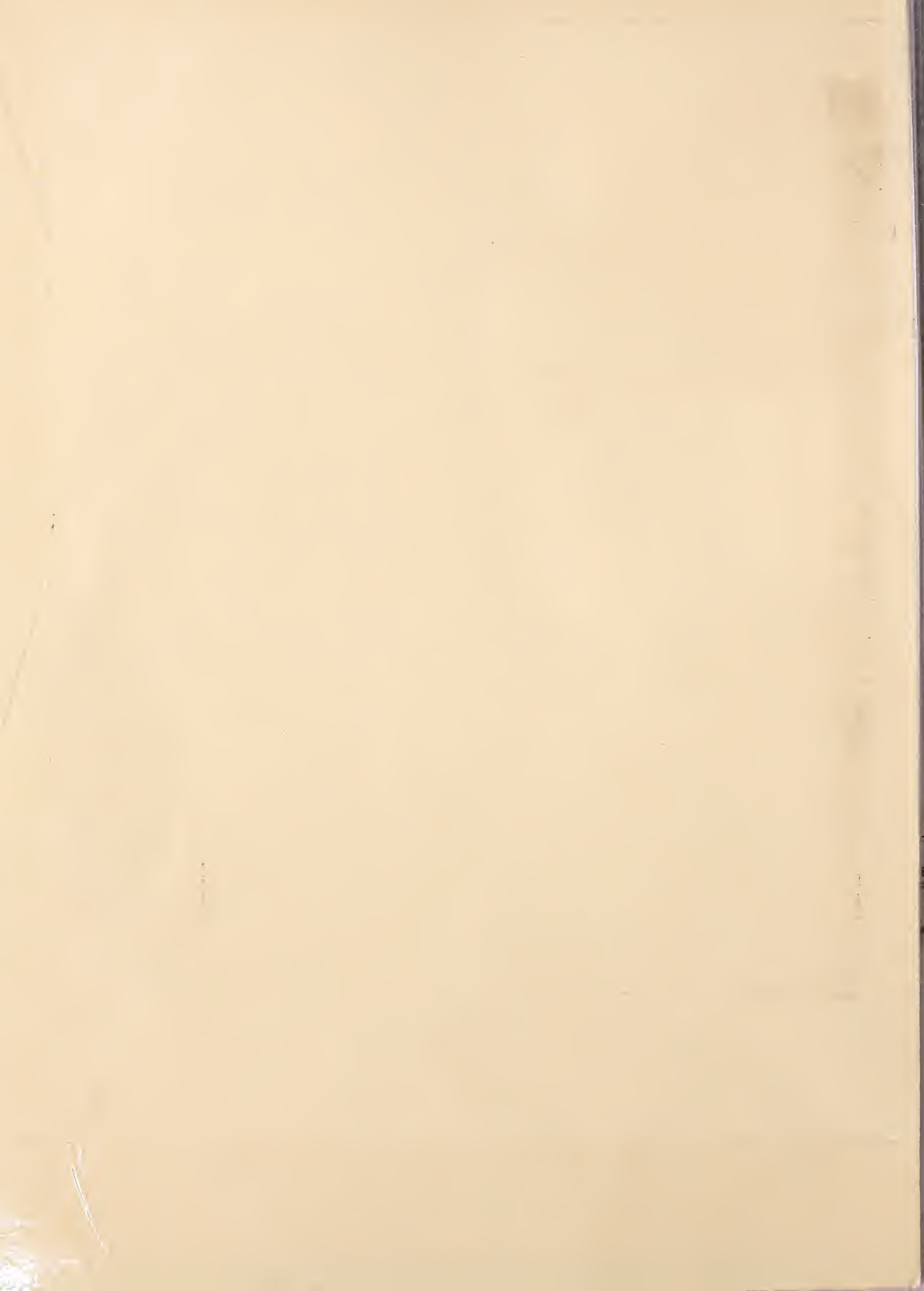


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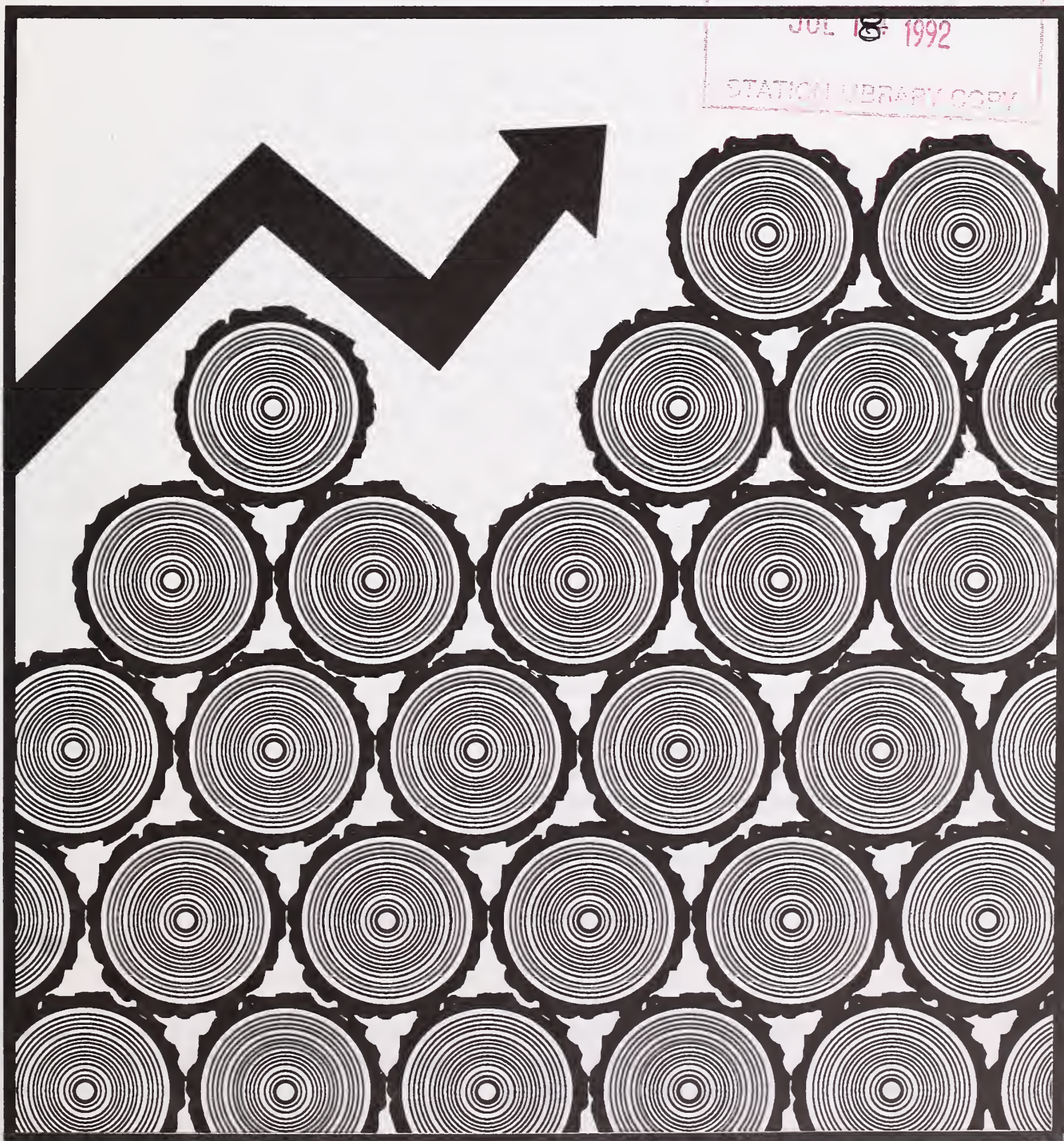
# Effects of New Export Rules, a Spotted Owl Plan, and Recession on Timber Prices and Shipments from the Douglas-Fir Region

