U.S.-Canada softwood lumber trade disputes and lumber price volatility

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Abstract
This paper uses analysis of variance (ANOVA) and regression analysis to study U.S. softwood lumber price volatility between 1980 and 2000, the period that coincides with several episodes of U.S.-Canada softwood lumber trade disputes. The results show that softwood lumber prices were more volatile in the 1990s than in the 1980s, with the period between 1991 to 1996 being the most volatile, the period covered by the 1996 U.S.-Canada Softwood Lumber Trade Agreement (SLA) being the second most volatile, and the period covered by the U.S.-Canada Memorandum of Understanding being the least volatile. Uncertainty, supply constraints due to the SLA and declining availability of federal timber in the western United States, and variations in housing starts were the primary causes of price volatility in the 1990s. The results of this paper have implications on resolving the U.S.-Canada softwood lumber trade disputes.

In the last 20 years, U.S.-Canada trade in forest products has received a great deal of attention on both sides of the border, as well as in international organizations such as the World Trade Organization. A dispute regarding softwood lumber imported from Canada to the United States, a $7 billion business in 1999, has been the most controversial. People involved in the dispute have described it as a “softwood lumber war,” and the two countries have experienced four formal rounds of countervailing duty proceedings. The latest round of negotiations between the two countries during 1994 to 1996 resulted in a 1996 Softwood Lumber Trade Agreement (SLA), which set up a tariff-regulated quota system on Canadian softwood lumber imports (3). The SLA covers 5 years, starting in April 1996, and defines Canada’s tax-free export limit, tax level, fee collection, and trigger price mechanism.

The softwood lumber trade disputes and debates focus on several factors. One factor is whether several provincial governments in Canada have subsidized their lumber producers through low stumpage rates and log export bans and whether the U.S. producers have been injured by the alleged subsidies. Another factor is the impact of the SLA on the welfare of U.S. producers, consumers, and the public in general. The agreement has been welcomed by the Coalition for Fair Lumber Imports, which represents a group of U.S. lumber producers who initiated several rounds of lobbying to restrict Canadian softwood imports in the past two decades. On the other hand, the National Association of Home Builders and the National Lumber and Building Material Dealers Association are firmly against the agreement, alleging that high prices and high price volatility caused by the SLA have hurt U.S. homebuilders and homebuyers (1). The parties in the debate tend to be polarized, and their arguments are political and uncompromising. Yet the only accurate way to evaluate these issues is through a careful analysis of the alleged subsidies and the welfare impacts of the agreement.

This paper contributes to the debate by presenting scientific and empirical evidence of lumber price volatility associated with the SLA.1 To date, both sides have had totally different views on the

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1 In another study, Zhang (13) examines the welfare impacts of the agreement. The findings indicate that while the change in lumber price is modest at about $53 in 1997 U.S. dollars or 14 percent on average for the first 4 years under the SLA, the gains to U.S. producers of softwood lumber are large and the losses to U.S. consumers are much larger. Lindsey et al. (4) reached similar conclusions using a different model.

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softwood lumber price volatility issue.² Obviously, both sides have been using data favoring their own positions in a non-scientific way.³ This study is intended to assess whether the volatility of U.S. softwood lumber prices has been changed over the past two decades, a time that coincides with various rounds of the disputes over softwood lumber trade between the United States and Canada. The results of this study could help resolve the lumber price volatility debate by presenting an analysis based on solid evidence rather than on editorial opinions and letting policy makers and the public concentrate on other issues.

**Methodology**

**Analysis of variance model**

The analysis of variance (ANOVA) methodology is often used in the investigation of the factors likely to contribute to outcomes under an experiment setting (8,9). It is a technique by which variations associated with different factors or defined sources are isolated and estimated.⁴ The procedure involves dividing total observed variations in outcomes into individual components attributable to various factors and those due to random fluctuation and performing tests to determine which factors influence the outcome. Most of the early applications of ANOVA were in the field of agricultural sciences, but it is now used in all areas of research, including social sciences.

