PRODUCTIVITY AND TRADE 
DURING THE SOFTWOOD 
LUMBER DISPUTE

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The gap in total factor productivity in sawmills and wood preservation between the US and Canada generally increased from 1958 to 2005. The present paper examines the effects of the various phases of the softwood lumber dispute, including relatively free trade, Canadian export taxes, and low and high countervailing duties, on this productivity gap. Exogenous control variables include US housing demand, the exchange rate, softwood lumber prices, and ratios of capital and nonproduction labor to labor. The effects of phases of the dispute on US imports from Canada are also examined.

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The United States and Canada are each other's largest trade partner and foreign investor, bilateral trade increasing 173% and bilateral foreign direct investment 226% between 1980 and 2005.

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These increases were more pronounced following the Canada-US Free Trade Agreement (CUFTA) between the United States and Canada in 1989 and the North American Free Trade Agreement (NAFTA) to include Mexico in 1994. Increased trade and investment are generally expected to encourage technology transfer and promote total factor productivity (TFP) convergence.

The present article examines the effects of phases of the softwood lumber dispute on TFP and US lumber imports in error correction models. The article focuses on trade in sawmills and wood preservation accounting for 70% of Canadian wood product revenue in 2005 and 26% of US revenue. One issue is the unintended consequence of US import restrictions increasing Canadian productivity. Determinants of US imports from Canada, including phases of the softwood lumber dispute, are also examined in an error correction model.

I. A REVIEW OF THE LITERATURE ON TFP AND TRADE


Cox and Harris (1986) and others predicted productivity convergence in North America prior to CUFTA and NAFTA. Bernard and Jones (1996) observe, however, at best weak labor productivity (LP) and TFP convergence in the OECD between 1970 and 1987. Bernard and Jensen (1999) uncover causality from productivity to exports but not vice versa, and find exports reallocate resources from less to more efficient plants. Carree, Klomp, and Thurik (2000) report mixed LP results for 28 manufacturing industries across 18 OECD countries between 1972 and 1992 and find knowledge and capital are barriers to productivity convergence.
Trefler (2004) reports Canadian labor productivity gains of 14% in export oriented industries and 15% in import competing industries in CUFTA between 1980 and 1996. Rugman (2004) suggests the depreciating Canadian dollar provided an important stimulus to Canadian exports while TFP growth did not enhance the underlying relative competitiveness of Canadian exports between the mid 1970s and 2001. Rugman also notes the relative absence of price, wage, and rate of return convergence after CUFTA. There remains some debate over whether CUFTA has improved productivity in Canada.


Nelson and Vertinsky (2004) bring out several structural and institutional differences between the United States and Canada such as forestland ownership, forest policies, status of mills, mill capacity, and political economy. Stock market event studies such as Begley et al. (1998), Zhang and Hussain (2004), and Malhotra and Gulati (2006) have found significant impacts of the various trade regimes on softwood lumber producers or consumers. Gulati
and Malhotra (2006) find trade diversion in exports from the Softwood Lumber Agreement (SLA) provinces. Weinstein (2004) notes overcapacity and falling prices during NAFTA may have been responsible for several sawmills shutting down, but the remaining mills were more efficient and Canadian firms maintained their share of the US market. None of these studies has explicitly examined the impact of the various trade regimes or softwood lumber dispute phases on TFP growth or imports in the softwood lumber sector.

II. A BRIEF HISTORY OF THE SOFTWOOD LUMBER DISPUTE

The United States and Canada trade freely for the most part but protection persists for softwood lumber. With strong US housing demand and the depreciating Canadian dollar, the share of Canadian softwood lumber in US consumption increased from 10% in 1958 to 33% by 1983, and to an all time high of 36% in 1996 before stabilizing at about 33% as seen in Figures 1 and 2.