Donald F. Flora and Wendy J. McGinnis

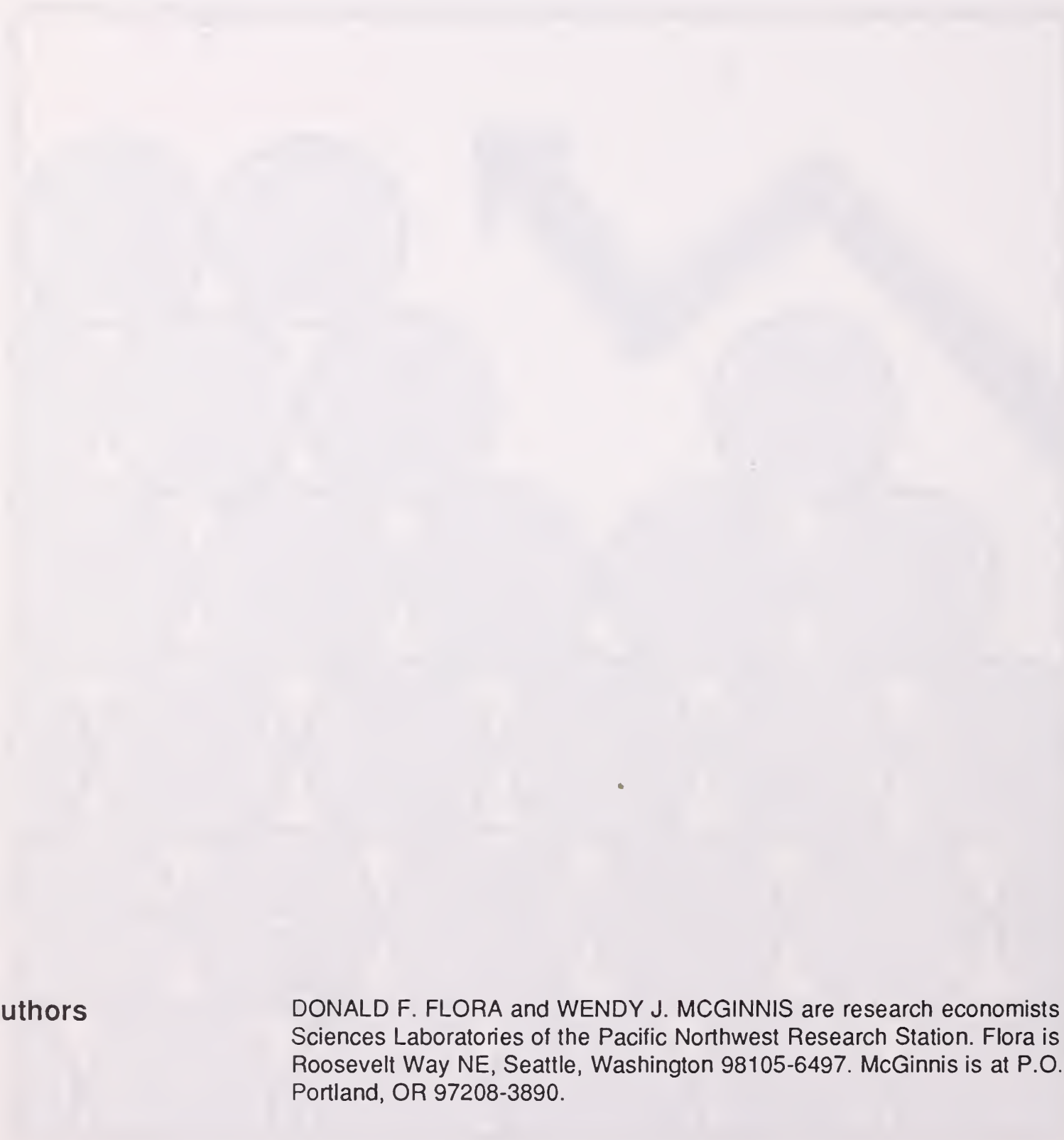
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## Abstract

**Flora, Donald F.; McGinnis, Wendy J. 1992.** Effects of new export rules, a spotted owl plan, and recession on timber prices and shipments from the Douglas-fir region. Res. Pap. PNW-RP-445. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 15 p.

Several recently emplaced and potential Northwest timber policies are causing considerable market turbulence. Estimated were price and volume changes induced by three supply-side policies (a state-log export embargo, forest replanning, and spotted owl reservations) and the demand slide of 1990-91. Impacts were gauged separately and together by using a four-sector model encompassing interactions between Pacific Rim and onshore markets and between logs and lumber. Log prices are expected to rise markedly despite the industry recession. Shipments onshore and abroad are declining, and our analysis offers little encouragement for stability. The log-lumber cost-price squeeze will not abate soon, and the capacity of the region to supply wood products demands onshore and abroad will diminish markedly, although by less than reductions in planned harvests would suggest.

**Keywords:** Markets (external), supply and demand (forest products), trade (Pacific Rim), log exports, lumber exports, spotted owl, forest planning.

## Summary

Controversy over three recent timber policies in the Northwest, and the considerable impacts expected from them, invite analysis to identify their several market effects. The timber-supply policies examined are enhancement of spotted owl habitat on private and public lands, forest replanning (apart from superimposed owl strategies) by private and public landowners, and a congressionally mandated limitation on exports of logs originating on State-owned lands. While these policies were being emplaced, a demand-side recession complicated perceptions of policy impacts, current and potential, thereby heightening the controversy.