In this study, we consider the ANOVA model with only one factor (time), in which sample observations are classified (grouped) by only a single criterion: time period. It provides the simplest data that contain observations at every level of the single factor.

Consider an experiment having p different levels of a single factor. Suppose nᵢ observations have been made at level i, giving a total of N observations. Let yᵢⱼ be the observed score corresponding to the j-th observation at the i-th level. The analysis of variance model for this experiment is given as

\[ yᵢⱼ = μ + αᵢ + eᵢⱼ \]  

where μ = general or overall mean (true grand mean) common to all the observations; αᵢ = effect due to the i-th level of the factor; eᵢⱼ = random error associated with the j-th observation, at the i-th level.

Equation [1] states that the outcome for observation j at level i is based on the sum of three components: the true grand mean μ of the population, the effect αᵢ associated with level i, and a third part eᵢⱼ that is strictly peculiar to the j-th observation under the i-th level. The term eᵢⱼ takes into account all those factors that have not been included in the model and is assumed to be normally and independently distributed and to have the same variance.⁵

In ANOVA, the variation in the response variable is separated into variation due to the factor and variation due to random error, i.e.,

\[ TSS = SS_B + SS_R \]  

where TSS (total sum of squares) = sum of the squared deviations of individual observations from the overall mean; SSᵦ (sum of squares between groups) = sum of squared deviations of the group means from the overall mean; SSₑ (sum of squares within groups) = sum of squared deviations of the observations from the group means. SSₑ represents the variation of the individual observations from their own sample means and is sometimes called the error or residual sum of squares.

The partition of the total sum of squares and the corresponding degrees of freedom can be used to make inferences about the existence of treatment effects. Ordinarily, it is convenient to deal with the quantities known as mean squares instead of sums of squares. The mean squares are obtained by dividing each sum of squares by the corresponding degrees of freedom. The two mean squares, namely between and within groups, can be denoted by MSᵦ and MSₑ respectively.

If we denote the true means of the p-th level as μ₁, μ₂, ..., μₚ, then we will test the null hypothesis that the treatment means are all equal against the alternative that at least two of the treatment means differ:

\[ H_0: μ₁ = μ₂ = ... = μₚ \]  

\[ H_a: \text{At least two of the } p \text{ treatment means differ} \]

It can be proved that the ratio:

\[ F = \frac{MSᵦ}{MSₑ} \]

is distributed as an F-variable with (p − 1) and (N − p) degrees of freedom (8). If the calculated value is greater than the critical value at a predetermined α-level, we will conclude that the hypothesis is false at the α-level of significance.

The results on the partition of the total sum of squares, degrees of freedom, and the analysis of variance F-test are usually summarized in the form of a table commonly referred to as the analysis of variance table. The table shows in a certain order the sums of squares and other related quantities used in the computation of the F-test. Such a table greatly simplifies the arithmetic and algebraic details of the analysis.

Sometimes, simply stating that the group means are significantly different may not be sufficient since one needs to know which particular means differ significantly from others or if there is some relationship among them. The ANOVA F-test does not directly provide answers to these questions. New test procedures, known as multiple comparison tests, have been developed to solve this problem.

² The National Association of Home Builders and the National Lumber and Building Material Dealers Association are concerned with high price volatility alleging that the quota system has created a supply structure that is not responsive to demand and that in a few weeks, lumber prices can change up to 20 percent (1). On the other hand, the Coalition for Fair Lumber Trade maintains that, compared to other commodities, lumber prices are not volatile (6). The Coalition also cited editorial comments from a leading industry market journal (7) that under the SLA, “[lumber prices] have been less volatile than at any similar time since 1991.”

³ For example, the Coalition’s choice of comparing commodities is rather arbitrary and its usage of monthly data tends to even the prices out and to hide the true price volatility. Furthermore, the editorial comments in Random Lengths’ Weekly Reports on North America Forest Products Market (7) quoted by the Coalition as evidence of low price volatility are merely personal opinions that are not based on scientific research. Finally, to make a conclusion about impacts of the 5-year SLA on price volatility based on 1-year’s data is not methodologically sound. The correct way is to study one or a few series as the benchmark products (similar to the SLA), which defines the benchmark product price as quarterly price reported by Random Lengths Inc. for eastern spruce-pine-fir, kiln-dried, 2 by 4, Std & Btr for a longer period of time.

