



# The end of the trade war? Effects of tariff exclusions on U.S. forest products in China

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## ABSTRACT

China's importance to the U.S. forestry sector and the disruptive effect of retaliatory tariffs raises questions about how U.S. forest products compete in the Chinese market. The goal of this study was to estimate China's lumber and log import demand and assess how tariffs affect the competitiveness of U.S. products compared to other exporting countries. Using a dynamic framework, we estimated import demand elasticities by exporting country and conducted simulations of China's new tariff exclusion policy for U.S. products. Results indicated that Chinese importers are highly sensitive to U.S. lumber and log prices, which could explain the significant decline in U.S. exports to China when the retaliatory tariffs were imposed. Projections suggest that tariff elimination should benefit U.S. lumber and log exports to China, primarily at the expense of Russian lumber. However, results indicate that China's new tariff exclusion policy may not be enough to get U.S. forest products back to pre-trade war levels.

## 1. Introduction

Although the "Phase One" Trade Agreement (signed January 2020) between the United States and China did not explicitly address the tariffs that China imposed on U.S. products in response to the Section 301 tariffs that the U.S. imposed on China, it set the stage for a decrease in tensions and the eventual removal of tariffs in the future.<sup>1</sup> This is somewhat evidenced by the announcement in February 2020 by China's State Council Tariff Commission that tariff exclusions will apply to select U.S. commodities. Included among eligible products are U.S. forest products that currently face retaliatory tariffs as high as 25% in the Chinese market. As of March 2020, Chinese manufacturers and importers are able to apply for exclusion and import U.S. forest products without paying the retaliatory tariffs (Inouye, 2020).

The retaliatory tariffs imposed on U.S. forest products resulted in a substantial decline in U.S. exports to China (Pryor, 2019). Most notable were the declines in U.S. lumber and log exports. Since 2001, U.S. forest product exports have increase from less than \$5 billion to a record \$9.6 billion in 2018 (an increase of 95%), primarily driven by increased

demand for U.S. lumber and logs in China. Since 2001, U.S. forest product exports to China increased from less than \$100 million to over \$3.2 billion by 2017, an increase of over 500% (Foreign Agricultural Service, 2020). Within the last two decades, China has gone from a negligible importer of U.S. forest products to accounting for over one-third of all U.S. forest product exports and approximately half of all U.S. lumber and log exported in 2017. In 2019, total U.S. lumber and log exports were down 26% and 31%, respectively, when compared to 2017. During this same period, U.S. lumber and log exports to China were both down 50% (Foreign Agricultural Service, 2020).

China's importance to the U.S. forestry sector and the disruptive effect of retaliatory tariffs raises questions about how U.S. forest products compete in the Chinese market. The primary question being, what are the losses from retaliatory tariffs and potential gains from the new tariff exclusions? The potential gains from tariff exclusions will depend on how Chinese importers view U.S. forest products vis-à-vis imports from Canada, New Zealand, Russia, and other exporting countries. In addition, Chinese preferences could also differ across forest products, where gains for one product (e.g., lumber) could be offset by losses for

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<sup>1</sup> The U.S. imposed Section 301 tariffs on Chinese products in 2018 based on an investigation that determined that Chinese policies and practices related to technology transfer, intellectual property, and innovation were unreasonable and discriminatory. Section 301 of the U.S. Trade Act of 1974 authorizes the President to take any appropriate action, including tariff-based and non-tariff-based retaliation.

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another (e.g., logs), even when imported from the same country.

Given the make-up of U.S.-China forest product trade, two product categories are considered for this study: Harmonized System Classification (HS) 4407 *lumber* and HS 4403 *logs*.<sup>2</sup> These two categories account for over 90% of all U.S. forest product exports to China (Foreign Agricultural Service, 2020). The overall goal of this study is to examine how tariffs affect the competitiveness of U.S. lumber and logs in the Chinese market. We employ a demand-system approach to estimate China's import demand for forest products by production source or country of origin (U.S., Russia, etc.) and product (lumber and logs). In this context, lumber or logs from a particular country (e.g., U.S. lumber) are individual goods that compete with lumber and logs from other exporting sources.

The generalized dynamic Rotterdam model developed by Bushehri (2003) is used in estimating China's demand for imported lumber and logs. The model is an extension of the static Rotterdam model developed by Theil (1980). However, unlike a static demand model, the model can account for dynamic behavior such as import trends, habit formation, and non-instantaneous adjustments in import demand. Results of this study shows that dynamic behavior significantly explain Chinese import demand beyond that of total expenditures and prices. Following the theoretical framework of Theil (1980) and Laitinen (1980) and recent empirical trade applications (Muhammad et al., 2018; Muhammad et al., 2012), we also estimate China's total import demand, i.e., the demand for lumber and logs aggregated across all sources. Total import demand estimates allow for policy simulations that can account for the trade-creation effect of a tariff or price change, whereas the estimates from the demand system can only account for the trade-diversion effect of a tariff or price change. Using the demand-system and total import demand estimates, we derive short- and long-run demand elasticities and conduct Monte Carlo simulations to derive import projections based on the elimination of tariffs on U.S. forest products.

This analysis builds upon the literature that focuses on the global demand for forest products and related policies and confirms the importance of accounting for product heterogeneity due to country of origin (source differentiation) (Sun and Niquidet, 2017). We make an important contribution by also discerning the competition across products within and across exporting countries (Sun, 2014, 2015). Studies have also considered the heterogeneity or separability of imported log and lumber demand in destination markets. That is, they estimated the demand for imported logs separate from imported lumber (Niquidet and Tang, 2013).

Forest-product trade policy research specific to China include Gan (2004) who examined the implications of China joining the WTO on global forest product trade and found that China's accession would increase global trade but would have a small impact on global prices. Past research also considered the role of policy and the importance of Asian markets to U.S. timber exports (Xiang and Yin, 2006). Although not specific to trade, studies have focused on economic reforms and social, environmental, and conservation policies in China (Huang et al., 2013; Tian et al., 2017; Zhang and gan, 2007). Given the recentness of the U.S.-China trade war, the literature on how the dispute affected U.S. forest products in the Chinese market is limited. A noted exception includes Zhang et al. (2020).