This analysis used an eight-equation, four-sector model with each equation a log-linear supply or demand function. Annual data made this a relatively short-term model. Supply policies were simulated by variously adjusting export and domestic log-supply equations. To assess long-term impacts, equations were modified with Koyck-type transformations. The influence of the recession was measured by operating the model first with yearlong average exogenous variables pertinent to 1990, and then with the same variables adjusted to levels seen in the first quarter of 1991.

Proportionately, price impacts exceeded volume effects several-fold. The longrun (several-year) analysis indicated that both price and volume effects can be expected to subside by as much as half relative to shortrun (1-year) consequences. The largest shortrun market impacts (ignoring recession effects) were a more-than-double increase in log and export lumber prices, and a one-quarter reduction of log export volumes. The recession, it was estimated, will have caused log export declines to exceed one-third, while moderating price increases modestly. The owl accounts for more than two-thirds of the effects of supply-side policies. And this is with the relatively conservative interagency strategy devised in early 1990.

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## Introduction

Three highly significant policy and management changes are being made in the Pacific Northwest. One is new timber production plans for most public and many private holdings that reflect new timber data, land withdrawals, and the evolution of timber harvesting. The second is set-asides of old-growth timberland for protection of spotted owl (*Strix occidentalis caurina*) habitat, a matter whose full dimensions are not yet clear. The third is Federal legislation halting most exports of timber from State-owned lands in the western contiguous States. This report covers certain key results of these three changes. Estimated here are interactions among private harvests, log flows to Northwest and Pacific Rim users, lumber shipments from the Northwest to domestic and offshore markets, and log and lumber prices in domestic and export trade. Also estimated are the effects of a 1991 forest products recession on the impacts of the policies.

Together, these harvest and export changes are significant. In the Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) region, the focus of our analysis, replanning has reduced the outlook for Federal timber harvests by 25 percent (at current prices) and private and State cutting by 10 percent. Management of the spotted owl may involve as much as a 35-percent additional reduction. And State-timber export reductions from Washington and Oregon ports correspond to about 15 percent of all log exports from the region. The combined policy and planning changes affect about 6 billion board feet of timber activity in the Douglas-fir region, equal to about one-half of the harvest in the region.

Several previous studies have appraised portions of the economic consequences. The USDA Forest Service (1990a) gauged **domestic** effects of National Forest replanning, management of the spotted owl, and curtailment of State-sold log exports. Estimated were impacts on private harvests, wood product manufacture and prices, and direct and indirect employment. Counterpart reports were prepared by Beuter (1990) and Rasmussen (1990). They also recognized the outlook for lower harvests on private lands, distinct from the spotted owl issue. Olson (1990) estimated income and employment effects of the spotted owl strategy for 15 subregions within the strategy-affected territory. Economic impacts for Oregon were estimated,<sup>1</sup> Gilles (1990) did the same for California, as did Sommers and Briss (1990) for Washington, all focused on employment and income. Lippke and others (1990) drew on the three State-level studies in compiling a west coast impact report and continued the emphasis on a domestic chain of timber reductions and consequent economic and social effects.

Recent analyses have addressed **offshore** trade effects of an export embargo of logs from State-owned lands, and consequences of ending the export ban on Federal logs (Flora 1990, Flora and McGinnis 1989). The interagency economic report on reservations for spotted owls included an estimate of domestic economic effects of a total export embargo of western softwood logs as an additional scenario (USDA Forest Service 1990a). Earlier, studies were done on a complete embargo on log exports

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<sup>1</sup> Greber, Brian J.; Johnson, Norman K.; Lettman, Gary. 1990. Conservation plans for the northern spotted owl and other forest management proposals in Oregon; economic implications of changing timber availability. Corvallis, OR: Oregon State University, College of Forestry. (Draft)

(Darr and others 1980, Haynes 1976). Projections of export activity excluding new policy constraints also have been made (Flora and Vlosky 1986, Flora and others 1990). None of these studies used an analytical structure that deals with interactions among products and between the export and domestic markets.

## Procedure

The price and flow impacts that we wanted to examine required estimates of supply and demand in four market sectors—onshore (Douglas-fir region) lumber, onshore logs, exported lumber, and exported logs. For each sector we estimated supply and demand separately. Then, equilibrium prices and flows of timber products in each sector were calculated together, with the inter sector interactions that affect the whole system being considered. Base-case calculations were made first, by using our estimates of external factors, like housing starts and exchange rates, for 1990. Then the several policy changes were inserted, separately and together, and the new equilibrium of the system was recalculated. The work was done with eight simultaneous equations (described in the appendix).

The process is illustrated graphically in figure 1; the situation is portrayed as it would have been in 1990 without the policy changes. The four frames represent log and lumber markets, onshore and foreign. The positions and slopes of the curves derive from the equations of the model. "Domestic" and "onshore" allude to activity in the Northwest, defined earlier. "Foreign" and "offshore" refer to export prices and shipments destined for export. Panel D shows our estimated demand and supply curves for export logs. Offshore log demand is net demand facing the Northwest and accounts for consuming countries' purchases less other producer countries' sales. Export prices pertain to inland log yards rather than ports, to make the prices comparable with prices of logs destined for domestic manufacture.<sup>2</sup> Prices and volumes were derived from U.S. Customs data, as reported by the Census Bureau (U.S. Department of Commerce, Bureau of the Census, various years).

Panel C portrays the domestic log market. Total supply corresponds to timber harvests, as reported by state forestry agencies (informally for 1990 for this study). This panel refers to logs at the first point where they are marketed, usually close to the woods.

Domestic lumber supply and demand (panel A) are based on Northwest lumber shipments to points within the United States. Data are from the Western Wood Products Association (various years).

Panel B is the lumber counterpart to panel D. The export premium was judged small enough, however, as to require no adjustment for comparability with domestic lumber. Data are from the same sources as panel D.

Intersections of the curves in each panel were calculated, for individual years, by simultaneous solution of the equations in all four panels. For instance, the indicated 1990 average price for domestic lumber (in panel A) was \$309, with 7.76 billion board feet shipped from the region.

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<sup>2</sup> Flora, Donald F.; McGinnis, Wendy J. 1990. The export premium. On file with: Pacific Northwest Research Station, Forestry Sciences Laboratory, 4043 Roosevelt Way NE, Seattle, WA 98105.

