A Re-examination of Factors Affecting United States Softwood Lumber Imports from Canada

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Abstract

This paper examines the effects of the lumber price, the housing starts, and the bilateral exchange rate on U.S. softwood lumber imports from Canada in a cointegration framework. To that end, the Phillips-Hansen fully-modified cointegration (FM-OLS) procedure is applied to monthly data for the period from January 1994 through June 2009. Results show that there exists the long-run equilibrium relationship between the U.S. lumber imports from Canada and the selected macroeconomic and market variables. We also find that the U.S. lumber price and housing starts are more important than the bilateral exchange rate in influencing U.S.-Canada softwood lumber trade.

Keywords: Exchange rate; housing starts; lumber imports; lumber price; Phillips-Hansen fully-modified cointegration technique; softwood lumber trade

INTRODUCTION

In the case of the U.S. softwood lumber industry, many researchers believe that in addition to market variables (e.g., domestic and imported prices of softwood lumber) macroeconomic variables (e.g., exchange rate and income growth and housing activity in the U.S.) are important factors affecting U.S. lumber trade with Canada. Accordingly, the effects of macroeconomic (and market) variables on the bilateral lumber trade has been studied extensively (e.g., Buongiorno et al. 1979 and 1988; Chen et al. 1988; Jennings et al. 1991; Wear and Lee 1993; Myneni et al. 1994; Baek and Yin 2006; Baek 2007). Buongiorno et al. (1988), for example, examine the effects of changes in the bilateral exchange rate and U.S. domestic lumber price on U.S. lumber imports from Canada using standard Granger causality tests; they find that while the U.S. price of softwood lumber is a dominant force in affecting Canadian lumber imports, the exchange rate has a negligible effect on imports. Sarker (1996) analyzes the effects of major excess demand side factors on Canadian lumber exports to the U.S. using Johansen cointegration analysis; he shows that U.S. lumber price, U.S. disposable income and U.S. housing starts are found to be the major determinants of Canadian softwood lumber export to the United States. More recently, Baek (2007) investigates the dynamic relationships between macroeconomic variables (i.e., exchange rate and U.S. income) and U.S.-Canada trade in forest products including softwood lumber using an autoregressive distributed lag (ARDL) model; he concludes that the U.S. income growth is more a powerful factor than the exchange rate.

An important point frequently overlooked in the literature, however, is that studies have mostly used time-series methods with little cognizance of the unit root problems associated with level variables (e.g., Buongiorno et al. 1979 and 1988; Chen et al. 1988; Jennings et al. 1991; Wear and Lee 1993; Myneni et al. 1994). In other words, most past studies use the level of each variable in their regression analysis without taking into account the non-stationarity in the data. When data are not stationary, standard critical values used in determining the significance of estimated coefficients are not valid (Wooldridge 2006). Another shortcoming of most previous studies evaluating U.S.-Canada lumber trade is that not enough attention has been given to the import price of softwood lumber (e.g., Sarker 1996; Baek and Yin 2006; Baek 2007). Given the fact that U.S. and Canadian softwood lumber are not perfect substitutes in the U.S. lumber market, excluding the Canadian import price in an empirical model may yield biased estimates, known as the omitted variable bias (Wooldridge 2006).[1] These shortcomings thus could raise questions about the validity of the results of previous studies. Furthermore, for several decades Canada has been the principal source of softwood lumber in the U.S. market, providing more than 90% of U.S. total imports and more than 30% of U.S. consumption. Given heavy dependence of U.S. lumber consumption on Canadian imports, it is very important to fully understand the macroeconomic and market factors that contribute to the ever-changing pattern of the bilateral lumber trade.

The objective of this paper is to re-examine the effects of macroeconomic and market factors on U.S. lumber imports from Canada with enhanced models and variables. The empirical focus is on identifying the long-run relationship between U.S. lumber imports from Canada and macroeconomic aggregates such as exchange rate and housing starts and lumber market variables such as domestic and import prices of softwood

[1] The reason why imported lumber from Canada is not a perfect substitute for domestic lumber is well-summarized in Buongiorno et al. (1979; pp. 642-643).

lumber. To that end, we use the fully-modified cointegration technique (FM-OLS) developed by Phillips and Hansen (1990). Since the FM-OLS method is less sensitive to changes in lag structure and performs better for finite sample size than other cointegration techniques (e.g., Engle and Granger 1987; Johansen 1988), it is a fully efficient method of estimating long-run equilibrium relationships among the selected variables (Hargreaves 1994). This dynamic analysis will enhance the understanding of U.S.-Canada lumber trade and contributes to the literature on forest products trade.

