

Clearwood Quality and Softwood Lumber Prices: What's the Real Premium?

Thomas R. Waggener, *College of Forest Resources, University of Washington, Seattle, WA 98195*, and **Roger D. Fight**, *USDA Forest Service, Pacific Northwest Research Station, Portland, OR 97208*.

ABSTRACT: *Diminishing quantities of appearance grade lumber and rising price premiums for it have accompanied the transition from old-growth to young-growth timber. The price premiums for better grades are an incentive for producers to undertake investments to increase the yield of those higher valued products. Price premiums, however, are also an incentive for users to substitute lower grades, lower priced species, or nonwood materials for these higher priced appearance grades. This possibility may cast doubt on the permanence of the price premiums associated with appearance grade lumber. The real price premiums paid for appearance grades of lumber from January 1989 through October 1995 were substantial and quite stable during a widely fluctuating softwood lumber market. We found little or no evidence to suggest that these premiums are either "temporary" or are in decline. Although care is required in extrapolating these findings over future long time horizons typically required for silvicultural investments in wood quality changes, the results of this study may help forest managers better understand the possible magnitude of real price premiums to use in evaluating those investments. West. J. Appl. For. 14(2):73-79.*

To better meet the wood quality needs of the wood processing industry, foresters in the Pacific Northwest are currently assessing whether intensive silvicultural treatments such as thinning and pruning represent a viable economic strategy for producing increased volumes of higher valued clearwood lumber. Recent research indicates that intensive forest management is probably the best method for improving the quality of timber derived from forest plantations, potentially increasing the gross value of the resource and perhaps generating a higher net return on forest investments (Cahill et al. 1986, Cahill et al. 1988, Cahill 1991, Fight et al. 1992, Haynes and Fight 1992, Fight et al. 1993). The decision to adopt intensive silvicultural practices is ultimately influenced by many factors, including what timber quality attributes will be valued by end users and to what extent those users are willing to pay a higher price for these attributes (Briggs 1995, Fahey and Willits 1995, Horgan 1995).

Price trends for appearance grade lumber suggest that greater returns might be derived through intensive forest management practices selected to increase wood quality rather than simply volume growth in the Pacific Northwest (Somerville 1988, Fight et al. 1993, Mitchell and Polsson 1993). Despite this, questions arise as to whether secondary manufacturers and consumers will be willing to utilize clearwood from fast grown plantations and whether recent

price premiums for higher grades of appearance grade softwood lumber will likely be sustained with an increase in second-growth timber.

Clearwood and Wood Quality

Manufacturers of secondary softwood forest products in the United States have traditionally relied on readily available defect-free, straight-grained lumber, primarily derived from high-quality large-diameter, old-growth timber. The availability of high-quality appearance grades of softwood lumber, often referred to as "clearwood," has influenced the perceptions of "quality" held by both manufacturers and users of wood. "Appearance grade" lumber, as used here, represents those lumber grades without visual defects (Selects) or other grades of lumber that are generally ripped lengthwise to produce moulding products requiring clear lengths of visually defect-free stock as well as those product grades yielding appearance grade "shorts" cross-cut from primary lumber stocks. This concept of "appearance grades" thus refers to the attributes of the end product rather than the initial lumber cutting stock.

As the quality structure of forest resources changes, however, secondary forest product manufacturers are encountering increasing difficulty in obtaining reliable supplies of clearwood lumber products derived from old-growth resources. Private supplies of old growth are greatly diminished. Court decisions and federal legislation have resulted in substantial decreases in timber harvests, particularly old-growth timber, from public forests in the Pacific Northwest.

NOTE: Thomas R. Waggener is the corresponding author and can be reached at (206) 543-8151 and waggener@u.washington.edu. This paper draws on cooperative research undertaken by CINTRAFOR, University of Washington, and the USDA Forest Service, Pacific Northwest Research Station.

Because of the reductions in public harvests, wood processors in the Pacific Northwest have increased their reliance on timber harvested from private forest lands. Private timber harvests as a percentage of the total harvest in Washington and Oregon increased from nearly 50% in 1988 to 74.9% in 1997 (Warren 1998). Logs obtained from these private forests tend to be smaller and frequently of lower average quality than old growth obtained from public forests (Flora 1986, Mitchell et al. 1989, Robinson 1992, Tomasko 1992). Overall, the proportional yields of higher grade products have fallen sharply in terms of total lumber production since the early 1980s.