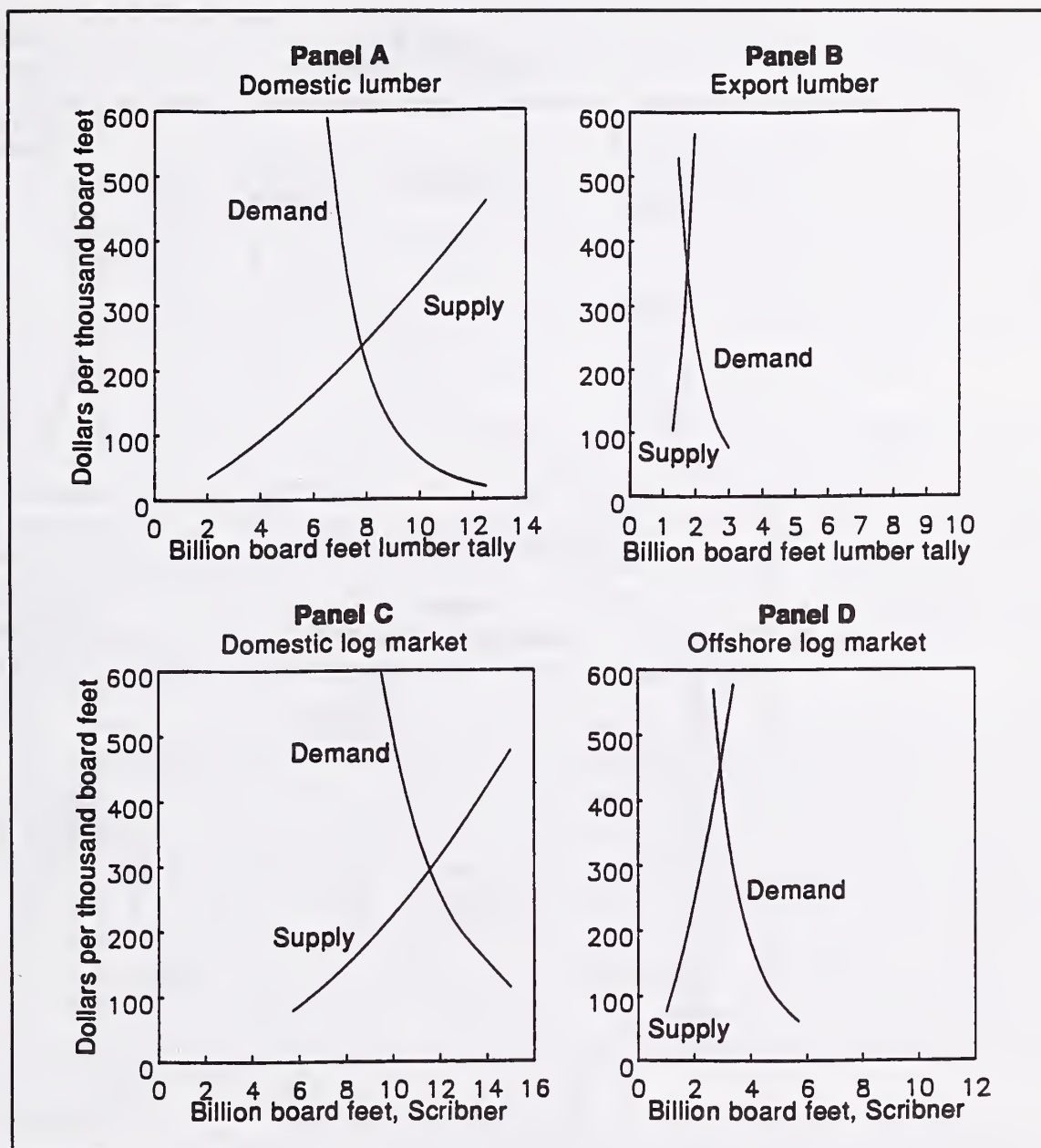


Figure 1—Four market sectors, before a policy change.

Figure 2 illustrates a hypothetical policy-based change in Northwest timber supplies. Dashed curves are the postpolicy positions. The logic starts in panel C, with an assumed 30-percent reduction in timber supplies because of, say, land-use diversions. In economic terms, that produces a 30-percent leftward shift in the log supply curve, thereby indicating that at any price, fewer logs will be offered (or equivalently, the old volume can be purchased but at higher prices). A new price-volume intersection occurs in the domestic log market, a change that induces leftward shifts (supply reductions) in both the export-log supply curve in panel D and the domestic-lumber supply curve in panel A.

The lumber export supply curve of panel B changes concurrently because it is affected by the domestic-market changes of panel A. In this example, the export supply of lumber tightens because log supplies for lumber manufacture have shrunk. Offshore lumber demand expands (panel B), however, because fewer logs are available to overseas customers. On balance, exports of lumber shrink with a considerable price increase.