## 2. Background

The growth in China's demand for forest products, particularly imported lumber and logs, has been driven by a rise in construction activity and global demand for Chinese furniture, plywood, flooring, and other

<sup>2</sup> Official trade definitions: HS 4407 (lumber) – wood sawn or chipped lengthwise, sliced or peeled, whether or not planed, sanded or end-jointed, of a thickness exceeding 6 mm, and HS 4403 (logs) – wood in the rough, whether or not stripped of bark or sapwood, or roughly squared.

wood-product exports (Flynn, 2017). Since 2008, China's lumber imports have increased considerably, from 7 million cubic meters (m<sup>3</sup>) to 35 million m<sup>3</sup> in 2018, an increase of 385%. China's log imports also increased during this period (from less than 30 million m<sup>3</sup> to 59 million m<sup>3</sup>).<sup>3</sup> In terms of value, lumber imports increased from around \$2 billion in 2008 to \$10 billion in 2018, and log imports increase from around \$5 billion to \$11 billion (Fig. 1).

In 2019, China's lumber and log imports slowed in terms of quantity and actually decreased in terms of value (\$21 billion to \$18 billion). This decline is partly due to the U.S.-China trade war. The tariffs that China imposed on U.S. products resulted in a substantial decrease in imports from the U.S. The decrease in total imports could be due to Chinese buyers not being able to immediately transition to alternative sources due to specificities in production (i.e., U.S. hardwoods used for a particular type of furniture) and the time needed to find new foreign suppliers. Compounding this issue are the tariffs that the U.S. imposed on furniture and other wood products from China. For instance, U.S. furniture imports from China were down \$8 billion (–25%) in 2019 when compared to the previous year (U.S. Census Bureau, 2020). Since the U.S. is a major destination for Chinese exports, the decrease in sales to the U.S. may have decreased overall demand for primary inputs like lumber and logs. The decline in 2019 may not be solely due to the trade war. Decreases in the available supply of lumber and logs globally, shifts in exports to more competitive markets like Vietnam, and Chinese policies to slow the growth of construction are factors that may have also contributed to the recent decline (Flynn, 2017; Pryor, 2019).

## 3. Empirical model

Source differentiation (Armington, 1969) is assumed for modeling China's demand for imported lumber and logs. In this context, lumber or logs from the *i*th exporting country are treated as individual goods (e.g.,

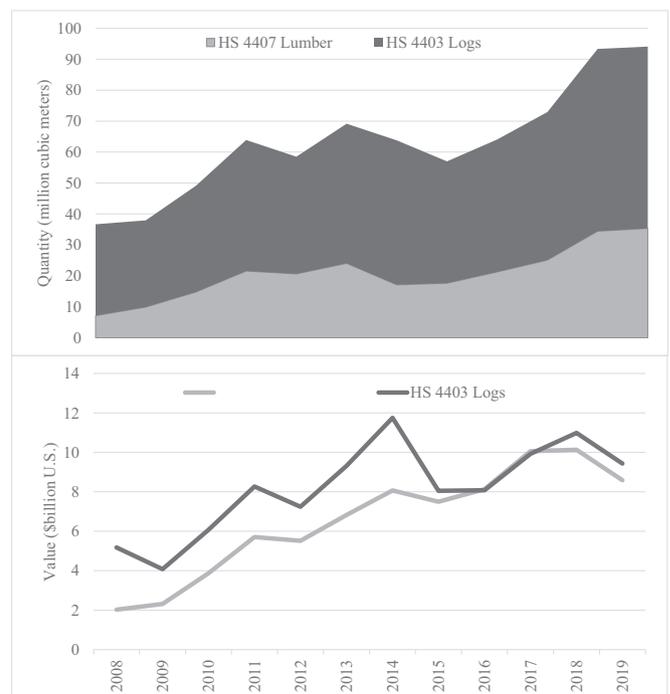


Fig. 1. China's Lumber and Log Imports: 2008–2019. Note: A cubic meter is approximately 424 board feet. Source: Trade Data Monitor, Inc.

<sup>3</sup> A cubic meter is approximately 424 board feet.

U.S. logs), which are part of the product group *imported lumber and logs*. Each good is considered an imperfect substitute for lumber or logs from other exporting countries. There is also imperfect substitutability between lumber and logs when imported from the same country.

Let  $q$  and  $p$  denote the quantity and price of imported lumber or logs in China,  $i$  and  $j$  denote the product origin (exporting country), and  $n$  denote the number of individual imports within the product group. Given these terms, the demand for lumber or logs from the  $i$ th country is expressed using the following dynamic demand model (Bushehri, 2003):

$$\bar{w}_{it}\Delta q_{it} = \gamma_i + \sum_{j=1}^n \gamma_{ij}\Delta q_{jt-1} + \theta_i\Delta Q_t + \sum_{j=1}^n \pi_{ij}\Delta p_{jt} + \varepsilon_{it} \quad (1)$$

Note that  $\Delta$  is the log-difference operator where for any  $q$  and  $p$ ,  $\Delta q_t = \ln q_t - \ln q_{t-12}$  and  $\Delta p_t = \ln p_t - \ln p_{t-12}$ . Since monthly data are used for this analysis, the 12th-period difference is used to correct for seasonal variation (Lee, 1988).  $w_{it} = \frac{p_{it}q_{it}}{\sum_{i=1}^n p_{it}q_{it}}$  is the average import share for the  $i$ th source and  $\bar{w}_{it}$  is the two-period average of  $w_{it}$ :  $\bar{w}_{it} = \frac{1}{2}(w_{it} + w_{it-12})$ .  $\Delta Q_t$  is the finite version of the Divisia volume index, which is a measure of aggregate import expenditures in real terms and is derived as follows:  $\Delta Q_t = \sum_{i=1}^n \bar{w}_{it}\Delta q_{it}$ .  $\theta_i = \frac{\partial q_i}{\partial Q}$  is the marginal import share or expenditure effect and  $\pi_{ij}$  is the Slutsky price coefficient or conditional price effect measuring the impact of the  $j$ th country price on imports from the  $i$ th source.  $\gamma_i$  is a constant, which is a measure of imports trends since a trend term in levels is represented by a constant term in a differenced model.  $\varepsilon_{it}$  is a random disturbance term.