Clear softwood lumber has been defined historically as knot-free, straight-grained wood with narrow growth rings, suitable for both appearance and structural end-use applications (Anonymous 1992). Clearwood has been changing, however, reflecting the structural change of Pacific Northwest forests from old-growth to a second-growth plantation resource. In comparison to old-growth forests, wide growth rings, more knots, and different physical and mechanical properties characterize plantation-grown timber. These differences can be attributed to the faster growth rates of trees in plantations, different earlywood-latewood ratios, and a higher proportion of juvenile wood. The differences between old-growth timber and plantation timber extend beyond appearance to include strength properties, physical properties, and processing characteristics. As a result, the clearwood resource derived from intensively managed second-growth forests differs substantially from old-growth clearwood.

Changes in the total timber supply as well as in the quality composition have contributed to lumber market price instability, characterized by relatively large price fluctuations for lumber products at the national level (Irland et al. 1993, Anonymous 1994). For example, the nominal price of Douglas-fir (*Pseudotsuga menziesii*) structural timber increased 58% between 1988 and 1993, while nominal prices for ponderosa pine (*Pinus ponderosa*) No. 2 5/4 Shop grade lumber increased 59% over the same period (Warren 1995). Lumber prices have since declined as the market responded to demand uncertainties. Expectation of continuing future price instability contributes to the desire of secondary manufacturers to seriously consider alternative lumber species and grades and to potentially substitute nonwood materials to maintain a competitive foothold in the U.S. marketplace.

In response to recent U.S. lumber price trends, some secondary manufacturers who have traditionally used appearance grade lumber from the Pacific Northwest also have turned to other global suppliers to supplement lumber supplies. Competition from global suppliers may dampen relative price movements for appearance grade softwood lumber in the future or at least may moderate upward real price trends. New suppliers are able to now penetrate U.S. markets. Increasing production from radiata pine (*P. radiata*) plantations in New Zealand, Chile, and South Africa, and the maturing of southern pine (*P. palustris*, *P. echinata*, *P. taeda*, and *P. elliottii*) plantations in the southeastern United States, southern Brazil, and Argentina potentially could replace the declining production of clearwood from traditional Pacific

Northwest old growth. These new suppliers will help to moderate future timber supply volatility and will contribute to the supply of clearwood products available to secondary wood manufacturers (Sohngen and Haynes 1994).

Analysis of Clearwood Consumers and Prices

Both secondary manufacturers and consumers are often willing to pay a higher price for appearance grade lumber to obtain specific product attributes, such as no knots, longer lumber lengths, narrow growth rings, or uniform moisture content. The perceived quality of lumber is measured relative to the consumer's perception of both tangible and intangible product attributes. Where premiums in price for similar products persist over time, the products are assumed to be at least partially differentiated.

Individual product attributes may not be equally important for all products, end uses, or markets, and the importance of various attributes can differ drastically by end user (Adams et al. 1992). Nevertheless, specific product attributes are reflected in different lumber grades that are assumed to account for most of the price variation within the aggregate softwood lumber market at any given time. Price premiums among products also can vary dramatically over time depending on changes in prevailing market conditions, as well as intrinsic softwood product attributes and the buyer's perceptions of the unique value of these attributes. This is demonstrated by the greater price volatility of higher grade lumber products when compared to the price levels of lower grade lumber products (Irland 1994).

Many manufacturers have recognized that the average quality of wood contained in most lumber grades is not the same as that which could be purchased a few years ago (Haynes and Fight 1992, Fryer 1995). This further obscures important quality and price information even when specific lumber grade price data are available. The substitutability of second-growth and alternative nonwood products for old-growth appearance grade lumber will ultimately determine whether recent real price trends and premiums for quality are likely to continue into the future. A short-term increase in the absolute price for appearance grade lumber, however, does immediately result in raw material substitution. Competitive substitution occurs over several periods and depends on an awareness of a sustained change in the relative price between two products, the likely magnitude of the price premium, and the transitional costs associated with the raw material substitution process. Relative price changes that are expected to persist over the longer term can be expected to encourage manufacturers to look for substitutes (McKillop et al. 1980, Irland 1994).