Figure 1
Canadian Share in the US Softwood Lumber Consumption and the C$/$ Exchange Rate
Figure 1 shows how the Canadian share in the US softwood lumber consumption grew in tandem with the depreciating Canadian exchange rates over the period. Figure 2 presents paths of the exchange rate $E = CS/\text{US}$ and US housing starts ($H$). The US dollar generally appreciates over the period, lowering the price of imports except during the late 1980s and early 2000s. US housing starts appear to be highly cyclical, volatile, and stationary.

The softwood lumber dispute dates back about 200 years as discussed by Reed (2001) and has passed through several distinct phases. The present analysis begins with relatively free trade between 1958 and 1982 followed by the four distinguishable periods of dispute as noted in Zhang (2007):

- Lumber I 1958–86 Relatively free trade
- Lumber II 1987–91 Canadian export tax
- Lumber III 1992–94 Low countervailing duty
- SLA 1996–2000 Tariff rate quota
- Lumber IV 2001–05 High countervailing duty and anti-dumping duty
Figure 3 shows the US softwood lumber production, consumption, Canadian imports, its share in the US consumption, and the dispute phases over the study period. Free trade in Lumber I included US appeals for protection against Canadian softwood lumber imports in 1982 under the US countervailing duty law, alleging that various Canadian forest management and stumpage practices amounted to subsidies. After an investigation by the US Department of Commerce, the countervailing duty (CVD) was denied. During this relatively free trade period from 1958 to 1986, the US consumption and production increased by 57.3% and 28.8% respectively, while Canadian imports rose by 358% (3.1 bbf to 14.1 bbf) and its share in the US consumption by 191% (10.3% to 30%).

Lumber II began with another CVD petition and after preliminary investigation an interim CVD was imposed. Subsequent negotiations resulted in a Memorandum of Understanding (MOU)
with the CVD transformed to an equivalent Canadian export tax designed to increase the costs of Canadian lumber and reduce any subsidy advantage (Wear and Lee, 1993). CUFTA began in 1989 and Lumber II ended when Canada unilaterally withdrew from the MOU in September 1991. During this period from 1987 to 1991, the US consumption and production declined by 16.8% and 13.1%, while Canadian imports and its share declined by 21.6% and 6.1%.

Lumber III began when the Department of Commerce self-initiated a new CVD investigation and a CVD of 6.5% was applied in July 1992 beginning a three year CUFTA dispute settlement and a period of free trade between 1994 and 1996. This period of low CVD, from 1992 to 1994, saw 6.9% increase in the US consumption, but 1.2% decline in the US production, while Canadian imports registered an increase of 21.6% and its share by 13.8%. However in 1995, which was in effect a free trade period, the US consumption increased by 5.5%, but production declined by 6.7%. In that same year, Canadian imports and its share shot up dramatically by 28.5% and 21.8% respectively.

The Softwood Lumber Agreement (SLA) of 1996 imposed a tariff rate quota system. The SLA stipulated an annual duty free quota of 14.7 billion board feet (bbf) of lumber with increasingly prohibitive tariff rates (for quantities above duty free quota) that lasted until March 2001. The SLA period from 1996 to 2000 saw the US consumption and production up by 9.1% and 8.1%, while Canadian imports increased by 2.9%, but its share declined by 5.7%.

Lumber IV began in 2001 as the US imposed an interim CVD as well as interim anti-dumping duties (ADD) amounting to 27%. The final combined CVD and ADD of 20% were applied to most imports after May 2002 although these were reduced to 11% in 2003. In October 2006, a new SLA stipulated an export tax ranging up to 15% or an export charge up to 5% plus volume control for a period of up to 9 years. Between 2001 and 2005, a period of high CVD and ADD, the US consumption and production increased by
19.9% and 17.6%, while Canadian imports increased by 15.5%, but its share was down by 3.7%.

The dispute settlement mechanism failed at every stage. Canada has challenged US decisions at several stages in CUFTA, NAFTA, and the World Trade Organization (WTO). Canada has won several major legal challenges especially under NAFTA while the US has some success with WTO. Braudo and Trebilcock (2002) point out the institutional failure of the NAFTA dispute settlement process. Froese (2006) believes that dispute settlement has been ineffective because Canada is a small economy facing the challenge of enforcing panel decisions while the United States chooses to avoid compliance.

