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U.S. Policy and Canadian Lumber: Effects of the 1986 Memorandum. of Understanding

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ABSTRACT. A 1986 Memorandum of Understanding on softwood lumber imports (MOU) between Canada and the United States required that provincial governments levy export taxes on softwood lumber shipped to the United States. This agreement, with subsequent amendments, influenced trade from 1987 until it was abandoned by Canada in October of 1991. This paper investigates the market impact of the MOU, first by estimating an aggregate impact model of the Canadian share of the U.S. softwood lumber market and then by examining the implied price, quantity, and welfare effects. While the study shows the anticipated gains to U.S. producers of softwood lumber and losses to Canadian producers, U.S. consumer and efficiency costs were high, and the net of Canadian profit loss and export tax revenue was strongly positive. In addition, the net impact on market share appears to have persisted through 1990, in spite of considerable change in the policy's structure. These and other results should provide information for ongoing policy debate. FOR. SCI. 39(4):799–815.

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THE IMPORTATION OF SOFTWOOD LUMBER FROM CANADA has important consequences for U.S. wood products industries and for regions that depend heavily on the wood products sector. An important phase of U.S.-Canada trade in lumber concluded October 4, 1991, when Canada terminated a Memorandum of Understanding (MOU) on softwood lumber trade with the United States. This pact had governed exports of Canadian softwood lumber since 1987, and its abandonment has refueled long-standing debates over competitiveness and trade. Because the Canadian government's action came during a period of retrenchment for lumber manufacturers in the U.S., it was viewed as especially harmful to domestic interests. Accordingly, the U.S. government responded quickly with trade sanctions.[1] This paper is meant to inform ongoing debate over

[1] Political response to the Canadian withdrawal from the MOU came almost immediately. For example, Sen. Max Baucus (D., Montana) seemed to foreshadow a U.S. response within hours of the announcement: "The United States can't afford to let this action by the Canadians go unanswered. The United States must take action under U.S. trade laws to let the Canadians know we won't sit idly by as they back out of the softwood lumber agreement (*Wall Street Journal*, Sept 4, 1991)." In fact, shortly after Canada withdrew from the MOU, the United States initiated trade proceedings and imposed duties. This decision is currently being appealed to a binational panel by Canada under the U.S.-Canada Free Trade Agreement, and the panel must rule on the decision within a year. While the duty is under appeal, however, the United States collects cash or bonds equal to the proposed duty

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softwood trade policy by examining the impacts of the Memorandum of Understanding. Specifically, we estimate the agreement's effects on imports of Canadian lumber, U.S. production of softwood lumber, and consequent impacts on producer profits and U.S. consumer costs.

The MOU was negotiated after a period of sustained and especially intense debate about Canadian competitiveness. This debate focused mainly on allegations of unfair competition arising from underpricing of timber by provincial governments—by far the largest forest owners in Canada. While rights to federal timber in the U.S. are auctioned through relatively small and short-term contracts, provincial governments negotiate large-scale, long-term forest management leases with wood products firms. The structure and size of Canadian contracts suggests to some that provinces sell timber for less than its fair market value.

Protests against alleged Canadian timber subsidies by domestic wood products firms resulted in U.S. congressional and administrative action in the early 1980s. Trade sanctions were announced in October 1986 when the Department of Commerce, International Trade Administration (ITA), made a preliminary determination in favor of the industry's complaint regarding subsidies, and the International Trade Commission found injury to domestic lumber producers.[2] As a result, a 15% countervailing duty was immediately placed on Canadian softwood lumber bound for the U.S. contingent on a final determination to be made by December 30, 1986. However, the final determination was averted, and the countervailing duty was never implemented. Instead the U.S. and Canada negotiated an eleventh-hour agreement (the MOU) which set out an alternative arrangement for collecting the fee. The MOU transferred collection of the proposed countervailing duty by the importer (the U.S.) to the collection of a tax by the exporter (Canada). Subsequent amendments to the MOU allowed provincial governments to increase their stumpage fees in lieu of assessing the full export tax. Several provinces, including British Columbia, had raised their stumpage fees and eliminated the export tax by September 1991. The policy, applied either as an export tax or a stumpage fee adjustment, was designed to increase the price of Canadian lumber in U.S. markets and to thereby reduce any Canadian competitive advantage arising from the alleged timber subsidy.

The MOU took effect at the beginning of 1987 and influenced lumber trade for almost 5 yr. Predictably, the policy was not popular in Canada. Because U.S. markets have been so important to Canadian producers, the export tax–stumpage fee assessment was seen as a significant infringement on Canada's sovereignty over resource use and management. Also, not everyone agrees that Canadian producers receive a substantial subsidy. Some have argued that the ITA's economic analysis of Canadian stumpage prices was flawed; that they did not account for important differences in log quality and in harvesting and transportation costs for logs (e.g., Constantino 1988 and McCloy 1986) and that land values were incorrectly applied in the calculations (Percy and Yoder 1987, p. 59). In addition, it has also been argued that, because allowable cuts are set using biophysical criteria on Crown lands, stumpage pricing cannot influence lumber outputs (Uhler

on all softwood lumber imports from Canada. These fees will either be refunded or retained by the United States depending on the decision of the panel.

[2] Both subsidy and injury must be found for adverse action in a countervailing duty case (Finger et al. 1982).

1991).[3] Accordingly, there was a strong sentiment against the MOU in Canada, and it has been an issue of contention between the two countries.