Research Approach

Perceptions of lumber quality attributes by end users of appearance grade lumber and the price trends in selected softwood lumber markets were investigated by Eastin et al. (1996). This research examined the nature of price differentiation based on appearance grade lumber utilizing wholesale (F.O.B.) prices.

A time series of biweekly lumber price data covering a recent lumber market cycle was constructed for January 1989 to October 1995 in order to identify the real price premiums obtained for various appearance grade lumber products. Limited spot market price information was available for specific product and grade combinations. Price data for wholesale prices as reported by Crow's Market Report (1989–1995) were used.

Price premiums obtained for appearance-grade products relative to standard lumber grades form the basis for distinguishing between the willingness to pay for the actual “bundled” quality attributes that are important to secondary manufacturers and end users. Products were specified by species, production region, product size, and grades. This period reflects the typical cyclic volatility of softwood lumber markets and coincided with the heightened market interest in new species and products from second-growth materials as well as potential nonwood product substitution as revealed in the survey of secondary manufacturers (Eastin et al. 1996).

To minimize the apparent effects of inflation, nominal spot prices were converted to January 1995 real prices for ease of interpretation. The U.S. Department of Labor price index for all intermediate materials was used to adjust all nominal spot prices.

The products included in this analysis were chosen to represent a wide variety of grades and species in major timber regions (Table 1). Ponderosa pine was selected because it is the traditional species used to manufacture moulding and millwork products. Douglas-fir has also traditionally supplied old-growth appearance grade lumber. Southern pines and radiata pine, however, are now emerging as viable, low-cost alternatives to western pines in the moulding and millwork market. Although technical challenges still exist regarding drying and stability, many firms in the Pacific Northwest are using these species to produce moulding products (Anonymous 1994).

This analysis tracked the price premiums in terms of real prices among grades over the market cycle to determine the stability and trend in price differentiation. As such, this analysis does not seek to explain or model the underlying market cycle in lumber prices in terms of supply or demand determinants but rather focuses on the behavior of prices as the market fluctuates. Price differences are expressed as the real price premium, defined as the differences in real prices (inflation-adjusted) between the higher quality appearance grades and a selected lower valued structural commodity lumber grade representative of the particular species. This measure of price differentiation is the most relevant to evalu-

ating potential returns from intensive forest management regimes that are considered in large part for their potential for increasing the proportional yield of higher quality timber. It is this premium that economically justifies investments in silvicultural practices designed for quality rather than the quantity of yields. Future price trends and product differentiation of appearance grades based on second-growth substitution from the Pacific Northwest will, therefore, be critical to those making investment decisions designed to increase yields of higher grade products in the Pacific Northwest.

Results

The consideration of the price trends for softwood lumber products reflects several important questions relevant to forest investments. Perhaps the most important is whether markets can be anticipated to generally move toward increasing real prices and real price premiums for high-quality lumber products. The survey of secondary manufacturers who use clearwood indicated that they are indeed concerned about increasing clearwood prices and have begun to respond to those higher prices by substituting alternative products that provide an acceptable mix of quality attributes previously associated with appearance grade lumber.

Real Prices for Appearance Grade Softwood Products within Species

Ponderosa Pine

Ponderosa pine is a major clearwood species because the higher grades have traditionally been valued as a superior raw material for the production of moulding and millwork products. The Moulding and Select lumber grades are particularly appropriate for these industries. Ponderosa pine harvested in the Pacific Northwest is generally higher grade, more expensive, and in short supply relative to clearwood production in other supply regions including the U.S. South and Southwest. A substantial difference in real spot prices existed between the appearance and lower grades of ponderosa pine products. Real prices (January 1995 dollars) for ponderosa pine lumber products ranged from \$195/mbf to about \$2,870/mbf over the market period 1989–1995. Peak real prices of \$2,872 were observed for ponderosa pine C & Better (1 × 6) in April 1993, closely linked to the peak price of \$2,742 for Moulding & Better (1 × 6) grades at about the same time. The average real price for (1 × 6) C & Better over the 6 yr period was \$1899/mbf, \$367 more than the average real price (\$1,532) for the 5/4 Moulding & Better.

Table 1. Products chosen for the price trend analysis, by species and grade.