The remainder of the paper is organized as follows. The next section discusses the empirical model related to the import demand equation for U.S. softwood lumber as well as the empirical method related to the FM-OLS estimation. The following section describes the dataset used in the analysis. The last two sections discuss the empirical results, and make some concluding comments.

EMPIRICAL MODEL AND METHOD

To examine factors affecting Canadian lumber imports, following Buongiorno et al. (1979) and Chen et al. (1988), we derive the U.S. lumber import demand model. The reduced-form equation for U.S. lumber imports from Canada (IM) is specified as follows:

$$IM = IM(P^d, P^m, HS, ER) \tag{1}$$

where P^d is the domestic price of softwood lumber; P^m the import price of softwood lumber; HS is the housing starts; and ER is the exchange rate. Since lumber produced in Canada is a distinct commodity that is not a perfect substitute for domestic lumber (imperfect substitutes), demand for imported lumber in this model is specified as a function of two different prices such as domestic price and import price. In addition, an increase in the scale of U.S. economic activity through economic growth leads to a rise in demand for new homes and other new construction, thereby boosting the lumber demand for construction purposes; thus, an index of new construction such as housing starts is used as a shifter in the demand for import equation (Uri and Boyd 1990). Finally, U.S. import demand for Canadian lumber tends to rise with an appreciation of U.S. dollar against Canadian dollar via a decline in prices of Canadian lumber imports; hence, the bilateral exchange rate is another important factor determining lumber imports from Canada (Buongiorno et al. 1988).[2]

In the literature on international economics, studies have relied mostly on the standard import demand model developed by Houthaker and Magee (1969) and Kreinin (1973) in which the quantity of imports is regressed on the relative price defined as the ratio of domestic price to import price and other factors such as exchange rate and income. One of major reasons for using the price ratio is that it is insensitive to the choice of a price index; in other words, regardless of the price index used the ratio will not be altered.[3] We thus use the relative price in the empirical model as is done in other studies (e.g., Buongiorno et al. 1979). The U.S. lumber import demand equation (1) now becomes

[2] As Baek and Yin (2006) point out, demand for lumber in the U.S. is mainly derived from demand for new housing, and repair and remodeling. New housing is determined by housing starts, while repair and remodeling is decided by disposable income; thus, these two factors are key measures of the likely effects of a stronger economy on lumber consumption and imports. However, inclusion of both variables in the model would yield unacceptable coefficient estimates, because of multicollinearity between them; for example, the correlation coefficient between housing starts and disposable income over the sample period is 0.67. For this reason, we drop the disposable income from the final model. Furthermore, historically approximately 60% of the softwood lumber consumed in the U.S. has been used for new housing; under this circumstance, housing starts should be more relevant in explaining Canadian lumber imports.

[3] Another reason is that the ratio can narrow down the range of the variable to make it less susceptible to outlying or extreme observations (Wooldridge 2006).

$$\ln(IM_t) = \alpha + \beta_1 \ln(P_t) + \beta_2 \ln(HS_t) + \beta_3 \ln(ER_t) + \varepsilon_t \qquad (2)$$

where $\ln$ is natural logarithmic form; P_t is the relative price of softwood lumber defined as the ratio of the domestic price to the import price ($P_t = P_t^d / P_t^m$); and ε_t is an error term. When the domestic-import price ratio is greater (less) than 1.0, it indicates that domestic price has increased faster (slower) than import price, thereby increasing (decreasing) Canadian lumber imports; hence, it is expected that $\beta_1 > 0$. Since an increase in the number of housing starts in the U.S. leads to an increase in demand for softwood lumber and boosts lumber imports, it is expected that that $\beta_2 > 0$. Finally, it is expected that $\beta_3 > 0$, since an appreciation of the U.S. dollar causes an increase in U.S. imports of Canadian lumber through a decline in import prices.[4]

It is worth mentioning that in general, Canadian lumber imports and lumber prices in equation (2) are endogenously determined by (import) demand and (export) supply; in this case, the lumber price is likely to be correlated with the error term ε_t, which causes the OLS estimators to be biased. In addition, as will be seen in the empirical results section, the null hypothesis of a unit root cannot be rejected for all four variables in equation (2). The possibility of the unit roots in time-series models raises issues about parameter interpretation/inference and spurious regression (Harris and Sollis 2003). For example, OLS regression involving non-stationary variables no longer provides the valid interpretations of the standard statistics such as t - and F -statistics in equation (2). Furthermore, unless non-stationary variables combine with other non-stationary variables