The outcome of this particular trade battle was especially acrimonious because it reversed the findings of an essentially identical complaint against Canadian lumber imports in 1983. The impetus for this reversal was changes in the ITA's regulations used to define both whether a policy is targeted at a specific sector (the specificity test) and whether factors of production are provided at preferential rates to the targeted sector (the *preferentiality test*, see Percy and Yoder 1987, p. 47–50). These changes in the "rules of the game" allowed the Department of Commerce to reverse its 1983 finding with the preliminary finding of a resource subsidy in 1986, making the decision appear arbitrary.

In this paper we examine the consequences of the 1986 MOU. We do not, however, address the resource subsidy issues which led to the ITA's preliminary finding (and eventually to the MOU). Rather we examine the U.S. market level impacts of the MOU as given. Our empirical focus is on the Canadian share of U.S. markets. This metric has been a primary focus of the policy debate, and it serves as a useful aggregate measure of policy impact. We begin by examining how an export tax and a stumpage fee adjustment, the two instruments used under the MOU to address alleged subsidies, might influence market share. We then test for and estimate the extent of the policy impact on market share during the years influenced by the initial and amended MOU. This aggregate measure of impact is then used to estimate the price and quantity impacts of the policy and its welfare consequences. Finally, we draw conclusions and speculate on the future consequences of trade sanctions in an evolving forest policy environment.

POLICY STRUCTURE

As described above, trade under the MOU has been influenced by two fundamentally different instruments. The initial stipulations of the MOU called for an export tax on all Canadian lumber destined for the United States. Subsequent amendments to the agreement allowed provinces to remove the tax in exchange for stumpage price increases. The following section develops expectations regarding the differential impacts that these two instruments might have on the market share of Canadian lumber. We examine this question by defining the elasticities of share, first with respect to an ad valorem export tax and second, with respect to a stumpage price increase. Elasticity measures are developed using standard approaches and closely follow the approach used by Adams et al. (1986) to investigate the impacts of exchange rates on market share.

Export Tax

An ad valorem export tax has the effect of shifting an import supply function inward. If the initial import supply function for Canadian lumber is $S^c = S^c(p)$ with p representing U.S. lumber price, then supply under taxation can be described as $S^c = S^c((1 - \alpha)p)$ where $0 < \alpha < 1$ is the export tax rate. To derive the elasticity

[3] This case hinges on whether and how the allowable cut constraints bind on the production plans of wood products manufacturers.

of the import market share with respect to the tax rate, first define the market clearing condition for the U.S. domestic lumber market with an export tax on Canada's lumber:

$$D(p) = S^o(p) + S^c((1-\alpha)p) \tag{1}$$

Where D is the demand for lumber, S^c is Canadian lumber supply, and S^o is all other lumber supply (almost exclusively domestic). Next, define the elasticity of lumber price with respect to the tax rate ($e_{p,\alpha}$) by taking the total derivative of Equation (1) and rearranging terms:

$$e_{p,\alpha} = \frac{\alpha}{\alpha - 1}\left(\frac{e_{S^c,p}S^c}{e_{D,p}D - e_{S^o,p}S^o - e_{S^c,p}S^c}\right) \tag{2}$$

Where elasticities of the form $e_{Y,p}$ are own-price elasticities with respect to the referenced quantity (Y). Note that because $e_{D,p} < 0$, $e_{S^c,p}$ and $e_{S^o,p} > 0$, and $0 < \alpha < 1$, $e_{p,\alpha}$ is unambiguously positive. That is, price will always increase with an increase in the tax rate. Using the formula for $e_{p,\alpha}$ allows the elasticity of Canadian share to he similarly derived from the derivative of $m^c = S^c((1-\alpha)p)/D(p)$:

$$e_{m^c,\alpha} = \left(e_{S^c,p}(1-\alpha) - e_{D,p}e_{p,\alpha}\left(\frac{\alpha - 1}{\alpha}\right)\right)e_{p,\alpha} - e_{S^c,p}\alpha \tag{3}$$

$e_{m^c,\alpha}$ has an ambiguous sign, though for reasonable values of the elasticities a negative impact on share is indicated. For example, using lumber supply and demand elasticities estimated by Adams et al.[4], market quantities observed in 1987, and a 15% tax rate, we calculated $e_{p,\alpha} = 0.07$ and $e_{m^c,\alpha} = -0.10$. Therefore, this estimate suggests that the export tax had reduced Canada's share of the U.S. lumber market by about 2.8%.

Stumpage Price Adjustments

The elasticity of share with respect to the price of stumpage is similarly derived from the equilibrium condition

$$D(p) = S^o(p) + S^c(w,p) \tag{4}$$

where w is the price of stumpage and the other variables are as defined above. The increase in factor cost also has the effect of shifting the supply curve inward and the elasticity of lumber price w.r.t stumpage price is:

$$e_{p,w} = \frac{e_{S^c,w}S^c}{e_{D,p}D - e_{S^o,p}S^o - e_{S^c,p}S^c} \tag{5}$$

The share elasticity is therefore

$$e_{m^c,w} = e_{S^c,w} + (e_{S^c,p} - e_{D,p})e_{p,w} \tag{6}$$

The sign of $e_{p,w}$ is positive while the sign of $e_{m^c,w}$ is ambiguous. Using the elasticity evidence from Adams et al. and 1987 observations on market quantities, we

[4] These values are $e_{S^c,p} = 0.91$, $e_{S^o,p} = 0.40$, $e_{D,p} = -0.17$, $D = 50.35$ billion board feet (bbf), $S^c = 14.60$ bbf, and $S^o = 35.75$ bbf. For subsequent computations, we used Constantino and Haley's (1988) estimate for $e_{S^c,w}$, the Canadian supply elasticity with respect to wood price, of -0.93.

calculated $e_{p,w} = 0.39$ and $e_{m',w} = -0.54$. Accordingly, a 15% increase in wood price would lead to about a 2.4% decrease in market share.