III. THEORY AND SPECIFICATION OF THE TFP GROWTH GAP AND IMPORTS

TFP growth is driven by more efficient utilization of inputs and technology, and free trade is expected to increase competition and diminish any TFP gap between countries. Firms protected by import restrictions might lax into inefficiency.

For the present analysis, the general production function is

\[ Y = f(K, L_p, L_N, E, M) \]

where \( Y \) is output, \( K \) capital, \( L_p \) production labor, \( L_N \) non-production labor, \( E \) energy, and \( M \) material input. Assume a translog production function, essentially a quadratic function in natural logs. The six lumber outputs in the data are softwood lumber, hardwood lumber, wood chips, wood preservation products, shingles & shakes, and other lumber products.

The production function predicts output based on inputs. TFP is the residual between actual and predicted outputs

\[ TFP = Y - Y_p. \]
TFP growth (TFP<sub>G</sub>) is the difference between weighted growth rates of output and inputs and is computed using the Törnqvist-Theil index that Dievert (1976) shows is exact and superlative,

\[
TFP_G = \frac{TFP_t}{TFP_{t-1}}
\]

(3)

\[
= \exp \left[ \sum_{j=1}^{m} .5(R_{jt} + R_{j-1}) \ln(Y_{jt}/Y_{j-1}) \\
- \sum_{i=1}^{n} .5(S_{it} + S_{i-1}) \ln(X_{it}/X_{i-1}) \right]
\]

where \( m = 6 \), the number of outputs, \( n = 5 \), the number of inputs, \( R_{jt} \) the revenue share of output \( j \) at time \( t \), \( S_{it} \) the cost share of input \( i \) at time \( t \), and \( X_{it} \) the input of factor \( i \) at time \( t \). The \( TFP_G \) index is computed as a chained index relative to the base year 1958.

For predicting growth, \( TFP_G \) is assumed to be a linear function of capital/labor ratio \( K/L \), the ratio of skilled labor to labor (nonproduction labor/total labor) \( LN/L \), the exchange rate \( E = C$/S$, US housing starts \( H \), and dummy variables \( D \) indicating various phases of the lumber dispute,

\[
(4) \quad TFP_G = f(K/L, LN/L, E, H, D).
\]

Dummy variables are \( D_{II} \) for Lumber II, \( D_{III} \) for Lumber III, \( D_{SLA} \) for the SLA, and \( D_{IV} \) for Lumber IV. The intercept represents free trade period that includes Lumber I (see Figure 3). For \( K/L \) and \( H \) the expected signs are positive while there is no clear expectation for \( LN/L \). An appreciating US dollar relaxes competition suggesting a negative effect of \( E \) in the US, and a positive effect in Canada.

The productivity gap is specified as

\[
(5) \quad \Delta TFP_G = f(\Delta K/L, \Delta LN/L, E, H, D)
\]

where \( \Delta \) is the difference between the US and Canada. The clear expected signs are positive for \( \Delta K/L \) and negative for \( E \). The
expected effect of $\Delta L_N/L$ is not clear as is the expected effect of $H$ that might stimulate $TFP_C$ in both countries and its expected effect is negative.

To examine the influence on imports, consider the function

\[(6) \quad M = f(E, H, P_m, P_d, D)\]

where $M$ is the quantity of US imports, $P_m$ the price of Canadian imported softwood lumber, and $P_d$, the US domestic price. Expected signs are positive for $E$, $H$, and $P_d$, and negative for $P_m$.

Augmented Dickey-Fuller (ADF) tests for unit roots determine the stationarity of various variables as in Enders (1995). Multivariate cointegration tests explore whether the series have common stochastic trends as suggested by (Johansen 1988, 1995). Trace and maximum eigenvalue test statistics find the cointegration rank. Cointegrated variables may contain some linear combination that is stationary, indicating a stochastic trend. If variables are cointegrated, equations 4 to 6 are estimated with error correction models (ECMs) to allow for long term adjustment. If variables are not cointegrated, a vector autoregression VAR method is utilized.