Ponderosa pine	Douglas-fir	Southern pine
Moulding & Better 5/4	Moulding & Better 5/4	Moulding & Better 5/4
Selects 1 × 6	N/A	Selects 1 × 6
Shop 5/4	Shop 5/4	Shop 5/4
Commons 1 × 6	Standard & Better 1 × 6	Commons 1 × 6
N/A	Utility 2 × 4	Utility 2 × 4
N/A	Framing RL 2 × 4	Framing RL 2 × 4

The higher valued product grades also exhibited greater price volatility than the lower priced structural or construction grades. This greater volatility of prices for appearance grades is especially important to the manufacturers of specialized secondary products including moulding, windows, and doors.

Douglas-Fir

Spot prices for appearance grade Douglas-fir only have been separately reported since July 1992. The average real price of Douglas-fir 5/4 Moulding & Better was \$1,201 between mid-1992 and 1995 (Figure 1). In comparison, Douglas-fir 5/4 #3 Shop, from the beginning of July 1992 until October 1995, averaged only \$551/mbf, indicating a clear differentiation between these two appearance grade product grades, with each product serving different markets. The 5/4 Moulding & Better tends to be used for mouldings as a stain grade, and the 5/4 #3 Shop is used primarily as a paint grade for door jambs and similar products because of the numerous knots allowed in this grade. The Douglas-fir (1 × 6) Standard & Better, used generally for specialty products such as hand rails, ranged in real price from \$169 to \$427/mbf, averaging \$272/mbf. Peak real prices for Douglas-fir were reached in late spring of 1993 for 5/4 Moulding & Better grade lumber (\$1,627/mbf) and 5/4 #3 Shop grade lumber (\$853/mbf) followed by secondary peaks in late 1993 and the beginning of 1994.

Finally, the real prices for Douglas-fir Standard & Better 2 × 4 remained relatively flat in the \$230–360/mbf range throughout the 1989–1992 period, then rose through early 1993, reaching a peak of \$564 in March 1993. Although the real price changes for this structural grade lumber were relatively small compared to the higher valued lumber grades, the range in real price (low to high) for this grade exceeded 145%. The Standard & Better 2 × 4 lumber grade was selected as an appropriate indicator product for the aggregate western softwood lumber market because this product, together with other light framing grades, constituted over 55% of the Douglas-fir lumber production volume at the end of 1994–1995. It is perhaps this product and market segment (light structural framing

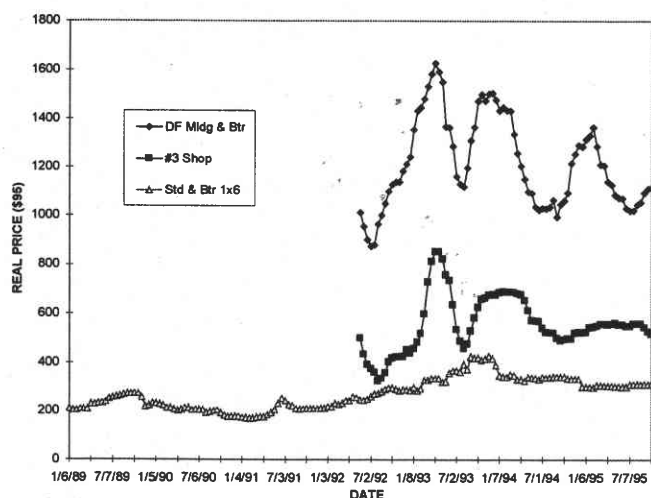


Figure 1. Douglas-fir real price trends

lumber) that most frequently characterizes the perception of the general softwood lumber market.

Southern Pine

Southern pines (*P. palustris*, *P. echinata*, *P. taeda*, *P. elliotii*) have recently attracted more interest as the volume of appearance grade lumber has increased. The average real price for 1 × 6 C & Better southern pine was \$741/mbf, which was clearly differentiated from the other southern pine products. Only limited price data were available for southern pine Moulding & Better grades, which averaged between \$1,023–\$1,155/mbf during the period of analysis. The 5/4 #3 Shop moulding lumber grade also was somewhat differentiated from the lower grade products but was not subject to the same volatility as the Standard & Better 2 × 4 lumber, although prices for #3 Shop were available only beginning with July 1994 reporting. Real spot prices for Standard & Better 2 × 4 were moderately stable from 1989 through mid-1992, ranging from \$210 to \$320/mbf. Since then, real prices have fluctuated but generally have trended upward, peaking toward the end of 1993 at about \$538 and thereafter declining to below \$400 throughout most of 1995.