These estimated elasticities indicate that increased stumpage prices would have a somewhat smaller impact on market share than an export tax. However, given the aggregate nature of the measures, these results do not suggest a strong hypothesis regarding the net change in market share resulting from changes in the structure of the MOU. In addition, the change in policy structures has not been "clean," in that provinces have negotiated changes at various dates and, perhaps more importantly, have adjusted prices using different approaches (Constantino and Percy 1991). Quebec, for example, has directly increased prices for harvested timber, while British Columbia has adjusted their fee structure to account for forest management costs (Constantino and Percy 1991, p. 70). The impacts of shifting the price of timber and increasing the fixed costs of the firm would lead to different production results. In the analysis that follows we test hypotheses regarding both the MOU's initial impact on Canada's share of the U.S. lumber market and the evolution of the policy's impact from 1987 through 1990. While limited to a highly aggregate measure of change, due to the reasons cited above, the results should provide useful insights for policy analysis.

METHODS

During the first half of the 1980s, the Canadian share of domestic lumber markets rose to unprecedented levels. This dramatic change in share exacerbated the impact of a deep recession on the wood products sector within the United States. Figure 1 shows that Canadian market share increased from only 12% in 1960 to a peak of 33% in 1985, and fell to 27% in 1990. The decline in market share began during the year prior to implementation of the MOU, while administrative investigations and the most intense debates about the policy were underway. While it is clear that market share has fallen from its peak in 1985, the policy has not been the only change in the market for lumber. Several other factors might also explain changes in market share. For example, market share has been shown to be sensitive to short-run changes in U.S.-Canadian exchange rates (Adams et al. 1986). The influence of all relevant factors must be sorted out before we can identify the influence of the MOU.

To isolate the influence of the MOU, we face severe data limitations. The policy was in place for less than 5 yr, hardly enough time to present the data required for us to isolate the policy's impacts on the structural parameters of the lumber market. In lieu of estimating a complete structural model of lumber trade, we construct and estimate what amounts to an aggregate reduced-form or impact model for Canadian share of the softwood lumber market. With this approach we test for a discernible, though highly aggregate, shift in the market coincident with the trade action. We then use estimates of structural market parameters from previous studies to translate this aggregate shift in market share into changes in quantity and price, which allows us to estimate changes in standard welfare measures. The analysis therefore applies an ex post estimate of aggregate change within the more typical ex ante study of trade structures. It contains much less production detail than the comprehensive spatial equilibrium model of North American wood products trade developed by Boyd and Krutilla (1987) to examine