[4] It is assumed that exchange rates (ER_t) is defined in a way that an increase reflects a real appreciation of the U.S. dollar against the Canadian dollar.

to form stationary cointegration relationships, the estimation can falsely represent the existence of a meaningful economic relationship, known as a spurious regression (Harris and Sollis 2003). To address these problems adequately, therefore, we use the Phillips-Hansen fully-modified ordinary least squares technique (FM-OLS) to estimate equation (2). The FM-OLS uses a cointegration framework to take into account the non-stationarity in the data as well as potential endogeneity of the explanatory variables and serial correlation of the error term. As a result, the FM-OLS is an optimal single-equation technique for estimating with $I(1)$ variables (Phillips and Loretan 1991).[5]

DATA

The data used for the analysis are collected between January 1994 and June 2009 (186 observations). The total quantity of U.S. softwood lumber imported from Canada is obtained from the Foreign Agricultural Service (FAS Online) in the U.S. Department of Agriculture (USDA). The U.S. producer price index (PPI) for softwood lumber is used as a proxy for the domestic lumber price (2005=100) and is taken from Bureau of Labor Statistics (BLS) in the U.S. Department of Labor (USDOL). The U.S. import price index for lumber and other unfinished building materials is used as a proxy for the import price of Canadian lumber (2005=100) and is collected from the BLS in the USDOL. The relative price of softwood lumber used in equation (2) is then defined as the ratio of domestic price to import price. The number of housing starts is taken from the U.S. Census Bureau. The U.S.-Canada real exchange rate is collected from the Economic

[5] We may handle the non-stationarity of time-series data using first or higher order differences rather than in levels in a framework of OLS. By differencing, however, we may lose valuable information concerning long-run properties inherent in the levels of time-series data (Perman, 1991). With the long-run information embedded in the levels data, therefore, cointegration approach (i.e., FM-OLS) offers a solution to this dilemma.

Research Service (ERS) in the USDA. Since the exchange rate is expressed as Canadian dollars per U.S. dollar, a decline in exchange rate indicates a real depreciation of the U.S. dollar. Finally, all variables are in natural logarithms.

EMPIRICAL RESULTS

The first requirement for the FM-OLS cointegration procedure is that the variables in equation (2) must be non-stationary with $I(1)$ processes. The presence of a unit root in the four variables is determined using the Dickey-Fuller generalized least squares (DF-GLS) test (Elliot et al. 1996). The results show that, with the level series, the null of non-stationarity cannot be rejected for all the four variables at the 5% level (Table 1). With the first-differenced series, on the other hand, the results indicate that all the variables are stationary; hence, we conclude that all the variables are non-stationary $I(1)$ processes. The DF-GLS test statistics are estimated from a model that includes a constant and a trend variable. The lag lengths are selected by Schwarz criterion (SC).

Since the FM-OLS is a single-equation cointegration procedure, it is essentially valid in the presence of a single cointegration vector. As a preliminary investigation to identify the number of cointegration vectors, therefore, we employ the widely used Johansen multivariate cointegration procedure (Johansen, 1988) using the same set of variables. The results of rank tests show that, with a lag length of eleven and an unrestricted constant and a linear trend, the trace statistics reject the null of no cointegrating vector (r = 0), but fail to reject the null of one cointegrating vector (r = 1) at the 5% significance level (Table 2), suggesting the existence of a *unique* long-run relationship among the four variables.[6] With identified one cointegrating vector, the test for long-run exclusion is then conducted to examine whether any of the four variables can be excluded from a cointegrating vector.[7] The results show that all the four variables are statistically relevant to the cointegrating space and cannot be excluded from the long-run relationship. From these findings, therefore, the use of the FM-OLS cointegration analysis can be justified to estimate equation (2).

With evidence that each of our data series is non-stationary $I(1)$ processes and existence of a single cointegration vector, the FM-OLS is applied to estimate equation (2). The result of the Phillips-Ouliaris (P-O) residual based test for cointegration indicates that the null hypothesis of no cointegration can be rejected at the 5% level (Table 3).[8] This finding suggests the existence of long-run relationships between Canadian lumber imports (IM_t) and the set of explanatory variables (P_t, HS_t and ER_t) in equation (2). In other words, even though individual series may have trends or cyclical or seasonal variations, the movements in one variable are matched (at least approximately) by movements in other variables (Perman 1991).[9]

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[6] Since the Johansen method is quite sensitive to changes in lag structure, we determine the lag lengths to define a correctly specified vector autoregression (VAR) model and conduct diagnostic tests to ensure that the residuals are approximately white noise (Maddala and Kim 1998). The lag lengths for the cointegration test, for example, are determined by the Schwarz (SC), Hannan-Quinn (HQ), and Akaike (AIC) information criteria using likelihood ratio (LR) tests (Doornik and Hendry 2001). In addition, diagnostic tests on the residuals of each equation and corresponding vector test statistics support the VAR model with eleven lags. The results are not reported here for brevity, but can be obtained from the authors upon request.