**IV. DATA ON SOFTWOOD PRODUCTION AND TRADE**

Annual data cover 1958 to 2005. For the period 1958 to 1996, the US industries are Standard Industrial Classification SIC 2421 Sawmills and Planing mills, SIC 2429 Special Products Sawmills, and SIC 2491 Wood Preserving, and for the period 1997 to 2005 North American Industry Classification System NAICS code 321113 Sawmills and 321114 Wood Preservation. Sources of US data are the Annual Survey of Manufactures and the Census of Manufacturing.

Outputs (softwood, hardwood, woodchips, wood preservation products, wood-ties-shingles-shakes, and other lumber products) are imputed from the value of shipments using prices derived from quantities and revenues. The capital stock is in millions of dollars converted to constant 2001 dollars in each currency with respective GDP deflators. The unit for labor input is hours worked. The unit for energy is the British thermal units Btu. Material inputs are in thousand board feet MBF but include nonwood materials such as chemicals and contract work, and are represented as equivalent quantities by dividing expenditure on nonwood materials by wood material prices. In the few cases of unavailable data, interpolation fills the gaps. A complete description of the data is in the Appendix of Nagubadi and Zhang (2006).

Annual housing starts and the C$/S$ exchange rate are from the website of the St. Louis Federal Reserve Bank. The US softwood lumber price index is from the Bureau of Labor Statistics, and the data on Canadian softwood lumber prices from Statistics Canada.

V. COINTEGRATION ANALYSIS FOR SOFTWOOD MARKET VARIABLES

The TFP growth indices in Figure 4 generally diverge since 1966 nearly converging in 1993 but then diverging more. The TFP gap reaches its highest level in 1998, appears to close in 2004, but increases again in 2005. Overall growth rates of TFP are 1.22% in
the US and 0.66% in Canada. Figure 4 indicates the TFP gap has increased in line with most manufacturing industries as shown by Eldridge and Sherwood (2001) and Bernstein, Harris, and Sharpe (2002).

Capital deepening should raise productivity and Figure 5 shows time trends of $K/L$ ratios. The $K/L$ ratio is consistently lower in Canada but rises with decreased employment during the oil crisis of 1974–75, the housing market collapse of 1981–82, and the recession after Gulf War I in 1991–92. The difference $\Delta K/L$ moves in waves.

The ratio of skilled labor to labor $L_N/L$ is higher in Canada until 1991 but declines as seen in Figure 6, while the US ratio has generally increased. The difference $\Delta L_N/L$ between the United States and Canada has generally increased.

Table I presents the ADF unit root tests. Equations with a significant constant or trend are retained. Lag length is selected with the Schwartz Information Criterion (SIC). The Durbin-Watson (DW) statistics for most tests indicate a lack of autocorrelation. Except for US housing starts $H$ and the TFP growth gap, all series exhibit unit roots and are stationary in first differences.