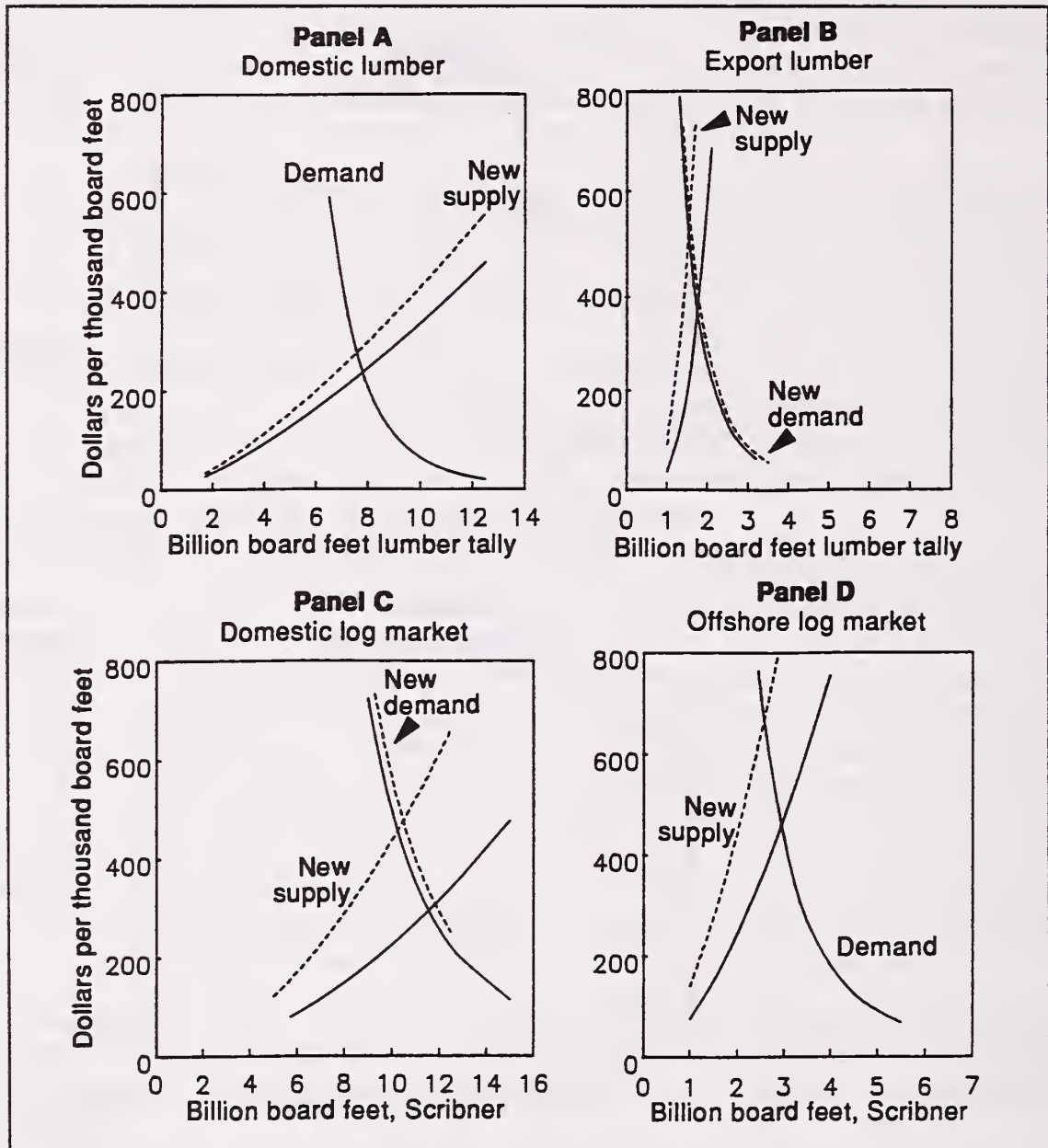


Figure 2—Four market sectors after a change in the domestic log supply.

Onshore, lumber moving to the domestic market declines, with rising prices (panel A). These price increases excite a demand increase for logs by lumber producers, which is reflected in a rightward log-demand shift in panel C. Log sellers receive higher prices; whether their revenues increase depends on the slopes of the curves as volumes decline. The same applies to lumber producers.

### Framing the Problem: Policy-Driven Supply Reductions

Reported impacts of recent policy changes have invariably been expressed in terms of volumes of timber cut or sold. Even for public lands where allowable sale quantities are set in advance, the amounts actually cut depend on market conditions. At least in the short term, other ownerships may provide offsetting supplies. Our model replicates these market characteristics as rightward-sloping supply curves (fig. 1, panel C), with higher prices inducing larger volumes.<sup>3</sup> Statements about volume impact actually allude to shifts of supply curves, as in figure 2. A leftward shift of a supply curve along an other-than-horizontal demand curve causes their intersection to move by less than

<sup>3</sup> Our equations have price elasticities of 0.59 and 1.09 for stumpage and log export supplies, respectively.

the supply shift. Thus, in general, a stated supply change generates an actual volume change of smaller magnitude; for instance, the 30-percent supply change hypothesized in figure 2 generated, in our model, a harvest change of 8 percent.

With the Forest Resources Conservation and Shortage Relief Act of 1990 (U.S. Congress 1990), Congress halted exports of most State-sold logs. Excepted were Alaska (irrelevant to this study) and one-fourth of the harvests of State-owned timber in Washington. We estimated that, at 1990 prices, total State-sold timber exported from the Douglas-fir region would decline by about 450 million board feet, or about 15 percent of softwood log exports from the region. In figures 1 and 2, this would be reflected in a leftward shift of the export log supply curve in panel D.

The current round of replanning on National Forest lands coincides with a revised outlook for harvests on private lands, thereby reflecting the evolution of wood-products markets and timber use. These changes generally predate, and are separate from, the spotted owl Habitat Conservation Areas (HCA) reservations. For replanning impacts on Federal lands, we relied on USDA Forest Service (1990b) estimates. Our estimates for private and State lands came from Beuter (1990) and Rasmussen (1990). We estimated a regional harvest reduction, at 1990 prices, of about 2 billion board feet annually, or about 18 percent.

The report of an interagency scientific committee on a conservation strategy for the northern spotted owl was released in mid-1990 (Thomas and others 1990). Specific geographic zones, mostly on public old-growth lands, were proposed for owl-habitat reservations. Additionally, revised harvest scheduling was proposed for lands, private and public, considered essential to restoring viable owl populations. Effects of the strategy on timber harvests were estimated for this study from USDA Forest Service data (1990b) and reports of consultants (Beuter 1990, Rasmussen 1990). First, we counted annual harvest impacts on public lands only, amounting to about 1 billion board feet after reductions for replanning. This harvest level is about 26 percent below the 1990 level (at 1990 log prices) absent replanning; it is about 11 percent below the replanning level.<sup>4</sup>

Finally, we estimated the combined impact of replanning with reservations for spotted owl on private as well as public lands. The harvest reduction at 1990 prices apparently would be about 47 percent relative to a nonreplanned situation, or about a 35-percent reduction relative to replanned harvests.

Our model draws on annual-average market data (for 1962-89). Use of annual data implies that the model is pertinent to short-term impacts, on the scale of a year. Our results address the question of what would have happened, in 1 year, if all the policy changes had occurred in 1990 and if the impacts were fully experienced in that year.

In the base-level (1990) column of table 1, volumes are in billions of board feet (Scribner for logs, lumber tally otherwise); prices are in U.S. dollars per thousand board feet. The other three columns list percentage changes, relative to 1990 volumes and prices, attributable to the policy combinations shown.

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<sup>4</sup> For National Forest, our "replanning" level corresponds to the widely discussed 3.4 billion board feet pertinent to the Pacific Northwest Region; our "owl reservations" level is consistent with 2.6 billion board feet for the Pacific Northwest Region.

## The State-Log Export Restriction

## Replanning

## Spotted Owl Reservations

## Short-Term Market Effects

**Table 1— Short-term market effects**

Sector volume or price	Base level (1990)	Replanning (all lands) and embargo	Owl (public lands), replanning (all lands), and embargo	Owl (all lands), replanning (all lands), and embargo
<i>— — — Percent change from base level — — —</i>				
All-owner harvest	11.54	-5	-8	-16
Log export volume	2.92	-12	-16	-25
Lumber shipments	7.76	-2	-3	-5
Lumber export volume	1.76	-3	-7	-16
Domestic log prices	293	+30	+52	+135
Export log prices	450	+48	+66	+137
Domestic lumber prices	309	+9	+14	+31
Export lumber prices	336	+24	+43	+116

## Long-Term Market Reactions

Our study pertains to 1990 and 1991—what timber prices and flows would have been if these policies had been put into place in those years. To some extent, however, the estimated policy-caused market effects were already occurring in anticipation of these and perhaps other limitations on harvests and log exports. And it is possible that anticipatory log inventory accumulations overseas will lead to a drop in purchases as inventories are reduced in the face of declining demand, thereby restraining prices rather than pressing them upward. To deal with both possibilities, we included in our model several lagged variables, which make estimates of the policy impacts for this year partly dependent on the levels for last year of those variables.