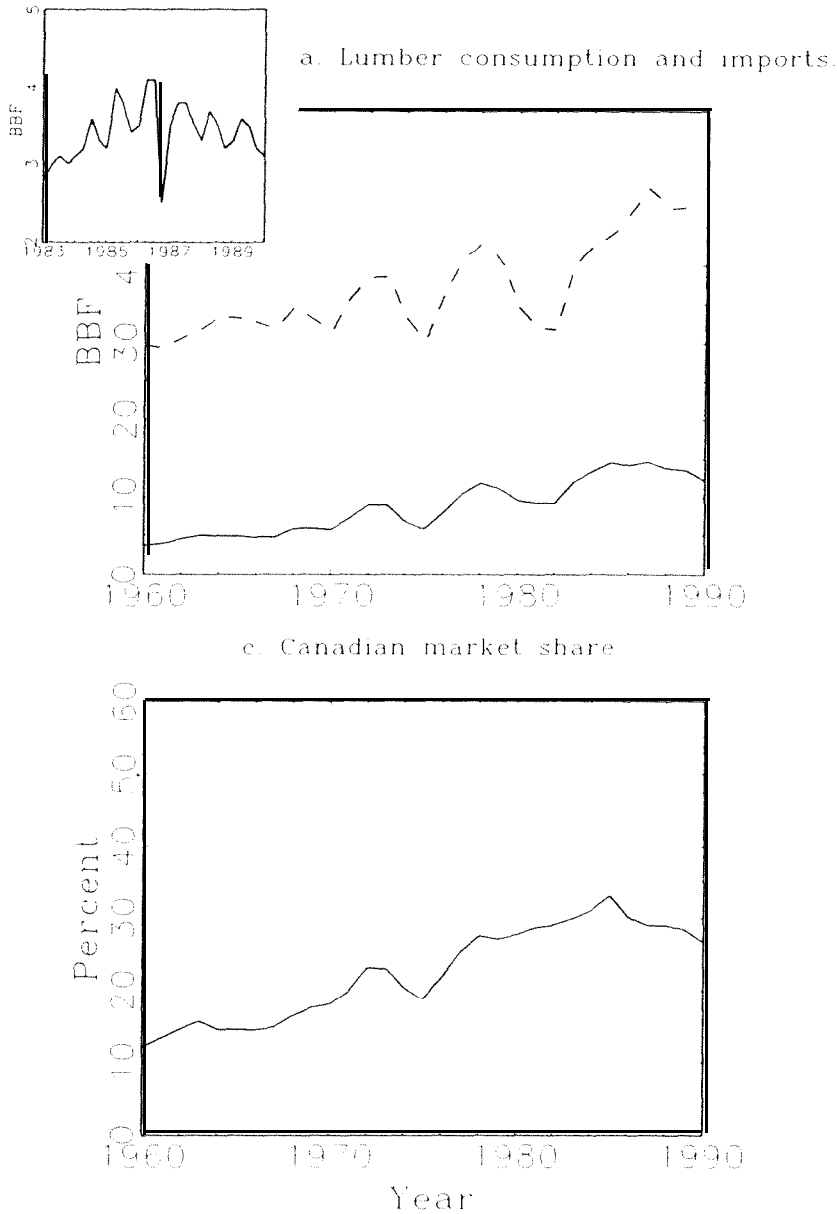

FIGURE 1. (a) Total U.S. consumption and Canadian imports of softwood lumber (1960–1990); (b) Quarterly imports of softwood lumber from Canada to the U.S. (1983–1990); (c) Canadian share of the U.S. market for softwood lumber (1960–1990).

potential policy instruments. However, we take a positive approach and attempt to make maximum use of very limited empirical information regarding what has actually happened to trade. Accordingly, we must take a more aggregate approach.

Our market share formulation treats softwood lumber as a homogenous commodity and models the U.S. lumber market in aggregate. It therefore leaves

unaddressed the spatial structure of regional submarkets and transportation cost differentials (see Boyd and Krutilla 1987). However, this aggregate view should be instructive for looking at overall impacts and for developing the intuition behind their structure. By abstracting from the spatial structure of the market we assume that the policy influences total consumption but not the spatial distribution of consumption. Therefore, consumers are indifferent to lumber source, and demand can be seen as a function of a single representative price. Canadian firms face an effective price defined by the exchange rate and, to the extent that short-run movements in exchange rates may not be reflected in actual cost differences in the lumber manufacturing sector, Canadian and U.S. firms may accordingly face different real prices in the short run. The structure of our market view is similar to those used to assess other recent interventions in Canada-U.S. trade in potash (Picketts et al. 1991) and poultry (Moschini and Meilke 1991) markets. We depart from these previous studies by employing an empirical measure of impact in our welfare analysis.

Our empirical measure, market share, is described by the following equation:

$$m^C = g(HS, GNP, t, CLUM, XLUM, XLOG, XCH, M) \qquad (7)$$

Equation (7) is an aggregate reduced form equation that includes relevant domestic demand and supply variables as well as Canadian export supply variables. Because the export supply and U.S. domestic supply functions have different slopes, ceteris paribus changes in both demand and supply variables will lead to changes in the market share. While it is ad hoc in that we cannot translate reduced form coefficients into structural coefficients, this equation serves the purpose of isolating residual impacts unexplained by changes in the relevant supply and demand factors. Demand factors are U.S. housing starts (*HS*), Gross National Product (*GNP*, a proxy for nonhousing uses of lumber), and a time index (*t*) which allows for a changing relationship between demand factors and lumber consumption. Domestic supply factors include domestic export of comparable lumber (*XLUM*) and logs (*XLOG*). In addition we include the Canadian-U.S. exchange rate (*XCH*), Canadian lumber consumption (*CLUM*), and a vector of impact variables (*M*) which are used to test for discrete shifts in the level of market share during the period influenced by the MOU. We treat all right-hand-side variables as exogenous, and apply Ordinary Least Squares as the appropriate estimator.

A shift in market share does not, however, provide economically meaningful insights into the policy's effects. This is because movements in the market share mask movement in both its numerator and denominator. The former defines the quantity shift in imports, the latter defines the change in total domestic consumption. These in turn imply shifts in domestic production of softwood lumber and lumber prices. Estimates of these separate movements require additional insight into the market for softwood lumber in the United States.

Our methods for estimating market impacts are summarized in Figure 2, which describes the U.S. softwood lumber market with an aggregate demand function for lumber (D) and a two-part lumber supply with total supply (S^T) equal to the sum of Canadian supply (S^C) and other supply (almost exclusively domestic, S^o). The export tax is implemented as a proportional assessment on lumber price so the policy results in a pivotal inward shift in Canadian supply (ΔS^C) directly analogous to the implementation of an ad valorem tax, and a consequent shift in total supply (ΔS^T). The difference, $\Delta S^T - \Delta S^C$ is described by movement along