⁴ In the language of ANOVA, factors are those variables whose effect on the response or dependent variable is of interest. They are also called independent variables or classification variables.

⁵ In practical applications, none of the preceding assumptions can be expected to be completely satisfied. Fortunately, for the fixed effect model, both analytical results and empirical studies attest to the fact that the failure to satisfy the assumptions of normality and equal variance has little effect on the result (8). Lack of independence can result from biased measurements, but the violation of this assumption is often difficult to remedy.
There are a number of popular multiple comparison procedures. This study uses the Scheffé’s method because it is applicable whether or not the sample sizes are equal for all factor levels. This test can rank the group means by magnitude and then identify whether the subsets of means are significantly different.

**Regression analysis model**

The ANOVA method can identify whether the response (price volatility in this study) to each level of the factor (time period) is significantly different. However, there may be additional factors that have contributed to price volatility in a particular period. For example, change in demand variables such as housing starts and supply variables such as U.S. governmental policy that greatly reduced timber supply from federal lands in the western United States may have contributed to the price volatility of lumber. In order to investigate the contributions of these additional factors, we used a linear regression model:

\[ Y_i = f(x_i) \]  

where \( Y_i \) = price volatility measures; \( x_i \) = dummy variables for various periods, a continuous variable for change in housing starts (measured as the percentage of change in monthly housing starts), and a variable representing the availability of federal timber in the western United States.

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6 Other tests include the least significant difference test, Bonferroni’s test, Dunn-Sidak’s test, Newman Keuls’ test, Duncan’s multiple-range test, and Dunnett’s test. Each test has its relative merits and drawbacks (8).

7 A variable representing the general price level (measured as percentage change in Consumer Price Index) was found to be insignificant and subsequently eliminated from the final model.

8 The real prices are derived by deflating the nominal prices using the Consumer Price Index (all items, seasonally adjusted U.S. city average, 1982 to 84 = 100, U.S. Bureau of Labor Statistics Serial #: CUSR0000SA).

9 We have also used Random Lengths’ Weekly Composite Index of Framing Lumber, and the results are similar to those reported in this paper. The similar results can be explained by the fact that the prices used in this paper and the index are highly correlated (\( r = 0.9765 \)).

10 The cash prices for lumber are based on spruce-hem-fir before May 1980 and on spruce-pine-fir after, in the Chicago Mercantile Exchange. To avoid errors caused by change of species, we chose to use the data after May 1980.

11 This period was also divided into two sub-periods: May 1980 to May 1983 and June 1983 to December 1986. The results do not differ from those reported in this paper.

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**Specification and data**

The volatility of lumber prices is the response or dependent variable. The price volatility measures are standard deviation (SD) of nominal prices, SD of real prices that control the possible effect of inflation, and coefficient of variation (COV). Weekly prices are used to generate monthly SD, and SD divided by the average monthly price is the COV. Weekly lumber prices are represented by the weekly average of cash prices of spruce-pine-fir 2 by 4 recorded in the Chicago Mercantile Exchange (2). The study period was from May 1980 to August 2000 and had 244 monthly observations totally.

In October 1982, the United States Coalition for Fair Canadian Lumber Imports filed a petition to the U.S. International Trade Administration (ITA). It alleged that the Canadian government and several provincial governments subsidized certain softwood lumber exports to the United States through their stumpage systems. After investigation, the ITA concluded that Canadian lumber imports did not qualify for a countervailing duty. The negative determination by the ITA marked the end of Lumber I.