$\gamma_{ij}$  is a measure of dynamic behavior, that is, the impact of past imports from the  $j$ th source on present imports from the  $i$ th source. A positive own-lag estimate ( $\gamma_{ii} > 0$ ) suggest habit persistence or adjustment costs, indicating that imports of a product increases preference for that product, resulting in even greater imports in the future. A negative estimate ( $\gamma_{ii} < 0$ ) reflect short-run inventory management and stocking behavior. The sign and magnitude of the cross-lag estimates ( $\gamma_{ij}$ ) depend on the cross-price relationship between products (substitutes versus complements) and the adjustment behavior of buyers (habits persistence versus inventory management) (Pollak, 1970).

Eq. (1) states that changes in the quantity imported from the  $i$ th source weighted by the  $i$ th import share is a function of the import trend for that source and changes in past imports from all countries, real aggregate expenditures on imported lumber and logs, and individual import prices.

$\gamma_i$ ,  $\gamma_{ij}$ ,  $\theta_i$ , and  $\pi_{ij}$  are treated as fixed parameters for estimation. Demand theory requires the following parameter restrictions for adding-up, homogeneity, and symmetry:  $\sum_i \theta_i = 1$  and  $\sum_i i' = \sum_i i'j = \sum_i i'j = 0$  (adding up);  $\sum_j \pi_{ij} = 0$  (homogeneity); and  $\pi_{ij} = \pi_{ji}$  (symmetry). The model satisfies adding-up by construction. Homogeneity and symmetry are imposed on the parameters and statistically tested.

Given the parameters in Eq. (1), the short-run expenditure and compensated price elasticities are respectively  $\frac{\theta_i}{\bar{w}_i}$  and  $\frac{\pi_{ij}}{\bar{w}_i}$  (Seale et al., 1992). Setting  $\Delta q_{jt} = \Delta q_{jt-1}$ , we can derive the long-run expenditure and compensated price elasticities respectively as follows:  $\frac{\theta_i}{\bar{w}_i - \gamma_{ii}}$  and  $\frac{\pi_{ij}}{\bar{w}_i - \gamma_{ii}}$ .

It is important to account for both trade creation and diversion when analyzing the impact of tariffs or prices. Tariffs on a product affect the price that Chinese importers pay for that product, resulting in importers substituting across exporting sources (trade diversion), decreasing imports from one country in favor of another. However, a tariff could also impact China's aggregate import expenditures (trade creation). To account for this effect, we estimate China's total import demand for lumber and logs. Given the derived nature of lumber and log demand, total import demand is based on the notion that imports are "resold" in China for further processing. Following Theil (1980), the relationship between total import demand and prices is specified by the following Divisia quantity index relationship:

$$\Delta Q_t = \Theta [\Delta p_t^* - \Delta P_t^i] \quad (2)$$

The variable  $p^*$  denotes a representative domestic or final-good price, which also reflects the price that importers receive if they resell lumber or logs domestically, and  $\Delta P_t^i$  is the Frisch import price index, which is an average measure of import prices. The Frisch import price index is defined as follows:

$$\Delta P_t^i = \sum_j \theta_j \Delta p_{jt} \quad (3)$$

$\theta_j$  is the marginal import share for the  $j$ th source and  $\Delta p_{jt} = \ln p_{jt} - \ln p_{jt-12}$ , both are as previously defined.  $\Theta$  is the Frisch price effect, which is assumed positive since an increase in China's domestic price makes importing logs and lumber more profitable resulting in an increase in total imports. A positive Frisch price effect also indicates an inverse relationship ( $-\Theta$ ) between the import price index ( $\Delta P_t^i$ ) and China's aggregate import expenditures.

Eqs. (1), (2), and (3) are used to derive the unconditional price elasticities in the short-run and long-run:

$$\eta_{ij}^{SR} = \frac{\% \Delta q_{it}^{SR}}{\% \Delta p_{jt}} = -\frac{\Theta \theta_i \theta_j}{\bar{w}_i} + \frac{\pi_{ij}}{\bar{w}_i} \quad (4)$$

$$\eta_{ij}^{LR} = \frac{\% \Delta q_{it}^{LR}}{\% \Delta p_{jt}} = -\frac{\Theta \theta_i \theta_j}{\bar{w}_i - \gamma_{ii}} + \frac{\pi_{ij}}{\bar{w}_i - \gamma_{ii}} \quad (5)$$

Both equations measure the percentage change in the  $i$ th import with respect to a one-percent change in the  $j$ th price. Eq. (4) is the immediate response to a price change and Eq. (5) is the long-run response. The first term in Eqs. (4) and (5) is the total import effect (trade creation), which is the effect of prices on an import through changes in total import expenditures. The second term is the conditional price effect (trade diversion), which accounts for the substitution across exporting countries due to relative price changes.

#### 4. Data

Monthly import data (2008:1–2019:12) were obtained from Trade Data Monitor®. As mentioned, China's lumber and logs imports are based on the following trade categories: HS 4407 (lumber) *wood sawn or chipped lengthwise, sliced or peeled, whether or not planed, sanded or end-jointed, of a thickness exceeding 6 mm* and HS 4403 (logs) *wood in the rough, whether or not stripped of bark or sapwood, or roughly squared*. The products included in the analysis are the following: Canadian lumber, Indonesian lumber, Russian lumber, Thai lumber, U.S. lumber, Canadian logs, New Zealand logs, Papua New Guinea logs, Russian logs, and U.S. logs. Imports from the *rest of world* (ROW) are also included in the analysis and are specified as ROW lumber and ROW logs. Both are aggregations of the exporting countries not specified.

Table 1 shows the annual value (2008–2019) of imported lumber and logs in China and market shares by product and source. On average, the import share of logs (58%) has been larger than lumber (42%). Lumber accounted for as low as 28% in 2008 but has steadily increased over the last decade. In 2008, logs from Russia accounted for a significant share of total lumber and log imports in China (35%). No other product was close by comparison. Since 2008, China has become less dependent on logs from Russia, but more dependent on lumber from Russia, which was up from 5% in 2008 to nearly 18% in 2019. This change mostly reflects Russian policies of taxing logs exports in favor of more processed products like lumber (Solberg et al., 2010).