Anticipations aside, the sharp shortrun market reactions to new policies can be expected to subside over time, even if background economic conditions do not change. In particular, the price spikes induced by sudden shortage are already being truncated as log and lumber suppliers and their customers reach farther for material, and as buyers move to ensure their market shares by securing contracts of longer duration.

By recasting the equations slightly and assuming that markets will respond at a geometric rate—rapidly in early years and more slowly later—we could estimate, from past market response data, the long-term elasticity of supply and demand in all four of the market sectors of figure 2, the rates of market adjustments, and their eventual price and production targets.<sup>5</sup>

In general, longrun supply and demand curves are flatter than those pertinent to a single year, which reflects the ability of higher prices to draw larger supplies as time passes, and the ability of buyers to shrink eventually from high-cost sources. Supply and demand have time to become more “elastic.” This is illustrated in figure 3, where panel A repeats the shortrun market for export lumber, first shown in panel B in figure 2. The second panel of figure 3 shows the more elastic longrun supply curve.

Table 2 lists the estimated longrun quantities and prices as percentage changes from 1990.

After mid-1990, economies of the Pacific Rim in general, and the U.S. timber industry in particular, moved downward significantly. By early 1991, building activity in the United States reached its lowest level in a decade, and construction in Japan had reversed its upward trend. Wondering how much the recession in demand might alter the effects of timber supply policies, we recalculated shortrun impacts based on the assumption that early-1991 economic conditions would prevail all year. Then we developed table 3 which compares our 1991 economy policy-change results with the prepolicy timber markets of 1990. As would be expected, price increases here are mostly lower than in table 1, and volume declines are greater. Lumber exports increase, however, because of the weak U.S. market and policy-constrained log exports.

All the volume effects estimated in our analyses were smaller than the supply shifts triggering the changes. For instance, a planning-driven change of 18 percent in log supplies (at current prices) generated only a 5-percent change in actual harvests. This reflects the reality, mentioned earlier, that because price increases are generally substantial, volume changes are muted by price-induced expanded offerings from other sources.

Effects of the policy changes also will be much greater on log prices than on log volumes, in both the domestic and export markets. The policies already firmly in place—replanning and the export embargo—are expected to jointly press domestic log prices up by a third in the short run. Addition of the spotted owl strategy for public lands raises the price changes by more than one-half, and imposing the strategy on private lands more than doubles log prices. Volume changes range from one-twentieth to one-fourth. These conclusions are consistent with the price-inelastic nature of log supply and demand in regional markets.

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<sup>5</sup> Technically, we performed Koyck-type transformations, with the assumption that the rate of elasticity adjustment will be constant among the explanatory variables within each equation (Johnston 1984).

## Effects of a Weakening Economy

## Discussion

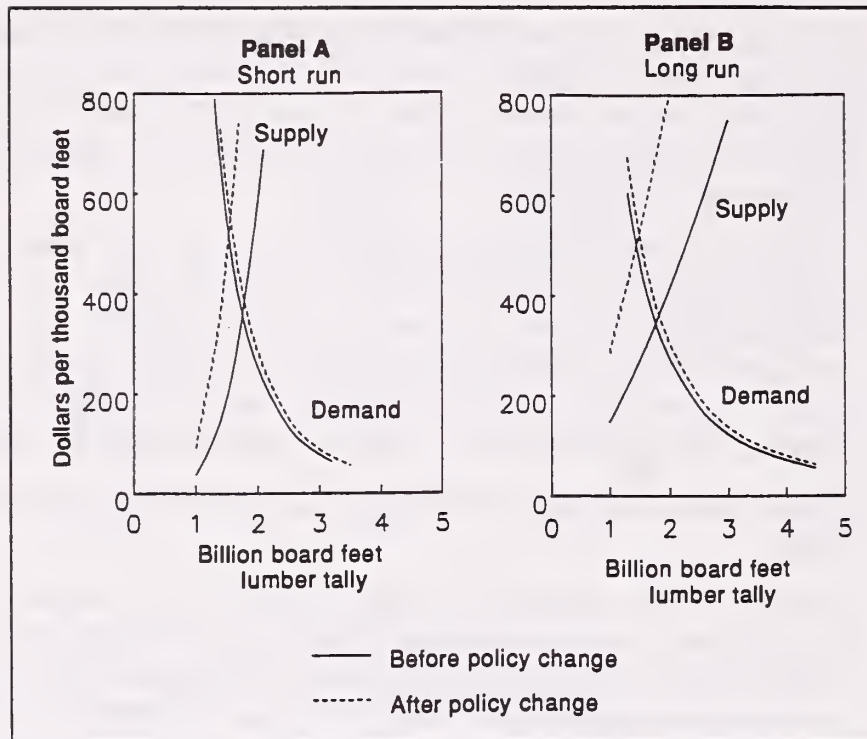


Figure 3—Shortrun and longrun market developments.

The export premium for logs—the difference between export and domestic prices—is expected to increase, as the tabulated results show. This result is attributable to the export-embargo trade barrier. Any policy impeding trade for a part of the resource can be expected to enhance prices of the exportable portion relative to the constrained part. Acting alone, the export embargo will depress domestic log prices (Flora and McGinnis 1989), but that effect is overridden (in our results) by log scarcity deriving from replanning and owl strategies.

The disproportionate changes in volumes and prices generate increased revenues for sellers. For instance, the combination of replanning and the log-export embargo is projected to increase payments to log sellers in the domestic market by 24 percent and by 30 percent for those who export logs. Shippers of lumber to the domestic market receive about 7 percent more, and the export lumber market generates about 20 percent more, all despite lower production. Buyers, conversely can expect to pay more for less wood; other things equal, mill managers will see raw material costs rising both in absolute terms and as a share of total production costs.

A cost-price squeeze on U.S. lumber producers is apparent. With all the policies in place, shortrun domestic log prices are estimated to more than double while domestic lumber prices rise by less than a third. Assuming that our export prices are akin to those experienced in other countries, with prices equalizing around the Pacific Rim, a similar squeeze confronts foreign lumber manufacturers; certainly those using North American timber. Whether individual firms can endure the squeeze depends on many factors, including how much product they can produce per unit of logs, the efficiency with which they do it, their log mix, energy costs, remoteness, and market niche.