In May 1986, a renamed Coalition for Fair Lumber Imports petitioned the ITA, seeking to reverse the finding in Lumber I. After investigation, a 15 percent countervailing duty was placed on Canadian softwood lumber bound for the United States, contingent on a final determination to be made by December 30, 1986. However, the final determination was averted as the Canadian and U.S. governments signed a Memorandum of Understanding (MOU) on December 30, 1986. The MOU, applied either as an export tax or stumpage fee adjustment by Canada, was designed to increase the price of Canadian lumber in U.S. markets and to reduce any Canadian competitive advantage arising from the alleged timber subsidy. The period was referred to as Lumber II.

In September 1991, the Canadian government notified the U.S. government that it would withdraw from the MOU 1 month later. The U.S. government and ITA responded by imposing an interim duty of 14.48 percent in March 1992 and a final affirmative countervailing duty of 6.51 percent in May 1992. By that time, the U.S.-Canada Free Trade Agreement (FTA) replaced court procedures in Canada and the United States with a binational panel of five experts for the review of ITA determinations. In its final decision in December 1993, the panel remanded the ITA’s determinations. The United States then filed a complaint to a three-member extraordinary committee under NAFTA, which ruled against the United States in August 1994. This period was referred to as Lumber III.

In September 1994, the Coalition filed a lawsuit and challenged both the results from the panel and the constitutionality of the binational panel dispute resolution process in NAFTA. In return for the Coalition to withdraw the lawsuit, the U.S. government promised to negotiate with the Canadian government. The government consultation between Canada and the United States started in December 1994 and resulted in the SLA. This concluded the period of Lumber IV.

Based on this history of the lumber debate, four time periods have been formed in this study:

Period I: May 1980 to December 1986
Period II: January 1987 to August 1991
Period III: September 1991 to March 1996

Data for change in U.S. monthly housing starts are calculated from the seasonally adjusted annual rate reported by the U.S. Bureau of Census (http://www.census.gov/const/C20/startssa.pdf). This variable is expected to have a positive sign as variations on the demand side (housing starts) inevitably lead to lumber price volatility. Data for availability of federal timber in the western United States is represented by uncut volume under contract (in million board feet) on national forest lands in Montana, Idaho, California, Oregon, and Washington as well as on Bureau of Land Management lands in Oregon (11). Since only annual (uncut volume)
data are available, monthly data are obtained by dividing the annual data by 12. This variable represents log supply constraints faced by sawmills that prevent them from putting on extra or expanded shifts to respond to increases in new orders. During the study period, the annual volume of federal timber under contract (sold but uncut) declined 90 percent (11). Therefore, this variable is expected to have a negative sign.

**Empirical results**

Figure 1 shows the trend of both nominal and real lumber prices. With the exception of a small peak in 1983, both nominal and real prices were relatively stable prior to 1991. There were four large peaks in 1993, 1994, 1997, and 1999. The two absolute measures of price volatility, i.e., SDs for both nominal and real prices, show similar trends, with the 1990s being more volatile than the 1980s (Figs. 2 and 3). The relative measure of price volatility (COV) shows that the middle of the 1990s was the most volatile period, followed by the early 1980s and later 1990s, with the latter 1980s being the least volatile (Fig. 4).

The result of the ANOVA F-test confirms that the price volatility was statistically different among the four periods (Table 1). For the nominal and real lumber prices, the null hypothesis that the four time periods had the same volatility is easily rejected with F-values of 25.4 and 12.5, respectively. Similarly, the null hypothesis that the COVs are the same among the four periods is rejected with an F-value of 9.1 ($p = 0.0001$). Therefore, the volatility of lumber price has changed with the passage of time in the past two decades.

We then made a comparison between each pair of means classified by the four time periods. In total, there are six comparisons for the four time periods. The results from Scheffé’s multiple comparison test are presented in Table 2. Means that are not significantly different at the 5 percent level were labeled with the same letters, while those that are significantly different are labeled with different letters. For nominal volatility of lumber price, the mean for period III (September 1991 to March 1996) is the largest. It is larger than the means for the two periods in the 1980s, but is not statistically different from that of period IV (April 1996 to August 2000). The mean of period IV is also larger than the means in the 1980s. The difference of the means for periods II and I is not statistically significant.