Before the U.S.-China trade dispute in 2018, U.S. lumber and logs respectively accounted for approximately 14% of China's imports. In 2019, U.S. lumber and logs only accounted for 9%. Countries that have account for a relatively large share of China's lumber and log imports over the last decade include Russia with an average share of 24%, the U. S. (12%), Canada (9%), and New Zealand (9%). Relatively smaller supplying countries include Thailand (5%), Papua New Guinea (4%), and Indonesia (1%).

Unit values (value ÷ quantity) are used as proxies for import prices

**Table 1**  
China's lumber and log import value and shares: 2008–2019.

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average
Value (\$ billion U.S.)	7.2	6.5	10.1	14.4	13.2	16.7	20.4	15.9	16.7	20.6	21.6	18.5	15.1
	Product market share (%)												
Lumber	27.9	35.9	38.2	39.6	41.9	40.9	39.5	47.1	48.9	48.9	46.9	46.5	41.9
Logs	72.1	64.1	61.8	60.4	58.1	59.1	60.5	52.9	51.1	51.1	53.1	53.5	58.1
	Exporter/product market share (%)												
Canadian lumber	2.9	5.6	7.5	9.7	9.6	9.3	7.4	7.0	5.4	5.0	4.4	4.8	6.5
Indonesian lumber	1.2	1.0	1.2	1.6	1.7	1.0	1.1	1.2	1.3	1.3	1.3	0.7	1.2
Russian lumber	5.3	9.3	8.9	9.2	9.7	8.2	7.6	11.2	14.0	14.5	15.1	17.5	10.9
Thai lumber	3.1	4.5	5.0	4.1	4.9	5.2	5.0	6.5	7.6	7.4	6.5	5.6	5.4
U.S. lumber	5.2	4.8	5.5	6.5	6.6	6.5	7.1	8.5	8.7	8.3	7.6	4.5	6.6
ROW lumber	10.3	10.7	10.2	8.6	9.4	10.9	11.3	12.8	11.9	12.4	11.9	13.4	11.1
Canadian logs	0.6	0.8	1.8	3.1	3.0	3.2	2.9	2.3	2.6	2.8	2.2	2.5	2.3
New Zeal. logs	3.4	6.6	7.9	8.1	8.5	10.1	8.3	7.6	8.6	9.3	11.3	12.3	8.5
Papua NG logs	5.7	4.3	4.7	4.0	4.0	3.7	3.9	4.2	3.4	2.9	3.7	3.3	4.0
Russian logs	35.3	26.9	18.0	14.7	11.9	8.4	7.5	8.0	7.6	6.8	6.0	4.9	13.0
U.S. logs	2.0	2.6	5.7	7.1	5.6	7.5	6.7	5.2	6.1	6.4	6.4	4.0	5.4
ROW logs	25.0	22.9	23.7	23.4	25.1	26.1	31.2	25.5	22.8	22.8	23.3	26.5	24.9

Note: New Zeal. is *New Zealand*, Papa NG is *Papua New Guinean*, and ROW is *rest of world*.

Source: Trade Data Monitor, Inc.

**Table 2**  
China's lumber and log import prices: 2008–2019.

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
	Price (\$/cubic meter)											
Canadian lumber	182.4	149.2	188.4	203.6	195.5	225.5	423.6	379.0	320.0	372.9	224.3	196.1
Indonesian lumber	379.3	302.7	306.4	290.6	301.2	439.3	916.2	858.4	883.5	927.6	861.8	800.1
Russian lumber	195.3	192.1	205.4	217.6	206.4	193.9	273.3	253.4	247.7	266.1	194.4	178.7
Thai lumber	285.1	285.0	355.9	371.3	426.1	455.3	525.8	449.8	414.1	423.5	423.1	380.1
U.S. lumber	358.5	334.7	386.1	347.3	389.1	416.8	828.9	817.0	757.9	805.3	686.1	593.8
ROW lumber	387.0	318.5	331.2	349.0	355.4	343.3	598.5	582.7	512.0	496.9	353.9	294.2
Canadian LOGS	205.3	137.7	153.0	181.0	162.3	197.4	224.0	193.0	203.2	241.1	193.2	184.2
New Zeal. logs	129.1	96.8	133.8	142.3	129.9	146.5	164.4	131.8	142.1	166.0	141.6	129.0
Papua NG logs	185.4	165.4	192.9	208.5	202.8	227.0	250.6	259.2	213.4	246.8	271.6	202.3
Russian logs	137.2	117.2	129.7	150.3	139.7	137.3	158.3	139.0	128.3	140.3	122.3	119.4
U.S. logs	369.6	221.3	208.5	210.2	203.3	221.6	254.0	230.9	222.4	247.5	220.4	198.5
ROW logs	284.7	230.4	263.0	273.5	278.1	289.6	349.7	274.0	243.7	253.3	232.3	183.3

Note: New Zeal. is *New Zealand*, Papua NG is *Papua New Guinean*, and ROW is *rest of world*. A cubic meter is approximately 424 board feet.

Source: Trade Data Monitor, Inc.

(Table 2). There are significant price differences across products, ranging from as high as \$605.6/cubic meter and \$560.1/cubic meter for Indonesian and U.S. lumber, respectively, to as low as \$137.8/cubic meter and \$134.9/cubic meter for New Zealand and Russia logs, respectively. Observe price differences are due to several factors. In general, softwoods grow quicker than hardwoods and are therefore easier to replenish. As a result, softwoods tend to be cheaper than hardwoods. Processed wood products are also more expensive than unprocessed logs. A large percentage of U.S. and Indonesian exports are higher quality hardwoods. China has historically been a major market for more than half of U.S. hardwood production. Also, according to FAO, Indonesia has a developed wood-based panel industry that exports high quality teak hardwoods. Russia has the capacity to process only a small percent of its annual harvest; and because of its limited processing capacity, it exports cheaper timber instead of higher priced forest products. Also, the majority of Chinese imports of cheaper softwood logs and lumber come from Russia and New Zealand. These factors likely contribute to the price differences across countries (Kinney, 2008; Robbins et al., 2004; Hasan, 1991).