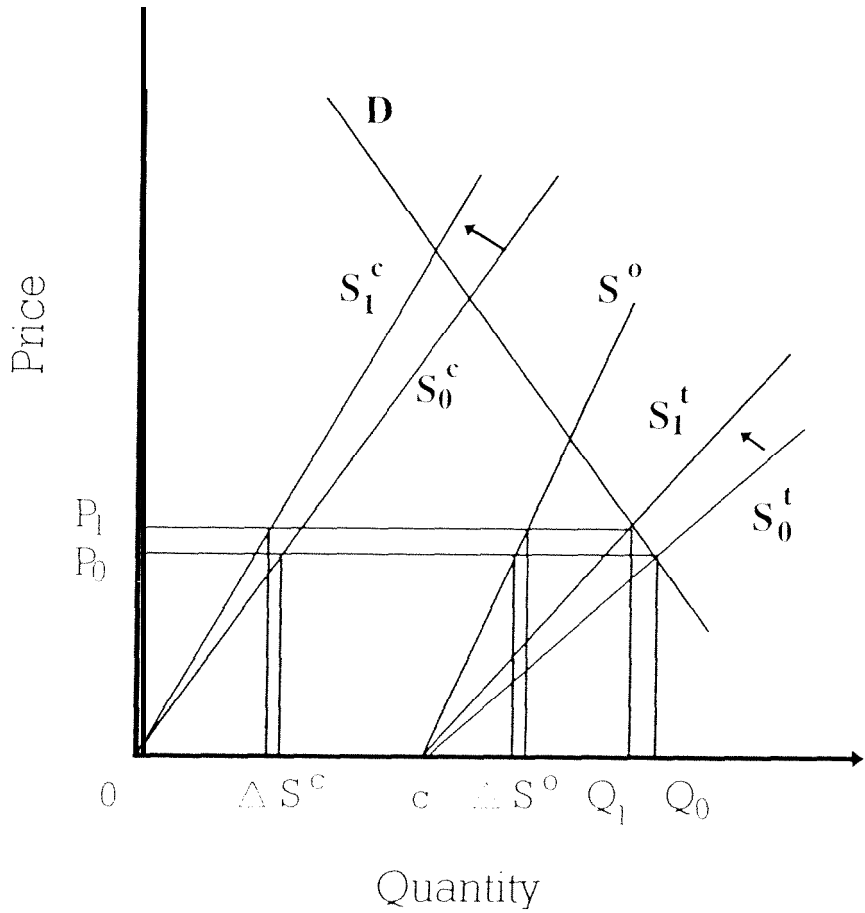

FIGURE 2. Structure of the U.S. softwood lumber market.

the other supply curve. The associated price shift, $\Delta P = P_1 - P_0$, is related to total change in market clearing lumber quantity $\Delta Q = Q_1 - Q_0$. Our policy therefore has an impact on five variables defining five unknowns. We solve for ΔS^O, ΔS^C, ΔS^T, ΔQ, and ΔP as follows. First movement along the lumber demand curve is defined:

$$\Delta Q = \eta \frac{Q_0}{P_0} \Delta P \tag{8}$$

where η is the own-price elasticity of lumber demand and the subscript 0 refers to base year observations. In similar fashion, movement along the other lumber supply curve is defined:

$$\Delta S^O = \delta \frac{S_0^O}{P_0} \Delta P \tag{9}$$

where δ is the own-price elasticity of other supply. The policy impact on market share can then be modeled by the differential of Canadian market share:

$$d\,m^C = d\left(\frac{S^C}{Q}\right) = \frac{Q_0 d\,S^C - S_0^C d\,Q}{Q_0^2} \tag{10}$$

Because shares must sum to 1, symmetrical result holds for other market share:

$$-d\,m^C = d\,m^O = d\left(\frac{S^O}{Q}\right) = \frac{Q_0\,d\,S^O - S_0^O\,d\,Q}{Q_0^2} \tag{11}$$

By setting $d\,m^C$ equal to the impact on share estimated using Equation (7) [and setting the identity: $\Delta Q = \Delta S^T$], we have four linear equations and four unknowns which can be solved once estimates of the two elasticities (δ and η) are provided.[5]

An analysis of exchange rates and North American lumber trade (Adams et al. 1986) is our source for elasticities. They estimate $\eta = -0.174$ and $\delta = 0.239$, 0.460, and 0.510 for Coast, Interior, and South supply regions of the United States respectively (each provides roughly one-third of U.S. production). Support for the demand estimate can be found in the $\eta = -0.173$ estimated by McKillop et al. (1980). Supply elasticities are generally consistent with several previous analyses (e.g., Robinson 1974 and Adams and Haynes 1980). Adams et al. (1986) also estimate the elasticity of export supply $\delta^C = 0.917$. For analytical convenience we set δ^C equal to unity, consistent with S^C shown in Figure 2. We calculate market impacts using the equations defined above, $\eta = -0.17$ and $\delta^0 = 0.4$. We also conduct a sensitivity analysis on the elasticity values by measuring impacts for the nine permutations of $\eta = -0.05$, -0.17, and -0.30, and $\delta^0 = 0.2$, 0.4, and 0.6.

Shifts in quantities and prices combine to define the total and distribution of related economic impacts. Estimates of changes in producer and consumer benefits follow directly from the market structure described in Figure 2. Again, the policy is implemented as a pivotal shift in import supply. Assuming a unitary own-price elasticity of supply means that the linear Canadian supply function pivots at the origin. Accordingly, total supply pivots at the x-intercept of the domestic supply function (point c in Figure 2). Total supply is therefore completely described by the import and domestic supply elasticities and base year observations:

$$P = b_T + \beta_T S^T; \qquad \beta_T = \frac{P}{\delta^T S^T} \tag{12}$$

$$b_T = P_0 - \beta_T S_0^T \tag{13}$$

where δ^T is the own-price elasticity of total supply and

$$\delta^T = \frac{\delta^C S^C + \delta^O S^O}{S^T} \tag{14}$$

[5] Without any distortion, the impact of the export tax would exactly define the shift in S^C. That is, $p = \alpha\,S^C$ would shift to $p = \alpha(1 + r)\,S^C$ with the tax rate set at r.

the quantity-weighted average of import and domestic supply elasticities, which follows directly from defining total supply as the sum of two linear supplies.[6]