![Figure 4](image-url)
Table I
Augmented Dickey-Fuller (ADF) Tests

<table>
<thead>
<tr>
<th>Variables</th>
<th>Levels</th>
<th>First-difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lags²</td>
<td>ADF</td>
</tr>
<tr>
<td>TFPGUS</td>
<td>2(c,t)</td>
<td>-1.33</td>
</tr>
<tr>
<td>TFPGCN</td>
<td>0(c)</td>
<td>-1.79</td>
</tr>
<tr>
<td>Diff TFPGUS-CN</td>
<td>0(c)</td>
<td>-3.01*</td>
</tr>
<tr>
<td>K/LUS</td>
<td>0(c)</td>
<td>-0.62</td>
</tr>
<tr>
<td>K/LCN</td>
<td>2(c,t)</td>
<td>-2.29</td>
</tr>
<tr>
<td>Diff K/LUS-CN</td>
<td>1(c)</td>
<td>-1.59</td>
</tr>
<tr>
<td>L$/LUS</td>
<td>0(c)</td>
<td>-1.08</td>
</tr>
<tr>
<td>L$/LN</td>
<td>0(c,t)</td>
<td>-2.30</td>
</tr>
<tr>
<td>Diff L$/LUS-CN</td>
<td>0(c,t)</td>
<td>-3.13</td>
</tr>
<tr>
<td>lnM</td>
<td>3(c)</td>
<td>-1.51</td>
</tr>
<tr>
<td>lnHUS</td>
<td>1(c)</td>
<td>-4.91**</td>
</tr>
<tr>
<td>lnE</td>
<td>1(c)</td>
<td>-2.26</td>
</tr>
<tr>
<td>lnFCN</td>
<td>0(c)</td>
<td>-1.23</td>
</tr>
<tr>
<td>lnPUS</td>
<td>0(c)</td>
<td>-0.94</td>
</tr>
</tbody>
</table>

² Based on Schwartz Information Criterion (SIC). Letters in parentheses indicate exogenous variables in the equation estimating the ADF statistic; c = constant, and t = trend.
³Durbin-Watson statistic.
** and * denote rejection of null hypothesis of a unit root at 1% and 5% significance levels, respectively.

Johansen’s multivariate cointegration tests are applied to \( \Delta TFP_G \), \( \Delta K/L \), and \( \Delta L_N/L \) to check for cointegration. The null hypothesis of no cointegration is accepted in Tables II and III according to both trace and maximum-eigenvalue statistics. There is no long run equilibrium between variables, and each variable has its own stochastic trend. When variables are nonstationary and not cointegrated, vector auto-regression (VAR) can capture short run relationships.

Table IV presents the VAR models with one lag for the \( TFP_G \) indices, explaining 88% and 77% of the variation for the United States and Canada. The exchange rate \( E \) and US housing starts \( H \) are insignificant and removed. The lagged \( TFP_G \) and the lagged...
Table II

Johansen’s Multivariate Cointegration Test for the US TFP

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>Eigen-Value</th>
<th>Trace Statistic</th>
<th>5 Percent Critical Value</th>
<th>Max-Eigen Statistic</th>
<th>5 Percent Critical Value</th>
<th>Hypothesized No. of CE(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_0: r = 0$</td>
<td>0.37</td>
<td>27.77</td>
<td>29.80</td>
<td>21.43*</td>
<td>21.13</td>
<td>None</td>
</tr>
<tr>
<td>$H_0: r \leq 1$</td>
<td>0.13</td>
<td>6.33</td>
<td>15.49</td>
<td>6.29</td>
<td>14.26</td>
<td>At most 1</td>
</tr>
<tr>
<td>$H_0: r \leq 2$</td>
<td>0.001</td>
<td>0.04</td>
<td>3.84</td>
<td>0.04</td>
<td>3.84</td>
<td>At most 2</td>
</tr>
</tbody>
</table>

*Trace test indicates no cointegration while Max-Eigenvalue test indicates one cointegration at 5%.

Variables included are TFP, index, K/L ratio, and LN/L for the United States.

Table III

Johansen’s Multivariate Cointegration Test for Canada TFP

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>Eigen-Value</th>
<th>Trace Statistic</th>
<th>5 Percent Critical Value</th>
<th>Max-Eigen Statistic</th>
<th>5 Percent Critical Value</th>
<th>Hypothesized No. of CE(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_0: r = 0$</td>
<td>0.28</td>
<td>21.89</td>
<td>29.80</td>
<td>15.27</td>
<td>21.13</td>
<td>None</td>
</tr>
<tr>
<td>$H_0: r \leq 1$</td>
<td>0.11</td>
<td>6.62</td>
<td>15.49</td>
<td>5.12</td>
<td>14.26</td>
<td>At most 1</td>
</tr>
<tr>
<td>$H_0: r \leq 2$</td>
<td>0.03</td>
<td>1.50</td>
<td>3.84</td>
<td>1.50</td>
<td>3.84</td>
<td>At most 2</td>
</tr>
</tbody>
</table>

Both Trace test and Max-Eigenvalue tests indicate no cointegration at 5%.