## 5. Estimation and results

The demand system represented by Eq. (1) was estimated using the generalized Gauss-Newton method in TSP (version 5.0), which is a maximum likelihood procedure for equation systems (Hall and

Cummins, 2009). Being of the class of differential demand systems, the Rotterdam model is estimated using differenced data. Although the process of modeling variables usually make nonstationary variables stationary (Matsuda, 2005), we still verify the stationarity of each price series using Phillips-Perron tests. Based on test results, we can reject the hypothesis of a unit root for each price series in annual differences, but not in levels (see Table A.3 in the appendix). The homogeneity and symmetry restrictions were imposed on the parameters and verified using likelihood ratio tests. The joint significance of the dynamic adjustment (lag) estimates was also assessed using a likelihood ratio test. Test results indicated that the lag estimates should be included in the model, but homogeneity and symmetry were both rejected at the 0.05 significance level. Homogeneity and symmetry were still imposed on the model because studies have shown that these restrictions improve the forecasting ability of demand systems even when they are statically rejected (Kastens and Brester, 1996).

### 5.1. Elasticity estimates

Since the model estimates are best understood when expressed as elasticities, the following discussion is limited to the elasticity estimates. The model estimates used to derive the elasticities are reported and discussed in the Appendix. The expenditure, unconditional own-price, and unconditional cross-price elasticities (with respect to U.S. prices) are reported in Table 3. The expenditure elasticities measure the

**Table 3**  
China's short-run and long-run expenditure and unconditional price elasticities of demand by source and product.

Country/ product	Expenditure	Own-price	Cross-price U. S. lumber	Cross-price U. S. logs
	Short-run			
Canadian lumber	2.01 (0.20)***	-0.60 (0.23)***	-0.12(0.15)	0.12(0.18)
Indonesian lumber	0.44 (0.07)***	-0.29 (0.06)***	0.25(0.10)***	-0.10(0.08)
Russian lumber	0.54 (0.10)***	0.32(0.22)	0.33(0.13)***	0.21(0.11)*
Thai lumber	1.06 (0.12)***	-0.40 (0.19)**	-0.11(0.16)	-0.36 (0.14)**
U.S. lumber	1.21 (0.10)***	-1.04 (0.17)***		0.16(0.12)
ROW lumber	0.76 (0.06)***	-0.79 (0.12)***	-0.11(0.07)	-0.01(0.06)
Canadian logs	3.03 (0.32)***	-0.98 (0.42)**	-0.04(0.40)	0.51(0.39)
New Zeal. logs	1.43 (0.16)***	-0.25 (0.23)	0.27(0.13)**	0.24(0.16)
Papua NG logs	0.97 (0.16)***	-0.11 (0.21)	0.29(0.15)**	-0.46 (0.17)***
Russian logs	0.48 (0.07)***	-0.71 (0.14)***	-0.08(0.06)	0.01(0.07)
U.S. logs	2.30 (0.25)***	-1.32 (0.33)***	0.25(0.18)	
ROW logs	1.00 (0.06)***	-0.30 (0.11)***	-0.06(0.04)*	-0.08(0.05)*
	Long-run			
Canadian lumber	5.71 (1.94)***	-1.69 (0.84)**	-0.34(0.43)	0.34(0.52)
Indonesian Lumber	0.54 (0.08)***	-0.36 (0.07)***	0.31(0.12)***	-0.12(0.09)
Russian lumber	1.22 (0.42)***	0.72(0.50)	0.75(0.36)**	0.46(0.30)
Thai lumber	2.42 (0.56)***	-0.92 (0.44)**	-0.26(0.36)	-0.81 (0.37)**
U.S. lumber	1.55 (0.20)***	-1.32 (0.22)***		0.20(0.15)
ROW lumber	0.90 (0.11)***	-0.95 (0.12)***	-0.13(0.09)	-0.01(0.08)
Canadian logs	2.74 (0.47)***	-0.89 (0.41)**	-0.04(0.36)	0.47(0.37)
New Zeal. logs	1.95 (0.34)***	-0.34 (0.32)	0.37(0.18)**	0.33(0.23)
Papua NG logs	1.10 (0.21)***	-0.13 (0.23)	0.33(0.17)**	-0.52 (0.20)***
Russian logs	0.66 (0.11)***	-0.98 (0.23)***	-0.11(0.08)	0.02(0.09)
U.S. logs	2.29 (0.31)***	-1.31 (0.33)***	0.25(0.18)	
ROW logs	1.45 (0.17)***	-0.43 (0.17)**	-0.09(0.05)*	-0.12(0.07)*

Note: New Zeal. is *New Zealand*, Papua NG is *Papua New Guinean*, and ROW is *rest of world*. Asymptotic standard errors are in parentheses.

\*\*\* Significance level = 0.01.

\*\* Significance level = 0.05.

\* Significance level = 0.10.

percentage responsive of an import to a one-percent change in total expenditures on the import group. The short-run expenditure elasticities for Canadian lumber (2.01), Canadian logs (3.03), U.S. logs (2.30), and U.S. lumber (1.21) indicate a relatively large responsive to total import spending. In percentage terms, these products have been the most sensitive to changes in total spending on imported lumber and logs in China. Since habit persistence was found for most imports, demand is more expenditure elastic in the long-run, particularly for Canadian lumber (5.71), Canadian logs (2.74), Thai lumber (2.42), and U.S. logs (2.29). Even in the long-run, the responsiveness of Indonesian lumber and Russian logs to changes in China's total expenditures is relatively small.