[7] The null hypothesis of exclusion test is formulated by restricting the matrix of long-run coefficients to zero ($\beta_i = 0$) (Johansen and Juselius 1990). To save space, however, the results are not reported here.

[8] The P-O test depends on the residuals calculated from regressions among the (log) levels of time-series data. This is designed to test the null hypothesis of no cointegration by testing the null that there is a unit root in the residuals against the alternative that the root is less than unity. If the null of a unit root is rejected, then the null of no cointegration is also rejected (Phillips and Ouliaris 1990, p.165).

[9] For comparison, we also estimate equation (2) using the traditional OLS. The Durbin-Watson (D-W) test shows that $AR(1)$ serial correlation is detected at the 5% level. Unlike OLS, the FM-OLS estimator takes account of serial correlation in a semi-parametric manner.

The results of the long-run coefficient estimates of U.S. lumber import function show that the coefficients of the lumber price and housing starts are statistically significant at the 5% level and have the expected signs (Table 3). More specifically, a positive coefficient of the domestic-import price ratio on the lumber imports suggests that, in the long-run, Canadian lumber imports tend to increase as domestic price relative to import price rises. A positive coefficient of the housing starts on the lumber imports implies that an increase in real domestic income and economic activity leads to a rise in U.S. imports of Canadian lumber through the increased demand for new homes and other new constructions. The results of U.S. lumber import function, however, show that the coefficient of the exchange rate is not statistically significant even at the 10% level, indicating that the bilateral exchange rate plays little role in determining U.S. lumber imports from Canada. One possible explanation for this finding is that, as the value of U.S. dollar decreases (depreciation), Canadian exporters tend to squeeze their profit margins to offset the increase in the export prices in order to maintain their share of the U.S. market. Notice that the housing starts is more pronounced than the lumber price in determining Canadian lumber imports in the long-run. As the lumber increases by 1%, for example, the Canadian lumber imports increase by approximately 0.36%. Given a 1% increase of the housing starts, on the other hand, the U.S. imports increase by approximately 0.51%.

It is worth mentioning that the 1996 Softwood Lumber Agreement (SLA96; April 1996-March 2000), the 2006 Softwood Lumber Agreement (SLA06; January 2007-present) and other market shocks such as the Asian financial crisis (September 1997-December 1998) may result in a change in U.S. lumber imports from Canada over the sample period. To capture such effects, three dummy variables are included in the estimation. It is found that the dummy variable for the SLA06 has a significantly negative effect on U.S. lumber imports from Canada (Table 3).[10] Having found insignificant coefficients, on the other hand, dummies for the SLA96 and the Asian financial crisis are dropped from the final model, indicating that these shocks have little impact on the bilateral lumber trade.

For completeness, we also estimate the error-correction model (ECM) using the residual obtained from equation (2) in order to examine the short-run adjustment to long-run steady state, as well as to confirm the existence of the cointegration relationship. The results show that the coefficient of the error-correction term (ec_{t-1}) is negative and statistically significant at the 5% level (Table 3). The negatively significant coefficient of ec_{t-1} implies that the equilibrium relationship will hold in the long-run, even with shocks to the system. The U.S. imports of Canadian lumber, for example, adjust by 86% to the long-run equilibrium in one month, implying that it takes less than two months (1/0.86=1.2 months) to eliminate the disequilibria. Additionally, the statistically