Variables included are TFP, index, K/L ratio, and LN/L for Canada.

$LN/L$ have significant and positive impact for the United States. Coefficients for the lagged $TPF_G$ and lagged $K/L$ have positive effect for Canada. Note that the lagged $K/L$ increases TFP growth in Canada but not in the United States. Trade restrictions during the last phase ($L_{IV}$) significantly increased $TPF_G$ in both the United States and Canada, while the other phases have no impact.

Regarding the TFP gap Johansen’s cointegration test reported in Table V rejects the null hypothesis of no cointegration. There is at most one cointegration relationship or long run equilibrium among the five variables. This implies that there are four stochastic trends in the system moving four different ways from the long run equilibrium relationship.
Table IV
VAR Model Estimates for the $\text{TFP}_G$

<table>
<thead>
<tr>
<th>Variables</th>
<th>US TFP$_G$</th>
<th>Canada TFP$_G$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>t-value</td>
</tr>
<tr>
<td>$\text{TFP}_{G-1}$</td>
<td>0.574***</td>
<td>3.22</td>
</tr>
<tr>
<td>$\text{K/L}_{I-1}$</td>
<td>0.579</td>
<td>0.41</td>
</tr>
<tr>
<td>$\text{LN}/L_{I-1}$</td>
<td>1.977*</td>
<td>1.66</td>
</tr>
<tr>
<td>Constant</td>
<td>0.269</td>
<td>1.54</td>
</tr>
<tr>
<td>$\text{D}_H$</td>
<td>0.007</td>
<td>0.14</td>
</tr>
<tr>
<td>$\text{D}_{II}$</td>
<td>0.000</td>
<td>0.00</td>
</tr>
<tr>
<td>$\text{D}_{IIA}$</td>
<td>0.101</td>
<td>1.19</td>
</tr>
<tr>
<td>$\text{D}_{IV}$</td>
<td>0.125</td>
<td>1.50</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.88</td>
<td></td>
</tr>
<tr>
<td>Adj $R^2$</td>
<td>0.85</td>
<td></td>
</tr>
</tbody>
</table>

***, ***, and * indicate significance at 1%, 5%, 10%, and 20%, respectively.

Table V
Johansen's Multivariate Cointegration Test for $\Delta \text{TFP}_G$

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>Eigen-Trace</th>
<th>5 Percent Critical Value</th>
<th>Max-Eigen Critical Value</th>
<th>Hypothesized No. of CE(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{H}_0: r = 0$</td>
<td>0.64</td>
<td>86.42*</td>
<td>60.82</td>
<td>46.45*</td>
</tr>
<tr>
<td>$\text{H}_0: r \leq 1$</td>
<td>0.26</td>
<td>39.97</td>
<td>47.86</td>
<td>14.08</td>
</tr>
<tr>
<td>$\text{H}_0: r \leq 2$</td>
<td>0.24</td>
<td>25.90</td>
<td>20.80</td>
<td>12.59</td>
</tr>
<tr>
<td>$\text{H}_0: r \leq 3$</td>
<td>0.20</td>
<td>13.30</td>
<td>15.49</td>
<td>10.29</td>
</tr>
<tr>
<td>$\text{H}_0: r \leq 4$</td>
<td>0.06</td>
<td>3.01</td>
<td>3.84</td>
<td>3.01</td>
</tr>
</tbody>
</table>

*Both Trace and Max-Eigenvalue tests indicate at most one cointegration equation at 5%.

Variables included are: diff TFP$_G$, diff K/L, and diff LN/L, exchange rate, US housing starts H.