Consumer surplus, the area under the demand curve and above the price line, defines consumer benefits. Change in consumer surplus is defined by the total quantity and price changes shown in Figure 2:

$$\Delta CS = -[(P_1 - P_0)Q_1 + \frac{1}{2}(Q_0 - Q_1)(P_1 - P_0)] \tag{15}$$

Producer surplus, the area above the supply curve and under the price line, defines producer profits. Change in domestic producer surplus also follows directly from Figure 2:

$$\Delta PS^O = (P_1 - P_0)S_0^O + \frac{1}{2}(P_1 - P_0)(S_1^O - S_0^O) \tag{16}$$

Where c is the horizontal intercept of the domestic supply function. The computation of producer surplus for Canadian firms following the policy is based on treating the shifted supply curve as an effective supply, and defining producer costs using the preshift supply curve. Accordingly, change in producer surplus is defined as

$$\begin{aligned} \Delta PS^C &= (1 - \alpha)P_1S_1^C - \frac{1}{2}P_1'S_1^C - \frac{1}{2}P_0S_0^C \\ P_1' &= P_0(S_1^C) \end{aligned} \tag{17}$$

where $\alpha = 0.15$ is the export tax rate and P' is the price defined by the prepolicy supply curve at S_1^C. The tax revenue is defined as $R = \alpha P_1 S_1^C$.

DATA

Equation (1) was estimated as a linear function using annual data for the period 1960 to 1990. The dependent variable, Canadian market share, was defined by dividing Canadian lumber imports (million board feet—mmbf) by total U.S. lumber consumption (Ulrich 1988, USDA Forest Service 1990). Gross National Product, in 1982 dollars, and the U.S.-Canadian exchange rate were taken from the Economic Report of the President (Council of Economic Advisors 1991 and back issues). Softwood lumber and log exports (mmbf) were defined as the corresponding exports from ports in Oregon and Washington and were taken from Warren (1991). We used these data because the Northwest region produces

[6] Canadian and other supply equations as well as the demand equation are derived directly from the own-price elasticities and base year observations:

$$P = a - \alpha Q; \qquad \alpha = \frac{P_0}{\eta Q_0}; \qquad a = P_0 + \alpha Q_0$$

$$P = b_c + \beta_c S^c; \qquad \beta^c = \frac{P_0}{\delta^c S^c}; \qquad b_c = 0$$

$$P = b_0 + \beta_0 S^0; \qquad \beta_o = \frac{P_0}{\delta^o S^o}; \qquad b_0 = P_0 - \beta_0 S^o$$

material output most similar to the major exporting regions of Canada. The time variable was defined as the calendar year for each observation. To test for discrete shifts in market share during the period impacted by the MOU, we include a vector of dummy variables: M_{85}, M_{86}, . . . , M_{90} which are set equal to one in their reference year and zero otherwise (e.g., $M_{85} = 1$ for 1985 and $M_{85} = 0$ otherwise).

ESTIMATION RESULTS

We initially estimated the share equation with the full complement of dummy variables. Results in Table 1 show that the coefficient estimate for M_{85} was insignificant (two-tailed t-test at $P = 0.05$) while coefficients for all other dummy variables were significantly negative. This indicates a significant reduction in market share beginning in 1986, 1 yr prior to implementation of the export tax. We then dropped M_{85} from the equation and tested the hypothesis that all of the remaining dummy variables had equivalent coefficients. This required placing four linear restrictions on the estimated equation and calculating the standard F statistic (equal to 0.7127). The critical F [$P = 0.05$ with numerator degrees of freedom equal to the number of linear restrictions (4) and denominator degrees of freedom equal to the number of observations minus the number of explanatory variables (18)] is equal to 2.93 so we cannot reject that the coefficients are equivalent. In addition, we test the hypothesis that the policy coefficient in 1990 is different from policy coefficients from 1986 through 1989. The F statistic is 2.952 while the critical F ($P = 0.05$ with numerator degrees of freedom equal to 1 and denominator degrees of freedom equal to 21) is 4.32. Again we cannot reject that the policy variables are equivalent. Our final model therefore has a single impact variable ($M_{86\text{-}90}$), which is equal to one for the years 1986–1990 and zero otherwise.

The results of estimating this final model (Table 1), indicate a high degree of success in explaining the variation of Canadian market share from 1960–1990 and indicate a significant shift in share roughly coincident with the policy. The coefficient of determination indicates that about 97% of the variation in share can be explained by the model and the overall F test indicates significance. The Durbin-Watson statistic indicates that we cannot reject the hypothesis of zero autocorrelation at the 5% level, but the value is in the inconclusive region of the test. Two-tailed t-tests ($P = 0.05$) indicate that housing starts, the exchange rate, time, and the policy variable hold significant influence over the Canadian market share. These few domestic factors account for nearly all of the change in market share over the historical period. While the model provides no mechanism for testing for subsidies it does suggest that the increase in share after 1975 might be largely explained by changes in the U.S.

The policy coefficient indicates a significant and negative impact (one-tailed test, $P = 0.05$), reducing market share by approximately 5% for the period 1986–1990. Therefore, after accounting for the influence of changing exchange rates, housing starts, and several other market variables, we find an otherwise unexplained and statistically discernible downward shift in market share around the time of the policy. However, this effect begins not in 1987, but in 1986, the year prior to implementing the MOU.