Recall that the total import demand estimates are needed to derive the unconditional price elasticities. To estimate China's total demand for

imported lumber and logs, the following empirical form was used:  $\Delta Q_t = \Theta_0 + \Theta_1 \Delta p_t^* + \Theta_2 \Delta P_t' + \mu_t$ . China's CPI was used as a proxy for the domestic price ( $p_t^*$ ) and should reflect the domestic conditions affecting final-product sales.<sup>4</sup> The Frisch import price index ( $\Delta P_t' = \sum_j \hat{\theta}_j \Delta p_{jt}$ ) was derived using the marginal share estimates, which are reported in the Appendix (see Table A.1). Results indicated that the estimated import price effect  $\hat{\Theta}_2 = -0.67(0.23)$  is consistent with theory and significant at the 0.01 level.<sup>5</sup> This indicates that given a one-percent increase in the import price level, aggregate expenditures on lumber and logs in China decrease by almost 0.7%. This estimate, along with the marginal share and condition price estimates, are used to derive the unconditional price elasticities.

The unconditional own-price elasticities measure the responsiveness of an import in percentage terms to a one-percent change in the price of that import. However, unlike conditional price elasticities these estimates encompassed both the trade creation and trade diversion effect of a price change. Overall, China's demand for lumber and logs by source is for the most part inelastic, that is, a relatively small response to own-price changes for most products. The exceptions are U.S. lumber (-1.04) and logs (-1.32), indicating that Chinese importers are particularly sensitive to U.S. prices in the short-run. This could explain the sudden decline in U.S. lumber and logs exports from the retaliatory tariffs. In the long-run, demand is relatively more elastic for Canadian lumber (-1.69) and U.S. lumber (-1.32). Estimates suggest that that Chinese importers are relatively more sensitive to North American prices, particularly when given the time to fully respond to price changes.

The unconditional cross-price elasticities with respect to U.S. prices are also reported in Table 3. Overall, the short-run and long-run cross-price elasticities with respect to U.S. lumber prices indicate a competitive relationship between U.S. lumber and Indonesian lumber (short-run = 0.25 and long-run = 0.31), Russian lumber (0.33 and 0.75), New Zealand logs (0.27 and 0.37), and Papua New Guinea logs (0.29 and 0.33). Note that imports of Russian lumber are the most responsive to U.S. lumber prices, suggesting that Russian lumber would be the most impacted by China's tariff exclusion policy. The short-run and long-run cross-price elasticities with respect to U.S. log prices indicate complementary relationships with Thai lumber (-0.36 and -0.81) and Papua New Guinea logs (-0.46 and -0.52). Note that these complementary relationships are based on the negative cross-price estimates between U.S. logs and Thai lumber and Papua New Guinea logs (See Table A.1), as well as the effect of U.S. log prices on total imports.

### 5.2. Policy simulation

The import projections reported in this section are based on the Chinese Government abolishing all retaliatory tariffs on U.S. lumber and logs. To simplify the analysis, we assumed that tariffs are fully passed through to import prices, which implies that Chinese importers bear the full burden of tariffs. Although this may not be the case, the resulting import projections could be considered upper-bound responses. Monte Carlo simulations are used to derive 95% confidence intervals (CI) of import responsiveness. All projections are based on 2019 baseline values. Three-year averages (2016–18) are also reported to assess how the projections compare to imports before the U.S.-China trade war. Projection are reported in Table 4.

Results indicate that the elimination of tariffs on U.S. lumber and logs will have a negligible effect on China's total log and lumber imports, but a significant impact on specific countries. To be expected, imports of U.S. lumber and logs are projected to increase due to lower

<sup>4</sup> China's CPI was obtained from the Federal Reserve Economic Data, Economic Research Division, Federal Reserve Bank of St. Louis: <https://fred.stlouisfed.org>.

<sup>5</sup> 0.23 is the standard error.

**Table 4**  
China's import projections assuming U.S. lumber and logs tariff exclusion.

Country/product	2016–18	Share	2019	Share	Projection	Share	95% CI	Δ 95% CI
	(\$ mill.)	(%)	(\$ mill.)	(%)	(\$ mill.) <sup>a</sup>	(%)	(\$ million)	(\$ million)
					Short-run projections			
Canadian lumber	960	5.0	890	4.9	890.2	4.9	[816.0 to 963.7]	[–73.7 to 74.1]
Indonesian lumber	254	1.3	130	0.7	126.6	0.7	[121.5 to 131.8]	[–8.5 to 1.8]
Russian lumber	2855	14.9	3233	17.9	2937.1	16.3	[2758.3 to 3114.2]	[–475.3 to –117.7]
Thai lumber	1400	7.3	1038	5.8	1121	6.2	[1045.5 to 1195.7]	[8.2 to 158.1]
U.S. lumber	1604	8.4	824	4.6	947.2	5.3	[890.1 to 1004.2]	[65.7 to 179.7]
ROW lumber	2371	12.4	2477	13.7	2527.8	14.0	[2447.7 to 2607.7]	[–29.2 to 130.6]
Canadian logs	496	2.6	468	2.6	430.5	2.4	[346.8 to 513.3]	[–121.2 to 45.6]
New Zeal. logs	1935	10.1	2277	12.6	2078.3	11.5	[1909.4 to 2246.3]	[–367.5 to –30.5]
Papua NG logs	657	3.4	605	3.4	622	3.5	[574.9 to 668.8]	[–29.6 to 63.6]
Russian logs	1321	6.9	909	5.0	919.2	5.1	[890.7 to 947.7]	[–18.2 to 38.6]
U.S. logs	1245	6.5	738	4.1	872	4.8	[774.2 to 969.9]	[36.0 to 231.7]
ROW logs	4010	21.0	4436	24.6	4548.7	25.2	[4443.8 to 4655.6]	[6.8 to 218.7]
Total imports	19,108	100.0	18,025	100.0	18,020.5	100.0		
					Long-run projections			
Canadian lumber	960	5.0	890	4.9	890.4	5.0	[598.7 to 1146.6]	[–289.1 to 256.5]
Indonesian lumber	254	1.3	130	0.7	125.8	0.7	[119.4 to 132.2]	[–10.6 to 2.2]
Russian lumber	2855	14.9	3233	17.9	2565.5	14.5	[1429.3 to 2997.3]	[–1809.8 to –235]
Thai lumber	1400	7.3	1038	5.8	1227.7	6.9	[1056.2 to 1462.8]	[18.0 to 423.7]
U.S. lumber	1604	8.4	824	4.6	980.9	5.5	[910 to 1055.8]	[86.6 to 231.9]
ROW lumber	2371	12.4	2477	13.7	2537.7	14.3	[2441.3 to 2639.1]	[–35.0 to 161.5]
Canadian logs	496	2.6	468	2.6	434	2.4	[348.7 to 508.9]	[–118.8 to 40.7]
New Zeal. logs	1935	10.1	2277	12.6	2006.1	11.3	[1725 to 2237.3]	[–552.2 to –39.8]
Papua NG logs	657	3.4	605	3.4	624.4	3.5	[571 to 679.2]	[–34.1 to 75.1]
Russian logs	1321	6.9	909	5.0	923	5.2	[884.2 to 965.5]	[–24.9 to 56.6]
U.S. logs	1245	6.5	738	4.1	871.3	4.9	[775.3 to 975]	[37.7 to 237.7]
ROW logs	4010	21.0	4436	24.6	4548.7	25.6	[4443.6 to 4655.3]	[7.9 to 219.1]
Total imports	19,108	100.0	18,025	100.0	17,735.5	100.0		