Real Price Trends Between Species by Product-Grade Category

Shop Grades

A comparison was also made of real spot F.O.B. prices for #3 Shop grade for ponderosa pine, Douglas-fir, and southern pine, although only ponderosa pine prices were available for the full observation period. Douglas-fir prices were first reported in May 1992, and prices for southern pine shop grades were not reported until May 1994. Hence, species comparisons are limited to the more recent market period. Real prices for ponderosa pine #3 Shop grades generally rose over the observed period, starting at \$440/mbf in January 1989 and increasing to \$780/mbf in April–May 1992. At that time, Douglas-fir #3 Shop was \$500/mbf. Both species then experienced a significant drop in real price until August 1992, when prices again increased sharply, reaching peaks in April 1993. Real prices were thereafter very unstable, clustering near \$550–600/mbf by late 1995. Southern pine, first reported in August 1994 at a real price of \$492/mbf, generally has trailed the price of Douglas-fir #3 Shop, having failed to increase after early 1995 in comparison to both Douglas-fir and ponderosa pine #3 Shop grades.

C & Better Grades

Although southern pine C & Better Selects exhibited a relatively steady trend in real prices over the 1989–1995 period, the price of ponderosa pine C & Better Select lumber displayed a greater variability. Southern pine real prices increased from about \$550/mbf in early 1989 to \$960/mbf in late 1994. In contrast, ponderosa pine real prices declined from \$2,150/mbf in early 1989 to a low of \$1,472/mbf during the period March–May 1991 before again rising to exceed \$2,840/mbf in March–May 1993. Prices then subsequently dropped, reaching a level of \$1,500/mbf by late 1995.

Moulding & Better Grades

The pattern of species price differentiation is best revealed in the prices of the highest valued appearance grade lumber products. For example, from January through March 1993, real prices for ponderosa pine 5/4 Moulding & Better rose from \$1,940/mbf to \$2,742/mbf, and for Douglas-fir from \$1,355/mbf to \$1,582/mbf (Figure 2). Real prices had actually declined from about \$1,360/mbf for ponderosa pine Moulding & Better grades in early 1989 to lows of about \$965/mbf by March 1991. Real prices then increased, at first modestly, then more steeply after August 1992 to the peak of \$2,738/mbf in early April 1993. By late 1995, ponderosa pine Moulding & Better had declined to \$1,312/mbf, below the real prices of early 1989.

Prices for Douglas-fir Moulding & Better grades were first reported in mid-1992, at just over \$900/mbf. The real price pattern thereafter mirrors the real price trend for ponderosa pine Moulding & Better through late 1995, but at lower levels and with somewhat less extreme fluctuations in both up and down markets. Ponderosa pine has obviously established a position as the higher valued softwood species for moulding products, and that hierarchy was maintained over the period shown in Figure 2.

Discussion

Real Price Premiums and Economic Returns to Wood Quality

The comparative price advantage for appearance grade softwood lumber was examined by means of the real price premium, computed as the real price difference between a species-specific appearance grade product and a representative commodity grade product for the same species. Where investment options in forest management are being considered that might be expected to result in changes in the relative yields of different product grades (as well as the total timber volume) the real price premium is of primary interest. This is because lower quality wood is potentially being "replaced" by higher grade wood. By improving the proportion of appearance grade yields, a higher gross lumber return may be obtained, potentially offsetting the added costs associated

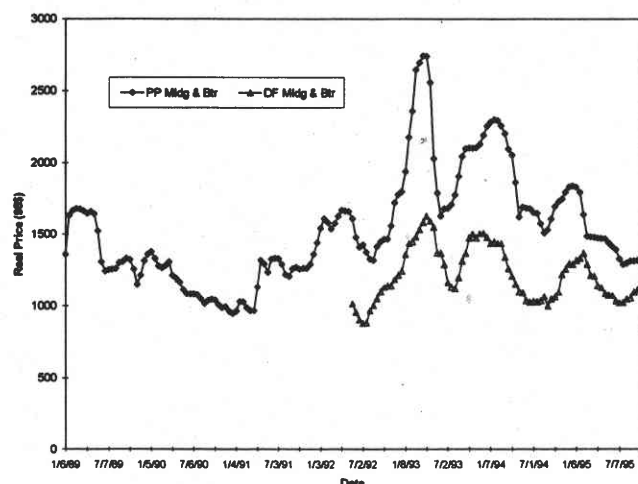


Figure 2. Real prices for 5/4 Moulding & Better grade ponderosa pine and Douglas-fir lumber.

