).

These calculations provide only rough indications of actual responses, as West Coast mill elasticities are not fully comparable and refer to isolated markets. Nonetheless, the results of this paper provide evidence that the trade market is more inelastic than more conventional analysis would suggest. 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. Consequently, Japan may place an alternating reliance on log and lumber trade over the course of a housing cycle. The lumber results indicate a reduced potential for North American lumber in supplying expanding Japanese markets.

Trade barriers and limited transport supplies have been proposed as causes of this market structure. Log results point to the importance of export restrictions and suggest a limited role for transport influences. Meanwhile, lumber estimates measure combined influences, but assessment of the importance of individual causes is not possible. However, the lumber margin equation did perform reasonably in a prediction interval test.[10] Whatever the cause, the results are therefore relevant for this decade.

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[10] In a 1981 prediction interval test based on equation (2b), the forecast error was 3,067 Yen/m^3. This compares favorably with the standard error of estimate: 3,203.5 Yen/m^3.

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Appendix

Suppose the margin-volume relation consists of two pieces:

$$(*)\ MLOG = (\alpha_0 + \beta_0 Q\tilde{X}L)D_0 + (\alpha_1 + \beta_1 Q\tilde{X}L)D_1, \text{ where}$$

$$D_0 = \begin{cases} 0; \text{ if } Q\tilde{X}L \leq Q\tilde{X}L^* \\ 1; \text{ otherwise} \end{cases},$$

$$D_1 = \begin{cases} 1; \text{ if } Q\tilde{X}L \geq Q\tilde{X}L^* \\ 0; \text{ otherwise} \end{cases}, \text{ and}$$

$$D_0 + D_1 = 1.$$

When the assumption that the two lines intersect at the threshold level,

$$\alpha_0 + \beta_0 Q\tilde{X}L^* = \alpha_1 + \beta_1 Q\tilde{X}L^*,$$

is substituted into equation (*) to eliminate α_0, a relationship for estimation of α_1, β_1 and β_2 results:

$$(**)\ MLOG = \alpha_1 + \beta_0 D_0(Q\tilde{X}L - Q\tilde{X}L^*) + \beta_1(D_0 Q\tilde{X}L^* + D_1 QXL).$$

Export deviations are based on segmented estimates of trend-level exports ($Q\hat{X}L$): $Q\hat{X}L = 15{,}575.46 + 249.745T$ for 1963–68 and $Q\hat{X}L = -3{,}919.4 + 85.74T$ for 1969–80, where T = year (63,64, . . . , 80).

The threshold values (in levels and number of standard deviations) and the standard deviation of regression residuals are tabulated below. The standard error is minimized when the threshold level is 70.807 MMBF (0.3σ).

Threshold Level ($Q\tilde{X}L$) (MMBF,ls)[a]	($n\sigma$)	Standard Error of Residuals ($/MBF,ls)[a]
94.406	0.4σ	25.528
70.807	0.3σ	25.505
59.055	0.25σ	25.569
47.204	0.2σ	25.657
23.602	0.1σ	25.886

[a] MMBF = million board feet
MBF = thousand board feet
ls = log scale

For information on hypothesis testing and more general formulations of the threshold problem, the reader may wish to consult Beckman and Cook; Hinkley; Stinson and Stam. The hypothesis of a simple linear relation was tested against the "two-phase regression with continuity restriction" (equation **). The null hypothesis (straight line) was rejected at the 5 percent confidence level. This suggests that the kinked relation is more appropriate.