The results for the volatility of real lumber prices are similar to those with nominal ones. The only differences are that the mean of period IV is not statistically larger than that of period I and that the mean of period I is larger than that of period II. The results for the COVs are identical to those of SD for real prices.

The results of regression analysis show that the variation in U.S. housing starts and declining availability of federal timber contributed to the volatility of lumber prices, and both variables have the expected signs (Table 3). The price volatility measured as the SD of nominal prices in periods I, III, and IV are all statistically different from period II. The price volatility (measured as the SD of real prices and COV) in period IV is positive but not statistically different from that in period II.
To investigate the change in price volatility in the two decades, we combined periods I and II and ran the regression model again. Table 4 presents the results. Not surprisingly, the price volatility is significantly higher in the 1990s than in the 1980s. Specifically, the volatility of nominal prices under the SLA is about $7 higher than in the 1980s, and the volatility of real prices under the SLA is about $4 higher than in the 1980s. In relative terms, the volatility of lumber prices increased by 1.24 percent under the SLA.

Conclusions and discussion

The main conclusions of this paper are that the volatility of lumber prices was the highest in the period from September 1991 to March 1996, followed by the period of April 1996 to August 2000, and that price volatility in the 1990s was higher than that in the 1980s. The period from January 1987 to August 1991 had the lowest price volatility.

Price volatility is often caused by uncertainty (5). The results of this study can be explained by the uncertain factors associated with various periods of U.S.-Canada softwood lumber trade disputes and the supply and demand relationship in each period. There was much uncertainty in the period of 1991 to 1996, caused by many events such as 1) Canadian government terminating the 1986 MOU; 2) U.S. government self-initiated trade proceedings and various ITA impositions of duty; 3) the Canadian government’s appeal to an international panel under the U.S.-Canada Free Trade Agreement; 4) the five-member international panel’s rulings; 5) the U.S. government’s challenge to an extraordinary challenge committee and the subsequent three-member committee’s ruling; 6) the Coalition’s lawsuit to challenge the constitutionality of the FTA’s (now NAFTA’s) binational panel dispute resolution process; and 7) various other news items coming from the U.S.-Canada negotiation process that led to the SLA.

Even with the signing of the SLA in 1996, disputes across the border, lawsuits and subsequent court rulings on the pre-drilled studs and rough-headed lumber, and allocation of quotas in Canada have caused some uncertainty in the lumber market. In addition, the SLA gives additional tax-free quotas when the lumber price is higher than $405 per
thousand board feet. The questions of whether and when exactly Canadian producers will use all tax-free quotas and whether they are willing to pay the tariff have generated additional uncertainty. In addition, the Canadian government policy governing quota allocation – use it or lose it – may have exasperated the price volatility by forcing some firms to use their quota even when prices are low. Finally and perhaps more important, the SLA has directly contributed to the price volatility by creating a situation in which supply cannot respond quickly to change in demand.

Traditional market factors have played a role as well. In particular, variations in housing starts and supply restrictions on federal timber in the western United States have contributed to softwood lumber price volatility. Finally, environmental concerns in other parts of the country, cyclical trends in the global economy, and industry speculation may have, to some extent, influenced softwood lumber price volatility (10). Some credit should be given to the 1986 MOU between Canada and the United States as the volatility of lumber prices in the period between January 1987 and September 1991 was the lowest. While the results of this study do not necessarily support another MOU-style trade agreement since there are a lot of other factors that need to be considered, they do show that the 1986 MOU is better than the 1996 SLA as far as lumber price volatility is concerned.