with intensive management practices. If the real price premiums persist or increase over time, the comparative cost-benefit relation for the potential investment may also persist or change favorably. In contrast, a decline in the real price premium over time would potentially reduce the economic attractiveness of intensive forest management investments.

Ponderosa Pine

The average real price premium for #3 Shop was \$315/mbf relative to ponderosa pine #3 Common. Cyclic variation was modest in this real price premium, with an overall increasing trend of about \$1.59/mbf per month. The real price premiums were considerably greater (and more variable) for both the Moulding & Better and C & Better clearwood lumber grades. The average real price premium for Moulding & Better was \$1,231/mbf, while for C & Better it was \$1,598/mbf. The premium trend for Moulding & Better prices was increasing at about \$5.33/mbf per month, although the shorter cyclic trend had been downward since early 1993. The trend for real price premiums was also positive for C & Better, increasing at about \$1.70/mbf per month (Figure 3).

Ponderosa pine also illustrated the importance of assessing the premiums and trends over a relatively complete business or lumber market cycle in comparison to assessing short-term trends. Over the entire data period, three distinct phases of the softwood lumber market can be observed. From early 1989 through about March 1992, markets were declining in response to the national economic downturn and slack demand. The market rebounded, however, beginning in mid-1992, and reached new peaks in early 1993. A distinct upward trend in real price premiums (as well as in real prices) is evident. Finally, real price premiums again declined after early 1993 through 1995. Where price-related decisions, including the consideration of real price premiums, are based on relatively short-term phases of the lumber market cycle, the average long-term trends are less helpful. Because investments are made on longer term considerations, however, short-term trends within a limited phase of the economic cycle do not necessarily reflect the more useful long-term trend. The average long-term trend reflecting at least one major market cycle will be a better indicator of price performance for this case.

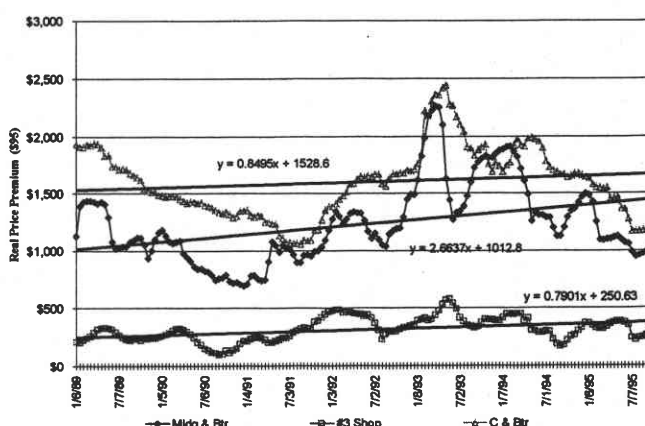


Figure 3. Real price premiums for ponderosa pine lumber relative to ponderosa pine #3 Common (1995 dollars).

Douglas-Fir

The real price premiums for the Douglas-fir appearance grades show contrasting trends. As noted, however, the biweekly price data for both of these grades were limited to the latter 3 yr of the market cycle. The real price premiums for the two appearance grades shown are measured against Douglas-fir Standard & Better 2 × 4's. The trends were determined by the real price premiums for the period June 1992–October 1995. Similarly, biweekly price data were available only for June 1992–July 1995 for the Douglas-fir appearance grades. Nevertheless, the trend in price premium is based on 156 data observations.

During this shorter phase of the market cycle, Douglas-fir Moulding & Better displayed an average real price premium of \$824/mbf while exhibiting considerable cyclic variation. Based on the limited trend observed, the real price premium declined by about \$1.07/mbf per month to about \$777/mbf (in real dollars) by October 1995. In contrast, the average real price premium for #3 Shop was \$166/mbf. With similar cyclic fluctuation, the real price premium trended upward by about \$2.88/mbf per month since mid-1992. Caution is required in extrapolating this trend beyond the limits of the data observations. Had a longer data series been available, covering the complete lumber market cycle from 1989, the real price trend would have undoubtedly been different.