VI. ERROR CORRECTION MODEL OF THE TFP$_G$ GAP

The ECM in Table VI indicates a significant error correction process. Among the exogenous variables only lagged $\Delta LN/L$ has any effect, lowering the TFP gap and it also has a negative effect through the error correction process. The implication is that an
increasing share of production workers in the labor force raises TFP in both countries. The capital/labor gap Δ(K/L)_t has a positive impact through the error correction process implying that increases in the capital/labor ratio raise productivity in both countries as expected.

The negative and significant coefficients for the phase dummy variables (L_I and L_{II}) indicate the various trade restrictions have helped to reduce the TFPG gap. This result is consistent with popular media reports (e.g., *The Economist*, 2003; *Washington Post*, 2003): restrictive duties have forced Canadian producers to be more efficient and fitter than before. The duties certainly hit Canada hard. But as production is now concentrated at the more efficient mills, Canadian firms maintained their share of the American market while still turning a thin profit. As the duties make the US producers oversupply, bring products from non-Canadian sources, and encourage the use of lumber substitutes, which together mitigate the initial price increase caused by the
duties, they do not protect American producers as much as they have hoped in the long run (Zhang, 2007).

VII. ECM FOR U.S. IMPORTS FROM CANADA

The Johansen cointegration test in Table VII indicates three cointegration relationships according to the trace statistic but two by the maximum eigenvalue test. Two error correction terms are included in the ECM for imports $M$ in Table VIII. The second cointegrating equation is a significant error correction process. Among the endogenous variables, the lagged difference in US housing starts has a positive effect on the quantity of imports $M$ effect offset somewhat by the error correction process with the net effect calculated as $0.52 = 0.70 - (0.41 \times 0.44)$. Increased US housing demand increases the level of imports.

The lagged exchange rate has no effect on the quantity of imports suggesting that Canadian producer's price to market offset changes in the exchange rate with a change in their own price. Canadian producers may also inventory and do some business in US dollars.

Table VII
Johansen's Multivariate Cointegration Test for Canadian Imports $M$

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>Eigen-Value</th>
<th>Trace Statistic</th>
<th>5 Percent Critical Value</th>
<th>Max-Eigen Statistic</th>
<th>5 Percent Critical Value</th>
<th>Hypothesized No. of CE(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_0: \tau = 0$</td>
<td>0.56</td>
<td>96.71*</td>
<td>69.82</td>
<td>37.43*</td>
<td>33.88</td>
<td>None</td>
</tr>
<tr>
<td>$H_0: \tau \leq 1$</td>
<td>0.45</td>
<td>59.28*</td>
<td>47.86</td>
<td>27.84*</td>
<td>27.58</td>
<td>At most 1</td>
</tr>
<tr>
<td>$H_0: \tau \leq 2$</td>
<td>0.31</td>
<td>31.44*</td>
<td>23.80</td>
<td>16.96</td>
<td>21.13</td>
<td>At most 2</td>
</tr>
<tr>
<td>$H_0: \tau \leq 3$</td>
<td>0.26</td>
<td>14.49</td>
<td>15.49</td>
<td>14.00</td>
<td>14.26</td>
<td>At most 3</td>
</tr>
<tr>
<td>$H_0: \tau \leq 4$</td>
<td>0.01</td>
<td>0.39</td>
<td>3.84</td>
<td>0.29</td>
<td>0.84</td>
<td>At most 4</td>
</tr>
</tbody>
</table>

*Trace test indicates at most three cointegration equations, while the Max-Eigenvalue test indicates at most two cointegration equations at 5%.
Variables in log form are: Canadian softwood lumber imports, exchange rate, US housing starts. Canadian softwood lumber price index, and US softwood lumber price index.
Prices in Canada and the United States have their expected effects through the error correction process. A higher lagged price in Canada \((Pm_{t-1})\) lowers US imports with an error correction coefficient of \(-0.36 = 0.41 \times -0.90\), while a higher lagged price in the United States \((Pd_{t-1})\) raises imports with the coefficient \(0.30 = 0.41 \times 0.77\).