MARKET IMPACTS

The empirical analysis bears out the casual observation that something unusual happened to reduce market share in 1986, 1 yr before the export tax was imposed in 1987. Close scrutiny of the inset to Figure 1 shows that this drop in import share during 1986 is accounted for by a dramatic import reduction in the fourth quarter. This was coincident with the preliminary finding of a resource subsidy by the ITA and with the subsequent negotiations between the two countries. Furthermore, the preliminary finding required that exporters post the amount of the proposed countervailing duty from October through December, with distribution of the fee hinging on the ITA's final determination (U.S. Federal Register 1986). Canadian producers evidently behaved as if countervailing duties were in place

TABLE 1.

Estimation of Canadian market share as a function of market and policy variables. t-statistics are in parentheses and an asterisk indicates significance at the 95% level.

Independent variables	Restricted model	Full model
Intercept	−17.5480	−14.8030
	(−3.572)*	(−2.351)*
Year	0.0089	0.0075
	(3.529)*	(2.324)*
Exchange rate	0.1119	0.0789
	(3.024)*	(1.459)
GNP ($82) (billion dollars)	$-2.3636\ 10^{-5}$	$0.8571\ 10^{-5}$
	(−0.572)	(0.158)
Housing starts (thousand units)	$4.1764\ 10^{-5}$	$3.9750\ 10^{-5}$
	(4.502)*	(3.989)*
Lumber exports (mmbf)	$1.1538\ 10^{-5}$	$1.4374\ 10^{-5}$
	(0.456)	(0.461)
Log exports (mmbf)	$-.9906\ 10^{-5}$	$-1.5198\ 10^{-5}$
	(−1.208)	(−1.566)
Canada's consumption (mmbf)	$0.0274\ 10^{-5}$	$-0.0404\ 10^{-5}$
	(0.156)	(−0.183)
M_{85}	—	−0.0014
		(−0.088)
M_{86}	—	−0.0442
		(−2.738)*
M_{87}	—	−0.0542
		(−2.854)*
M_{88}	—	−0.0521
		(−2.251)*
M_{89}	—	−0.0521
		(−2.164)*
M_{90}	—	−0.0773
		(−2.958)*
M	−0.483	—
	(−3.750)*	
Adjusted R^2	0.967	0.963
Durbin-Watson d	1.186	1.122

TABLE 2.

Market impacts for 1987 ($\delta = 0.4$, $\eta = -0.17$).

Market impact	With policy	Without policy	Policy impact (%)
Canadian imports S^c (bbf)	14.60	17.36	−2.76 (−18.9)
Total Consumption Q (bbf)	50.35	51.17	−0.82 (−1.63)
Other production S^o (bbf)	35.75	33.81	+1.93 (+5.41)
Lumber price P $ mbf (1982 U.S.)	137.56	124.35	+13.21 (+9.60)

during this period. Given the political climate of the time, a final negative finding was likely anticipated by Canada's wood products firms.[7]

The impact of a trade policy can be measured in several dimensions. Our empirical model measures the impact on the market share of Canadian imports and indicates a share-reducing effect roughly coincident with the policy. Given levels of lumber consumption during this period (1986–1990), a 5% reduction in share would amount to a reduction of about 2.5 billion board feet (bbf)/yr. But this does not mean that U.S. production would have risen by 2.5 bbf during the same period. U.S. production is simultaneously influenced by the resulting increases in lumber price and reductions in total lumber consumption described by Figure 2. As long as demand for lumber is downward sloping, then 2.5 bbf is the upper bound on any increase in U.S. production attributable to the policy. To estimate these changes in production and consumption, we use the information on U.S. supply and demand elasticities for softwood lumber described above [Equations (8)–(11)].

To estimate the impacts of the policy, we apply Equations (8)–(11) to actual production, consumption, and price data for the years 1987–1990. In this way we simulate what the market results would have been had the policy (measured as a 5% reduction in Canadian market share) not been in place. We present detailed estimates of impacts for the year 1987 in Tables 2 and 3 and then summarize total impact for the years 1987–1990 in Table 4. Results for 1987 (Table 2) show Canadian imports falling 2.76 (bbf) from the otherwise open market solution, and U.S. production increasing by 1.93 bbf. The consequent change in market equilibrium shows a net reduction in lumber consumption of 0.82 bbf with a price increase of $13.21/mbf. Sensitivity tests show quantity shifts are relatively insensitive over the range of elasticities tested. Percentage changes for quantity variables shift by only 3.5% between minimum and maximum values. The price effect is much more sensitive; percent change ranges from +6.4 to +21.7%.

Detailed welfare impacts of the 5% decline in Canadian market share were calculated for 1987 (1982 U.S. $). U.S. wood products firms receive the gains anticipated for such a policy—profit increases by $459 million. For Canadian firms,

[7] Even in the absence of a final negative determination by the ITA, several bills aimed at trade retaliation were before the U.S. Congress at the time (see Percy and Yoder 1987).

TABLE 3.

Welfare impacts for 1987 (million 1982 U.S. dollars) of a 5% reduction in Canadian share of the U.S. softwood lumber market and a 15% Canadian lumber export tax.