**Table 2—Long-term quantities and prices**

Sector volume or price	Base level (1990)	Replanning (all lands) and embargo	Owl (public lands), replanning (all lands), and embargo	Owl (all lands), replanning (all lands), and embargo
<i>--- Percent change from base level ---</i>				
All-owner harvest	11.54	-4	-6	-12
Log export volume	2.92	-11	-14	-23
Lumber shipments	7.76	-1	-2	-3
Lumber export volume	1.76	-3	-8	-21
Domestic log prices	293	+16	+26	+60
Export log prices	450	+27	+37	+68
Domestic lumber prices	309	+5	+8	+17
Export lumber prices	336	+19	+36	+101

As expected, lower log exports press lumber exports upward. As timber harvests drop, however, both log and lumber exports fall; log exports fall farther. Foreign customers respond to higher log prices and lower supplies by shopping for logs, as well as lumber, elsewhere. Canada and several Pacific Rim countries can be expected to respond to part of the increased demand to an extent estimated previously (Flora and Vlosky 1986).

Domestic lumber prices and shipments are affected markedly less than all export lumber prices. This occurs because different products are involved. Old-growth figures prominently in buying by offshore customers, as do large-dimensional cants and scantlings. For these products competition comes almost solely from British Columbia and Alaska. Domestic lumber purchasers, whose market basket includes a much smaller proportion of old growth, can and do reach into many source regions, both in North America and abroad.

**Table 3— Effects of 1991 policy change**

Sector volume or price	Recession effect only	Recession, replanning (all lands), and embargo	Recession, owl (public lands), replanning (all lands), and embargo	Recession, owl (all lands), replanning (all lands), and embargo
<i>— — — Percent change from base level — — —</i>				
All-owner harvest	-7	-12	-15	-22
Log export volume	-11	-22	-25	-34
Lumber shipments	-9	-10	-11	-13
Lumber export volume	+14	+10	+6	-4
Domestic log prices	-10	+18	+37	+113
Export log prices	-11	+31	+48	+111
Domestic lumber prices	-15	-7	-3	+12
Export lumber prices	-13	+9	+25	+89

Over longer periods, say 3 years, price effects are projected to subside as timber users find ways to avoid the costly wood products of the Northwest. Our analysis of the longrun projects a drop of about half in most of the near-term price spikes; for instance, as shown in the long-term tabulation, the 135-percent price spike for domestic logs is expected to subside to 60 percent. Even in the long run, price increases will be significant, although domestic lumber prices will be leveled considerably by supply competition from other U.S. regions. Longrun production and shipment reductions also will moderate; however, not much. Indeed, lumber exports are expected to increase despite reductions in harvests.

Replacement of policy-frozen timber from other sources may not be sustainable. Because of the substantial land set-asides involved in the policies assessed here, harvesting will be pressed onto a much smaller land base with finite inventories, which will greatly reduce opportunities for offsetting supplies from sources within the region. In an economic study of domestic market consequences of owl strategies, Haynes (USDA Forest Service 1990a) estimated that, by 2000, annual lumber

production in the Douglas-fir region will decline by about 25 percent in the face of replanning, owl management on public lands, and the State log embargo. That compares with our estimates of 3 percent for their shortrun (1-year) impact and 2 percent for the longer term (2-4 years).

The long-term price impacts of the Northwest timber supply circumstances seem variegated. Offshore, by 2000, expanded supplies of lower grade softwood timber may suppress prices of construction grades of lumber and small logs (Flora and Vlosky 1986). To some extent, these lower prices will radiate into the U.S. small-log market. As the decade proceeds, however pressures on the upper grade second-growth resource may exacerbate shorter run price impacts of regional timber policies (Flora and others 1991).

Alone, the spotted owl strategy evaluated here accounts for more than two-thirds of volume and price effects of the three supply-side policies. An exception is log exports, for which the fraction is about one-half.

As these several policies came into force in 1990-91, some of their impacts will have been obscured by falling demand, here and abroad. Thus there has been dispute over whether mill closures and job losses have been attributable to recession or new timber policies. A comparison of tables 1 and 3, policy impacts in an economically strong year (1990) with the impacts if imposed in a weak year (1991), shows that recession will account for a substantial share of the downshift in harvests and lumber shipments to domestic markets. As mentioned earlier, recession in the U.S. economy helps push lumber into the export market.

Without any policy changes, prices could be expected to fall, as much as 15 percent during the 1991 recession, as shown in table 3. All the candidate policies are expected to raise prices, however and the offsetting tendencies interact in complex ways. In general, policy constraints overwhelm effects of the weak economy, and prices rise on balance. Domestic lumber prices fall, though, except in the most severe policy case.

The latter part of 1992 may be strong economically. Too, some proposals for protecting the spotted owl are more restrictive on timbering than are the measures proposed by the interagency committee. Together, these circumstances clearly would produce log and lumber prices higher than any ever experienced in the domestic and export markets.

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## Appendix

An eight-equation system was developed to characterize Northwest timber markets. We included demand and supply functions for export logs, export lumber, stumpage, logs destined for onshore processing, lumber destined for export, and lumber bound for domestic markets.<sup>1</sup> Plywood and chips markets, important in themselves but modest relative to lumber activity in the Northwest, were not included. We did not differentiate high- and low-quality material to avoid encumbering the model. These equations pertain to shortrun (1-year) market behavior.

We present our eight shortrun equations, in pairs corresponding to the four sectors of figure 1. Not shown are slightly modified versions for 1991 and the long-term set of eight equations. Included are usual measures of statistical adequacy— $\bar{R}^2$ , DW, and F—with T-values in brackets.<sup>2</sup>

Data are annual, 1962-89.

### Domestic Lumber Shipments

#### Supply—

$$\text{LDOMSHIP} = 4.963143 + 0.7087583 \cdot \text{LRPLUMW} - 0.1487672 \cdot \text{LUSINTR}$$

[8.47]                      [7.83]                      [-4.39]

$$- 0.2890421 \cdot \text{LRAVGS2} + 0.2778664 \cdot \text{DUM8389} + 0.1961847 \cdot \text{LDOMSHIP}(-1)$$

[-3.81]                      [10.73]                      [2.69]

$\bar{R}^2 = 0.87$               DW = 1.37              F = 35

#### Demand—

$$\text{LDOMSHIP} = -1.804744 - 0.192612 \cdot \text{LRPLUMW} + 0.3782506 \cdot \text{LUSSTAR}$$

[-2.63]                      [-4.26]                      [9.79]

$$- 0.2075563 \cdot \text{LCALBUS} + 0.9680387 \cdot \text{LELBPRO} + 0.1579958 \cdot \text{LDOMSHIP}(-1)$$

[-7.76]                      [8.66]                      [2.20]

$\bar{R}^2 = 0.91$               DW = 1.70              F = 53

### Log Harvests

#### Supply—

$$\text{LPNWCUT} = 68.90618 + 0.5384052 \cdot \text{LRAVGS2} - 0.1234241 \cdot \text{LUSINTR}$$

[8.39]                      [5.89]                      [-2.19]

<sup>1</sup> In a variant of this model, we substituted supply and demand functions for log-for-processing, in place of stumpage supply and demand (McGinnis, Wendy J.; Flora, Donald F. 1990. Effects of a softwood log export duty on log and lumber markets in the Douglas-fir region and abroad. 12 p. On file with: Pacific Northwest Research Station, Forestry Sciences Laboratory, 4043 Roosevelt Way NE, Seattle, WA 98105.).