Southern Pine

The southern pine C & Better 1 × 6 real price premium is compared to southern pine Standard & Better 2 × 4's. The average real price premium for C & Better 1 × 6 was \$418/mbf over the data period, while the real price premium trended upward at about \$2.54/mbf per month.

Conclusions

Table 2 summarizes the findings for the real price premiums for the major species and grades of appearance grade lumber included in the price analysis. The real price premium

Table 2. Summary of average real price premiums for appearance grade lumber and rate of change (1995 dollars)

Species and grade	Ave real price premium (\$/mbf)	Ave real price change (\$/mbf/month)*
Ponderosa pine		
C & Better	1,598	+1.70
Moulding & Better	1,231	+5.33
#3 Shop	315	+1.59
Southern pine		
C & Better 1 × 6	418	+2.54
Moulding & Better	717	
#3 Shop 5/4	127	
Douglas-fir**		
Moulding & Better	824	-1.07
#3 Shop	166	+2.88

* Where no rate of change is indicated, price data series was not sufficient to establish a valid trend. Since biweekly observations were used, the approximate monthly change is twice the slope coefficient for the trend line

** Douglas-fir trend is for June 1992–July 1995 only. This limits the trend to a short-term phase of the lumber market cycle

represents the actual dollar premium commanded by a specific appearance grade product relative to the representative structural grade commodity lumber product for the same species. The real price premiums increased moderately over the 1989–1995 lumber market period for most appearance grades for the species examined. Unfortunately, price data for Douglas-fir Moulding & Better, were only available for a limited short-term period, and are therefore less reliable as long-term indicators.

The transition in timber supply from old growth to second growth was continuing during the lumber market review period, with substantially less old growth available for harvest. This period also covered a significant portion of the economic business cycle, which strongly impacts lumber markets, from the peak markets of 1989 and the subsequent decline in demand in the early 1990s. It also included the initial phase of the structural decline in public timber supply in the Pacific Northwest. This trend is attributable to the reduced harvest from the National Forests as environmental constraints and growing reservations of forests for wildlife habitat and other conservation measures became effective and impacted forest land use allocations for timber production.

The real price premiums are often large when expressed in real terms, and they tended to increase over the dynamic market period observed. The shorter term trend in Douglas-fir moulding and better grade was the exception and cannot be directly compared with the longer trends for other items. This indicates that the higher quality lumber grades within a species are differentiated by price from the commodity lumber grades of the same species. The several appearance grades also are differentiated between species, particularly for the higher quality grades. The persistence and trends in the real price premiums do not suggest that this quality differentiation is only a temporary, short-term distortion or abnormal market behavior. In spite of the significant timber supply and market adjustments, real price premiums were quite persistent over time. As noted above, the single exception to increased real price premiums was for Douglas-fir moulding grade, where the results reflect only a shorter segment of the business cycle and are thus representative of only one phase of the overall market cycle.

Literature Cited

- ADAMS, D.M., R. BOYD, AND J. ANGLE. 1992. Evaluating the stability of softwood lumber demand elasticity by end use sector: A stochastic parameter approach. *For. Sci.* 38(4):825–841.
- ANONYMOUS. 1992. The Challenge of Changing Patterns. *Crows For. Ind.* J.7(3):4-8.
- ANONYMOUS. 1994. Supply shocks and lumber prices. *Evergreen* (March–April):6.
- BRIGGS, D.G. 1995. Pruning in relation to forest inventory, wood quality, and products. P. 21–35 *in* Forest pruning and wood quality of North American conifers, Hanley, D.P. et al. (eds.). *Inst. of For. Resour., Contrib. 77*, Univ. Wash., Coll. of For. Resour., Seattle.
- CAHILL, J.M. 1991. Pruning young-growth ponderosa pine: Product recovery and economic evaluation. *For. Prod. J.* 41(11/12):67–73.
- CAHILL, J.M., T.A. SNELGROVE, AND T.D. FAHEY. 1988. Lumber and veneer recovery from pruned Douglas-fir. *For. Prod. J.* 38(9):27–32.
- CAHILL, J.M., T.A. SNELGROVE, AND T.D. FAHEY. 1986. The case for pruning young-growth stands of Douglas-fir. P. 103–107 *in* Stand management