This study shows that if uncertainty and supply constraints that make lumber producers and importers unable to meet changes in demand exist, lumber price volatility will be inevitable. The 1996 SLA expired on April 1, 2001, so more uncertainty about trade disputes be-

### Table 2. Results of multiple comparison test for softwood lumber volatility.

<table>
<thead>
<tr>
<th>Period</th>
<th>No. of observations</th>
<th>Standard deviation for nominal prices</th>
<th>Standard deviation for real prices</th>
<th>Coefficient of variation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean Grouping</td>
<td>Mean Grouping</td>
<td>(%)</td>
</tr>
<tr>
<td>III (09/91 to 03/96)</td>
<td>55</td>
<td>12.58 A</td>
<td>8.58 A</td>
<td>4.29 A</td>
</tr>
<tr>
<td>IV (04/96 to 08/00)</td>
<td>53</td>
<td>11.97 A</td>
<td>7.36 AB</td>
<td>3.56 AB</td>
</tr>
<tr>
<td>I (05/80 to 12/86)</td>
<td>80</td>
<td>5.63 B</td>
<td>5.74 B</td>
<td>3.42 B</td>
</tr>
<tr>
<td>II (01/87 to 08/91)</td>
<td>56</td>
<td>4.39 B</td>
<td>3.54 C</td>
<td>2.28 C</td>
</tr>
</tbody>
</table>

*a The alpha was set at 0.05; means of standard deviation are in SUS/MBF (thousand board feet); means in the same group (e.g., A or B) were not significantly different; means in group A were larger than those in group B or C statistically, and similarly, means in group B were larger than those in group C.

### Table 3. Results of regression analysis on softwood lumber volatility using period II as comparison period.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Standard deviation for nominal prices</th>
<th>Standard deviation for real prices</th>
<th>Coefficient of variation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>t-ratio</td>
<td>Coefficient</td>
</tr>
<tr>
<td>Intercept</td>
<td>8.4794</td>
<td>4.1002**</td>
<td>6.4598</td>
</tr>
<tr>
<td>Housing start</td>
<td>0.0899</td>
<td>1.7203*</td>
<td>-0.0023</td>
</tr>
<tr>
<td>Uncut volume</td>
<td>-0.0033</td>
<td>-2.1390**</td>
<td>-0.0023</td>
</tr>
<tr>
<td>I (05/80 to 12/86)</td>
<td>5.3796</td>
<td>2.3292**</td>
<td>5.1225</td>
</tr>
<tr>
<td>III (09/91 to 03/96)</td>
<td>5.4553</td>
<td>3.1747**</td>
<td>3.0701</td>
</tr>
<tr>
<td>IV (04/96 to 08/00)</td>
<td>4.2267</td>
<td>2.1621**</td>
<td>1.4253</td>
</tr>
</tbody>
</table>

*r² = 0.2642* 0.1638 0.1378
*r²-adjusted = 0.2487 0.1463 0.1197
F-test = 17.0900 9.3300 7.6100
*a = significant at the 10 percent level; ** = significant at the 5 percent level.

### Table 4. Results of regression analysis on softwood lumber volatility using 1980s as comparison period.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Standard deviation for nominal prices</th>
<th>Standard deviation for real prices</th>
<th>Coefficient of variation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>t-ratio</td>
<td>Coefficient</td>
</tr>
<tr>
<td>Intercept</td>
<td>5.3618</td>
<td>3.3700**</td>
<td>3.4912</td>
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<tr>
<td>Housing start</td>
<td>0.0936</td>
<td>1.7758*</td>
<td>0.0777</td>
</tr>
<tr>
<td>Uncut volume</td>
<td>-0.0001</td>
<td>-0.2013</td>
<td>0.0006</td>
</tr>
<tr>
<td>III (09/91 to 03/96)</td>
<td>7.2134</td>
<td>4.6301**</td>
<td>4.7442</td>
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<tr>
<td>IV (04/96 to 08/00)</td>
<td>6.6146</td>
<td>3.9376**</td>
<td>3.6991</td>
</tr>
</tbody>
</table>

*r² = 0.2474 0.1302 0.0914
*r²-adjusted = 0.2348 0.1156 0.0762
F-test = 19.6400 8.9400 6.0100
*a = significant at the 10 percent level; ** = significant at the 1 percent level.
tween these two countries could be created and remain in force for some time. Therefore, we may see lumber prices continue to be volatile.

**LITERATURE CITED**