Item	With policy	Without policy	Policy impact (%)
U.S. producer surplus	3,532.3	3,072.9	+ 459.4 (+ 15.0)
U.S. consumer surplus	20,370.8	21,041.3	− 670.5 (− 3.2)
Total U.S. impact	24,846.7	25,193.4	− 346.7 (− 1.4)
Canadian producer surplus	943.6	1,079.2	− 135.6 (− 12.6)
Export tax	301.3	0.0	+ 301.3
Total Canadian impact	1,244.9	1,079.2	+ 165.7 (+ 15.4)
Net impact	—	—	− 181.00

profits fall by $136 million and provinces gain $301 million in export tax revenue. Net gains to Canada are therefore $166 million. These producer gains are accounted for by consumer costs of $633 million and therefore a deadweight loss of $181 million. While it is difficult to make a direct comparison because of differences in the scenarios considered, our results generally correspond with Boyd and Krutilla's (1987) forecasts for an ad valorem tax on softwood lumber. If their estimate of tax revenue is transferred from the United States to Canada then they also show net gains to Canada which are more than offset by consumer costs net of U.S. producer gains.

The analysis for 1987 provides an estimate of the policy impact in its initial form, a 15% export tax. It estimates market and welfare impacts in 1987 by simulating market results without the policy. However, the form of the policy changed between its initiation and its termination as provinces adjusted their stumpage fees in accord with amendments to the MOU. These changes limit our ability to

TABLE 4.

Estimated total policy impacts for the years 1987 to 1990

	Total change	Annual average
Market impacts		
U.S. lumber consumption (bbf)	− 3.06	0.76
U.S. lumber production (bbf)	+ 7.32	+ 1.83
Lumber imports from Canada (bbf)	10.43	2.61
Lumber price (1982 U.S. $/mbf)	—	+ 19.90
Welfare impacts		
U.S. producer surplus (millions of 1982 U.S. $)	2632.4	658.1
U.S. consumer surplus (millions of 1982 U.S. $)	3789.5	− 947.4
U.S. total impact (millions of 1982 U.S. $)	− 1157.0	− 289.3

assess surplus and tax revenue measures for Canada during subsequent years of the MOU. This is because we cannot define the aggregate supply curve for the case where material costs have been changed. However, we may still assess the total quantity and price changes and the U.S. surplus impacts of the 5% reduction in Canada's market share for the years 1988–1990. We estimated these impacts using the same approach (simulating removal of the policy impact from market results in each of these years). The total as well as the average annual impacts of the policy are estimated and listed in Table 4. Over the full course of the MOU, U.S. producers gained about 2.6 billion (1982, U.S.$), while consumers lost about $3.8 billion. Accordingly, this analysis places the net U.S. cost at about $1.2 billion over this 4-yr period.

CONCLUSION

This analysis advances a methodological as well as a policy contribution. Our empirical model provides a modest contribution to methodology for measuring policy impacts on market parameters, based on its parsimony. While structural shifts can be econometrically estimated only long after a change, reduced form models of impact on market share can be estimated much sooner. This approach translates a discernible shift in share [by exploiting the complete information content of a shift in share, Equations (10) and (11)], into an economically meaningful analysis of market impacts. This provides for an early gauge of policy impact and cost; one which is tractable and quite amenable to sensitivity analysis. Policy analysts are often asked to estimate impacts before "all the evidence is in." This approach makes maximum use of the limited available evidence.

The empirical results isolate a downward shift in Canadian share of the U.S. softwood lumber market roughly coincident with the 1986 Memorandum of Understanding. While occurring 1 yr prior to policy implementation, we find it consistent with the evolution of the trade debate, noting especially that imports fell dramatically in the fourth quarter of 1986. During this period, lumber imports were assessed the 15% ad valorem fee to be held until a final determination on the countervailing duty case was made. It appears that this assessment strongly discouraged export during the fourth quarter of 1986, demonstrating how the policy-making process may influence market activity. While the policy was implemented in January 1987, steps taken during the policy-making process had substantial impacts on the lumber market before implementation.

The measures of welfare impacts estimated here reflect effective rent-seeking by domestic lumber producers. Significant positive returns accrued to domestic firms but also to the exporting country, and they are accounted for by increased consumer and efficiency costs. However, Canada's recent termination of the MOU indicates that these benefits, complicated by the MOU's prohibition on the redistribution of export tax revenue to wood products firms, were not adequate compensation for infringement on its resource sovereignty.

Perhaps more interesting than the magnitude of the impact is its persistence (evidenced in the first stage of our analysis). Because this analysis cannot explicitly address the evolution of the policy structure from 1987 to 1991, we can provide only limited insights here. However, we can detect no significant change in the residual impact measured by the dummy variables. This is especially in-

teresting in light of the evolution of the MOU through amendments which had eliminated the tax in favor of stumpage price adjustments. Our examination of share elasticities with respect to both the export tax and timber prices reveal no strong hypotheses regarding differences in the effect of the two changes in U.S. lumber markets. Our results also do not indicate a qualitative change in impact during these intervening years, suggesting that the impacts of stumpage adjustments have approximately offset the impacts of reducing the export tax. This area seems worthy of further investigation.

In the quantity terms of the original countervailing duty complaint, the MOU succeeded. Our analysis indicates that imports fell by about 2.6 bbf/yr, while U.S. production increased by about 1.8 bbf/yr. This, coupled with the consequent change in lumber price, led to considerable improvement in the competitive position of domestic producers in home markets and provided an important source of relief to U.S. firms as domestic environment/forest issues caused softwood timber inventories to contract. Trade sanctions were originally motivated by timber supply and pricing differences between Canada and the United States. The supply situation in neither country has been static, and change may continue to be most dramatic in the United States. The ongoing contraction of domestic supplies, especially supply from public forests, would necessarily push the consumer costs of any future lumber trade regulations even higher.

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