[10] In September 2006, the U.S. and Canada signed the 2006 Softwood Lumber Agreement (SLA06), which involves export charges and volume restraints to regulate Canadian lumber. In August 2007, however, the U.S. submitted its statement of the case regarding Canada's breaches of the SLA06 to the London Court of International Arbitration (LCIA). One of the two key issues that the two parties argued is regarding the Agreement effective date (January 2007 claimed by the U.S. side vs. July 2007 claimed by the Canadian side). The LCIA concluded that since the effective date stipulated by the Agreement can be interpreted as January 2007, Canada has failed to regulate lumber exports to the U.S. until July 2007; in other words, during the period of January- June 2007, Canada might have over-exported its lumber to the U.S. For this reason, we use two different dummies for the SLA 06 – one dummy for SLA06 covering from January 2007 and the other covering from July 2007 to capture the effectiveness of the Agreement accurately. It is found that only when using the dummy covering from July 2007, the SLA06 shows a significant impact on Canadian exports; thus, this dummy is included in the final model as reported in Table 3. This finding further provides evidence to support the hypothesis that Canada might have over-exported its lumber to the U.S. under the SLA06 during the period from January 2007 to June 2007 by failing to regulate export volumes.

significant ec_{t-1} further supports the validity of cointegrating relationship in equation (2).[11]

CONCLUDING REMARKS

In this paper we re-examine the main factors affecting U.S. softwood lumber imports from Canada. To address this issue adequately, we employ the more appropriate theoretical framework for representing U.S.-Canada lumber trade – that is, U.S. and Canadian softwood lumber are not perfect substitutes in the U.S. market, and attempt to assess the effects of the relative price of softwood lumber represented by the ratio as domestic price to import price, housing starts and exchange rate on U.S. lumber imports from Canada in a cointegration framework. For this purpose, the FM-OLS cointegration procedure is used with monthly time-series data from January 1994 to June 2009. The results of the FM-OLS show that there is one stable long-run equilibrium relationship between the U.S. lumber imports and macroeconomic and lumber market variables. The negatively significant coefficient of the error-correction term in the ECM model further supports the existence of a long-run equilibrium relationship among the variables. We also find that the lumber price and housing starts are key determinants of U.S. softwood lumber imports from Canada. The estimated coefficients further suggest that the number of housing start is more a powerful determinant of the bilateral lumber trade than the lumber price. This finding substantiates that of Baek and Yin (2006) who show that the effect of lumber price on Canadian imports is smaller than that of other market variables, particularly housing starts. On the other hand, the bilateral exchange rate is found to have

[11] The multivariate diagnostic tests on the estimated model as a system indicate no serious problems with serial correlation, heteroskedasticity, and normality; hence, the model is well defined.

a negligible effect on the level of Canadian lumber imports. This finding confirms results of Buongiorno et al. (1988) and Jennings et al. (1991), but contrasts with Sarker (1996) and Baek (2007).

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Table 1. Results of unit root test

Variable	Level	First difference	Decision
$\ln(IM_t)$	-1.909 (1)	-9.612** (3)	$I(1)$
$\ln(P_t)$	-1.128 (1)	-6.374** (1)	$I(1)$
$\ln(ER_t)$	-1.194 (1)	-3.655** (3)	$I(1)$
$\ln(HS_t)$	0.934 (9)	-7.589** (1)	$I(1)$

Note: ** and * denote the rejection of the null hypothesis of non-stationarity at the 5% and 10% significance levels, respectively. The 10% and 5% critical values for the DF-GLS, including a constant and a trend, are -2.654 and -2.944, respectively. Parentheses are lag lengths, which are chosen by the Schwarz criterion (SC).

Table 2. Results of Johansen Cointegration Test

Null hypothesis	Eigenvalue	Trace statistics
$H_0: r = 0$	0.243	75.266 [0.00]**
$H_0: r \leq 1$	0.074	26.558 [0.708]
$H_0: r \leq 2$	0.044	13.013 [0.739]
$H_0: r \leq 3$	0.029	5.212 [0.574]

Note: ** denotes rejection of the null hypothesis at the 5% significance level. p –values are given in parentheses.

Table 3. Result of the fully-modified OLS (FM-OLS) estimation

Variable	ln (Lumber imports)	
	Coefficient	t -statistic
ln (Price)	0.357	2.01**
ln (Exchange rate)	-0.107	-1.61
ln (Housing starts)	0.507	15.32**
SLA_{06}	-0.159	-4.13**
Trend	0.001	2.88**
Constant	12.554	82.72**
Phillips-Ouliaris statistic	-7.726 [1]**	
ec_{t-1}	-0.863 (-11.6)**	

Note: ** and * denote significance at the 5% and 10% levels, respectively. SLA_{06} represents a dummy variable for the Softwood Lumber Agreement 06. A bracket in the Phillips-Ouliaris (P-O) statistic is lag lengths. The 10% and 5% critical values for the P-O test are -4.195 and -4.489, respectively, which are obtained from Table Ⅱc in Phillips and Ouliaris (1990). ec_{t-1} indicates an error-correction term.