Note: New Zeal. is *New Zealand*, Papua NG is *Papua New Guinea*, and ROW is *rest of world*.

<sup>a</sup> Projections are based on 2019 imports as the baseline.

prices from tariff elimination. Imports of U.S. lumber increase from \$824 million to \$947 million in the short-run and \$981 million in the long-run. The confidence interval suggests that imports of U.S. lumber could increase to as much as \$1.06 billion in the long-run. This is still less than the 2016–18 three-year average (\$1.6 billion), which indicates that tariff elimination alone will not result in the full recovery of U.S. lumber in the Chinese market. This is also the case for U.S. logs where the elimination of tariffs results in an increase in imports from \$738 million to about \$872 million in the short-run and long-run. Imports of U.S. logs could increase to as much as \$975 million in the long-run based on the confidence interval for this projection. Note that this is still less than the 2016–18 three-year average (\$1.25 billion).

The confidence intervals for the import change ( $\Delta$  95% CI) contain zero for the following: Canadian lumber, Indonesian lumber, ROW lumber, Canadian logs, Papua New Guinea logs, and Russian logs, indicating that projections for these imports are statically zero, regardless of the direction or magnitude. That is, the elimination of tariffs on U.S. products would have a negligible effect on these imports in the Chinese market. Russian lumber would be the most impacted by the elimination of tariffs on U.S. products. Russian lumber is projected to decrease from \$3.2 billion to \$2.9 billion in the short-run and \$2.6 billion in the long-run. The confidence interval indicates that imports of Russian lumber could fall to \$1.4 billion in the long-run, which is a loss of \$1.8 billion. New Zealand logs will also be impacted by the elimination of tariffs on U.S. products. Imports of New Zealand logs decrease from \$2.3 billion to \$2.0 billion in the long-run [95% CI: \$1725.0 to \$2237.3]. Thai lumber is the only import projected to benefit from U.S. tariff elimination, increasing from \$1.04 billion to \$1.2 billion in the long-run [95% CI: \$1429.3 to \$2997.3].

## 6. Conclusion

The goal of this study was to examine how tariffs affect the relative competitiveness of the U.S. lumber and logs in the Chinese market. We derived source- and product-specific import demand elasticities for China and assess the change in imports due to the elimination of tariffs on U.S. products. Price elasticity estimates indicated that Chinese importers are particularly sensitive to U.S. lumber and log prices, which could explain the significant decline in U.S. exports to China from the trade war.

Import projections suggest that tariff elimination can benefit U.S. lumber and log exports to China, primarily at the expense of Russian lumber. However, China's tariff exclusion policy may not be enough to get U.S. exports back to pre-trade war levels. Chinese importers may be responding to the uncertainty created by the trade war in addition to the tariffs. This could also explain why tariff elimination alone will not be enough for a full recovery. For instance, it has been noted that Chinese manufacturers shifted to using Russian birch instead of American yellow poplar, as a result of trade war (Pryor, 2019). As new trade relationships are established, Chinese manufacturers may not change back to U.S. logs and lumber when tariffs are lifted. Results suggest that there will be some substitution in favor of U.S. exports if the retaliatory tariffs are abolished, but even the long-run outlook for U.S. logs and lumber falls short of a full recovery. It is important to note that U.S. tariffs on Chinese products are still in place. If the U.S. eliminated tariffs on furniture and other wood products from China, this would likely increase Chinese demand for log and lumber from all sources and demand for U.S. logs and lumber used to produce particular types of furniture.

While tariff exclusion will benefit U.S. exports to China, more is needed to fully address the recovery of U.S. exports. The *Expanding Trade* Chapter in the U.S.-China Phase One Trade Agreement may be of some benefit in this regard. Note that U.S. forest products are considered as manufacturing products in the agreement, and China has agreed to increase manufacturing imports by about 45% each year for the next two years (2020 and 2021) relative to 2017 imports (Office of the U.S. Trade Representative, 2020). A 45% increase in U.S. forest product exports to

China relative to 2017 trade would be quite remarkable. Note that a 45% increase in purchases would require exports to China to increase to over \$4.6 billion. This would be a 195% when compared to 2019 (\$1.6 billion) and a record year for U.S. forest products in China (Foreign Agricultural Service, 2020; Muhammad and Smith, 2020). That said, there is no evidence suggesting that China will satisfy its commitments by increasing all imports proportionally.

## Note

The views expressed in this study are the authors and do not reflect official U.S. Department of Agriculture policy.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix A. Appendix

The conditional import demand estimates are reported in Table A.1. All marginal share estimates/expenditure effects are positive and significant at the 0.01 level. These estimates indicated how a dollar increase in total lumber and log expenditure is allocated across the 12 products, ranging from 0.269 for ROW Logs to 0.014 for Indonesian Lumber. The marginal shares for U.S. Lumber and U.S. Logs are 0.075 and 0.092, respectively. Both are relatively higher than the other exporting countries, with ROW Lumber, ROW Logs, Russian Logs, and Canadian Lumber being the only exceptions.