The positive constant 0.10 in Table VIII indicates a positive effect on the US imports during the free trade period that also included Lumber I. Coefficients for the phase dummies indicate that Lumber II, SLA, and Lumber IV have significantly lowered imports relative to the free trade period. Compared to the free trade period imports did fall, however, with the Canadian export tax during Lumber II \((0.10 - 0.12 = -0.02)\), while the high CVD and ADD during Lumber IV had no effect on Canadian imports \((0.10 - 0.10 = 0)\).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>t-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error Correction Term 1*</td>
<td>-0.035</td>
<td>-0.16</td>
</tr>
<tr>
<td>Error Correction Term 2b</td>
<td>0.412*</td>
<td>1.79</td>
</tr>
<tr>
<td>Diff. lnM_{t-1}</td>
<td>-0.252*</td>
<td>-1.26</td>
</tr>
<tr>
<td>Diff. lnE_{t-1}</td>
<td>-0.854</td>
<td>-1.07</td>
</tr>
<tr>
<td>Diff. lnH_{t-1}</td>
<td>0.701***</td>
<td>4.00</td>
</tr>
<tr>
<td>Diff. lnP_{t-1}</td>
<td>-0.079</td>
<td>-0.22</td>
</tr>
<tr>
<td>Diff. lnP_{d, t-1}</td>
<td>-0.251</td>
<td>-0.68</td>
</tr>
<tr>
<td>Constant</td>
<td>0.095***</td>
<td>4.20</td>
</tr>
<tr>
<td>DII</td>
<td>-0.117*</td>
<td>-2.28</td>
</tr>
<tr>
<td>DIII</td>
<td>0.049</td>
<td>0.65</td>
</tr>
<tr>
<td>D_{SLA}</td>
<td>-0.077*</td>
<td>-1.56</td>
</tr>
<tr>
<td>D_{IV}</td>
<td>-0.067*</td>
<td>-1.94</td>
</tr>
<tr>
<td>R^2</td>
<td>0.56</td>
<td></td>
</tr>
<tr>
<td>Adj R^2</td>
<td>0.42</td>
<td></td>
</tr>
</tbody>
</table>

*Coeff. eq1 = 0.51 + 1.0 lnM_{t-1} - 0.75 lnH_{t-1} - 0.36 lnP_{t-1};*** - 1.07 lnP_{C, t-1};*** - 0.77 lnP_{C, t-1};***.

bCoeff. eq2 = 3.71 + 1.0 lnE_{t-1} - 0.44 lnH_{t-1} - 0.90 lnP_{C, t-1} + 0.77 lnP_{C, t-1};***.  

***, **, *, and * indicate significance at 1%, 5%, 10%, and 20%, respectively.
VIII. CONCLUSION

Protection may have the unintended consequence of lowering domestic productivity for US firms, and the productivity gap between US and Canadian softwood lumber producers diminished under Lumber II (MOU) from 1987 to 1991, and under low countervailing duties of Lumber III from 1991 to 1994. The exchange rate and US housing starts have no effect on the productivity gap, while capital/labor ratios raise productivity as do higher shares of production workers.

US trade restrictions have generally been able to diminish Canadian imports relative to the free trade period of 1958 to 1986, except during the low countervailing duty period of 1992 to 1994 (Lumber III). Higher US housing demand significantly increases imports, while the exchange rate has no effect, perhaps due to pricing to market or currency substitution. As expected, imports increase with lower softwood lumber prices in Canada and higher prices in the United States.

The present significant effects of phases of the softwood lumber dispute suggest studies not including the trade regime would be incorrectly specified. The major conclusion regarding productivity is that various trade restrictions had the unintended consequence of lowering the US relative productivity. Except for the low countervailing period of Lumber III, the trade restrictions have succeeded in lowering the imports compared to free trade period. However, the net effect of export tax regime of Lumber II is negative. On the other hand, the trade regimes of Lumber III and SLA have a net positive effect similar to free trade, while the trade regime of Lumber IV has no effect on the imports.

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