<sup>2</sup> The Durbin-h statistics was calculated for equations containing lagged endogenous variables. The test indicated that the domestic lumber supply equation should be considered to have serial correlation. The implication is that coefficients in that equation are less precise than implied by the T-values.

$$+ 0.3655499 \cdot \text{DUM8389} - 3.152598 \text{D-02} \cdot \text{YEAR} + 4.69382 \text{D-02} \cdot \text{DUM8589}$$

[6.08]                      [-7.32]                      [3.71]

$$\bar{R}^2 = 0.77 \quad \text{DW} = 2.05 \quad \text{F} = 18$$

**Demand—**

$$\text{LPNWCUT} = 2.620386 - 0.2754675 \cdot \text{LRAVGS2} + 0.3208677 \cdot \text{LRPLUMW}$$

[3.75]                      [-4.98]                      [4.86]

$$+ 0.4707686 \cdot \text{LDOMSHIP} + 0.2477398 \cdot \text{LPNWCUT}(-1)$$

[7.94]                      [3.61]

$$\bar{R}^2 = 0.89 \quad \text{DW} = 1.69 \quad \text{F} = 53$$

**Supply—**

$$\text{LWAOLBEX} = -253.1075 + 0.2537987 \cdot \text{LPNWLBRP} - 3.106296 \cdot \text{LDOMSHIP}$$

[-9.86]                      [1.75]                      [-5.07]

$$+ 4.167286 \cdot \text{LPNWCUT2} - 0.6441775 \cdot \text{LWAOLGEX} + 0.1271771 \cdot \text{YEAR}$$

[5.69]                      [-3.65]                      [10.08]

$$\bar{R}^2 = 0.90 \quad \text{DW} = 2.23 \quad \text{F} = 46$$

**Demand**

$$\text{LWAOLBEX} = 8.433824 - 0.357596 \cdot \text{LPNWLBRP} - 0.3541627 \cdot \text{LWAOLGEX}$$

[5.39]                      [-3.91]                      [-3.38]

$$- 1.411111 \cdot \text{LREXCHJ} + 2.20045 \cdot \text{LAUSTGDP} + 0.4051638 \cdot \text{LJINTR60}$$

[-8.79]                      [10.40]                      [6.06]

$$- 0.2072283 \cdot \text{LJLBRINV}(-1)$$

[-4.41]

$$\bar{R}^2 = 0.95 \quad \text{DW} = 1.86 \quad \text{F} = 88$$

**Supply—**

$$\text{LWAOLGEX} = -52.39835 + 0.6076288 \cdot \text{LPNWL50} + 0.5871289 \cdot \text{LPNWCUT}$$

[-2.43]                      [2.23]                      [2.04]

$$- 0.6362146 \cdot \text{LRAVGS2} + 2.564082 \text{D-02} \cdot \text{YEAR} - 4.700412 \text{D-02} \cdot \text{DUM8589}$$

[-1.68]                      [2.54]                      [-1.36]

$$+ 0.4598234 \cdot \text{LWAOLGEX}(-1)$$

[2.92]

$$\bar{R}^2 = 0.88 \quad \text{DW} = 2.02 \quad \text{F} = 30$$

**Lumber Exports**

**Log Exports**

**Demand—**

$$\text{LWAOLGEX} = -5.083745 - 0.3341621 \cdot \text{LPNWLG50} + 1.174772 \cdot \text{LJAREA}$$

[-3.99]                      [-2.90]                      [7.47]

$$+ 0.7278733 \cdot \text{LJAINDP} - 0.156427 \cdot \text{LREXCHJ} - 0.1291649 \cdot \text{LJLOGINV}(-1)$$

[10.93]                      [-1.41]                      [-1.91]

$\bar{R}^2 = 0.96$                       DW = 1.68                      F = 111

**Variable Definitions**

DUM8286	Dummy for divergence between price and volume of log exports from 1982 to 1986.
DUM8389	Dummy for structural shift after 1982 recession.
DUM8589	Dummy for structural shift in export lumber market, starting in 1985 and continuing through 1989.
LAUSTGDP	Natural log (ln) of real Australia gross domestic product.
LCALBUS	Ln of U.S. lumber imports from Canada.
LDOMSHIP	Ln of lumber shipments from Douglas-fir region to all U.S. destinations.
LELBPRO	Ln of non-Douglas-fir region softwood lumber production.
LJAINDP	Ln of Japan industrial production.
LJAREA	Ln of Japan floor area.
LJINTR60	Ln of Japanese interest rate.
LPNWLBPR	Ln of real price of Oregon-Washington softwood lumber exports.
LPNWLG50	Ln of real price of Oregon-Washington softwood log exports adjusted downward \$50 per million board feet for extra sort and haul.
LRAVGS2	Ln of real average price of Douglas-fir and hemlock no. 2 saw logs (Industrial Forestry Association data, water and inland sales).
LREXCHJ	Ln of real U.S.-Japan exchange rate.
LPNWCUT	Ln of all-owner harvest in western Washington and western Oregon.
LRPLUMW	Ln of real domestic lumber price for Douglas-fir region.
LUSINTR	Ln of U.S. interest rate.
LUSSTAR	Ln of U.S. housing starts, all private.
LWAOLBEX	Ln of Oregon plus Washington softwood lumber exports.
LWAOLGEX	Ln of Washington plus Oregon softwood log exports.
YEAR	Year (trend variable).





**Flora, Donald F.; McGinnis, Wendy J. 1992.** Effects of new export rules, a spotted owl plan, and recession on timber prices and shipments from the Douglas-fir region. Res. Pap. PNW-RP-445. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 15 p.

Several recently emplaced and potential Northwest timber policies are causing considerable market turbulence. Estimated were price and volume changes induced by three supply-side policies (a state-log export embargo, forest replanning, and spotted owl reservations) and the demand slide of 1990-91. Impacts were gauged separately and together by using a four-sector model encompassing interactions between Pacific Rim and onshore markets and between logs and lumber. Log prices are expected to rise markedly despite the industry recession. Shipments onshore and abroad are declining, and our analysis offers little encouragement for stability. The log-lumber cost-price squeeze will not abate soon, and the capacity of the region to supply wood products demands onshore and abroad will diminish markedly, although by less than reductions in planned harvests would suggest.

**Keywords:** Markets (external), supply and demand (forest products), trade (Pacific Rim), log exports, lumber exports, spotted owl, forest planning.

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