- for the future, Hanley D.G., and J.A. Johnson (eds.). Inst. of For. Resour., Contrib. 77, Univ. Wash., Coll. of For. Resour., Seattle.
- CROWS MARKET REPORT. 1989-1995. Crow's weekly lumber report. Various issues.
- EASTIN, I.L., C. LANE, T. WAGGENER, R. FIGHT, AND J. BARBOUR. 1996. An assessment of the market for softwood clearwood lumber products. CINTRAFOR Work. Pap. 59. Univ. of Wash., Coll. of For. Resour., Center for Internat. Trade in For. Prod., Seattle, WA. 91 p.
- FAHEY, T.D., AND S.A. WILLITS. 1995. Volume and quality of clear wood from pruned trees. P. 115-126 in *Forest pruning and wood quality of North American Conifers*, Hanley, D.P., et al. (eds.). Inst. of For. Resour., Contrib. 77. Univ. of Wash., Coll. of For. Resour., Seattle.
- FLORA, D.F. 1986. Markets for radiata pine logs as seen from that other softwood region. N. Z. For. (May):19-22.
- FIGHT, R.D., N.A. BOLON, AND J.M. CAHILL. 1992. Financial analysis of pruning ponderosa pine. USDA For. Serv. Res. Pap. PNW-RP-449. 17 p.
- FIGHT, R.D., N.A. BOLON, AND J.M. CAHILL. 1993. Financial analysis of pruning Douglas-fir and ponderosa pine in the Pacific Northwest. West. J. Appl. For. 10(1):58-61.
- FRYER, A.P. 1995. Lumber looks cheaper but uglier this building season. Puget Sound Bus. J. (April):7-13.
- HAYNES, R.W., AND R.D. FIGHT. 1992. Price projections for selected grades of Douglas-fir, coast hem-fir, inland hem-fir, and ponderosa pine lumber. USDA For. Serv. Res. Pap. PNW-RP-447. 20 p.
- HORGAN, G.P. 1995. Clearwood: Supplies and markets. P. 89-105 in *Forest pruning and wood quality of North American conifers*, Hanley D.P., et al. (eds.). Inst. of For. Resour., Contrib. 77. Univ. of Wash., Coll. of For. Resour., Seattle.
- IRLAND, L.C. 1994. Why are softwood lumber prices so volatile? For. Res. Tech. Pap., AFPA. TB94-2. 27 p.
- IRLAND GROUP AND J. POPKIN AND CO. 1993. Final report: Assessment of price making forces in the US softwood lumber markets. Augusta, ME. 217 p.
- MCKILLOP, W., T.W. STUART, AND P.J. GEISSLER. 1988. Competition between wood products and substitute structural products: An econometric analysis. For. Sci. 26(1):134-148.
- MITCHELL, K.J., AND K.R. POLSSON. 1993. SYLVER: A decision-support system for silviculture. P. 34-44 in *Proc. of the Internat. Workshop: Forest growth models and their uses*, Chhun-Huor Ung (ed.). Can. For. Serv., Quebec City, Quebec.
- MITCHELL, K.J., R.M. KELLOGG, AND K.R. POLSSON. 1989. Silvicultural treatments and end-product value. P. 130-167 in *Second growth Douglas-fir: Its management and conversion for value*. SP-32. Forintek Can. Corp., Vancouver, BC.
- ROBINSON, W.T. 1992. Timber supply issue looms large. Crows For. Ind. J. 7(4).
- SOMERVILLE, A. 1988. Recouping the pruning investment. N.Z. For. (May):26-27.
- SOHNGEN, B.L., AND R.W. HAYNES. 1994. The "great" price spike of '93: An analysis of lumber and stumpage prices in the Pacific Northwest. USDA For. Serv. Res. Pap. PNW-RP-476. 20 p.
- TOMASKO, B.J. 1992. WMMPA moves with industry. Crows For. Ind. J. 7(3):11-17.
- WARREN, D.D. 1998. Production, prices, employment, and trade in Northwest forest industries. USDA For. Serv. Resour. Bull. [published quarterly]