Of the 12 country-product pairs, 8 own-price estimates are significant ( $P$ -value  $< 0.10$ ) and negative, which is consistent with the law of demand. These include: Canadian Lumber ( $-0.022$ ), Indonesian Lumber ( $-0.009$ ), Thailand Lumber ( $-0.017$ ), U.S. Lumber ( $-0.061$ ), ROW Lumber ( $-0.092$ ), Canadian Logs ( $-0.014$ ), Russian Logs ( $-0.137$ ), and U.S. Logs ( $-0.047$ ). A number of cross-price estimates indicate significant price competition (conditional substitute relationships) across products and exporting countries, as well conditional complementary relationship. Given the number of cross-price estimates, it would be monotonous to discuss each estimate. What is interesting, however, is that we do find evidence of within-country competitiveness. The estimates suggest within-country product competition for Russia (0.034), U.S. (0.015), and ROW (0.027). Thus, an increase in the price of lumber in the U.S., Russia, or ROW would lead Chinese importers to purchase more logs from these countries, and vice versa.

The trend and dynamic adjustment (lag) estimates are reported in Table A.2. The estimates indicate a declining trend for lumber from Canada ( $-0.006$ ) and logs from Russia ( $-0.022$ ), but an increasing trend for lumber from Russia (0.013) and Thailand (0.005). All other trend estimates were insignificant. It must be noted that these estimates do not necessarily indicate that imports from these countries have been persistently decreasing or increasing, but the direction of an import if other factors (total expenditures, prices, and dynamics) were held constant.

The own-lag effects are presented along the diagonal in Table A.2. The significant own-lag effects (9 out of 12) are all positive suggesting habit persistence. In other words, imports of a type of lumber or logs increases preferences for that product resulting in even greater demand in the future. Of the 12 lumber and log products, the most significant own-lag effects were for logs from ROW (0.084) and Russia (0.054) and lumber from Russia (0.042). All others were smaller by comparison: Canadian Lumber (0.031), Thailand Lumber (0.026), ROW Lumber (0.020), New Zealand Logs (0.016), U.S. Lumber (0.013), and Indonesian Lumber (0.006). A number of cross-lag effects are statically significant. It is difficult to interpret these estimates because their sign and magnitude depends on the cross-price relationship between products

Table A.1  
China's demand estimates for lumber and log imports by source and product.

Country product	Marginal share $\theta_i$	Slutsky price effect $\pi_{ij}$																
		Lumber						Logs										
		Canadian	Indonesian	Russian	Thai	U.S.	ROW	Canadian	New Zeal.	Papua NG	Russian	U.S.	ROW					
Canadian lumber	0.096 (0.009)***	-0.022 (0.011)**																
Indonesian lumber	0.014 (0.002)***	-0.003 (0.002)	-0.009 (0.002)***															
Russian lumber	0.041 (0.008)***	-0.047 (0.009)***	-0.007 (0.004)*	0.025 (0.017)														
Thai lumber	0.049 (0.006)***	-0.015 (0.006)**	-0.007 (0.003)**	-0.001 (0.009)	-0.017 (0.009)*													
U.S. lumber	0.075 (0.006)***	-0.001 (0.007)	0.009 (0.003)***	0.027 (0.01)***	-0.003 (0.007)	-0.061 (0.011)***												
ROW lumber	0.093 (0.007)***	0.026 (0.008)***	-0.002 (0.004)	-0.030 (0.011)**	0.023 (0.008)***	-0.009 (0.009)	-0.092 (0.015)***											
Canadian logs	0.046 (0.005)***	0.008 (0.005)	-0.001 (0.002)	-0.005 (0.007)	0.016 (0.005)***	0.002 (0.006)	-0.003 (0.007)	-0.014 (0.006)**										
New Zeal. logs	0.086 (0.01)***	-0.007 (0.009)	-0.003 (0.003)	-0.003 (0.009)	0.030 (0.007)***	0.021 (0.008)**	-0.002 (0.008)	-0.005 (0.006)	-0.010 (0.013)									
Papua NG logs	0.042 (0.007)***	0.003 (0.007)	0.000 (0.002)	-0.018 (0.007)**	0.002 (0.006)	0.015 (0.006)**	0.021 (0.007)***	-0.021 (0.005)***	0.010 (0.008)	-0.004 (0.009)								
Russian logs	0.097 (0.014)***	0.034 (0.012)***	0.022 (0.004)***	0.034 (0.016)**	-0.009 (0.011)	-0.011 (0.012)	0.036 (0.014)***	0.039 (0.009)***	-0.038 (0.013)***	-0.002 (0.011)	-0.137 (0.028)***							
U.S. logs	0.092 (0.01)***	0.012 (0.008)	-0.002 (0.002)	0.018 (0.008)**	-0.014 (0.007)**	0.015 (0.007)**	0.004 (0.008)	0.011 (0.006)*	0.020 (0.010)**	-0.017 (0.007)**	0.009 (0.013)	-0.047 (0.013)***						
ROW logs	0.269 (0.017)***	0.013 (0.011)	0.004 (0.003)	0.007 (0.010)	-0.006 (0.008)	-0.003 (0.008)	0.027 (0.009)***	-0.027 (0.007)***	-0.011 (0.012)	0.011 (0.009)	0.025 (0.018)	-0.007 (0.012)	-0.032 (0.024)					

Note: New Zeal. is *New Zealand*, Papua NG is *Papua New Guinean*, and ROW is *rest of world*. Homogeneity and symmetry constrained estimates. Asymptotic standard errors are in parentheses.

\*\*\* Significance level = 0.01.

\*\* Significance level = 0.05.

\* Significance level = 0.10.

Table A.2  
China's trend and dynamic estimates for lumber and log imports by source and product.

Country product	Trend $\varphi_i$	Lag Coefficients $\varphi_{ij}$ (one-period lag effects)											
		Lumber						Logs					
		Canadian	Indonesian	Russian	Thai	U.S.	ROW	Canadian	New Zeal.	Papua NG	Russian	U.S.	ROW
Canadian	-0.006	0.031	0.005	-0.005	0.010	-0.007	-0.005	0.012	0.006	0.000	-0.024	0.000	-0.044
Lumber	(0.003)*	(0.006)***	(0.004)	(0.013)	(0.006)	(0.007)	(0.010)	(0.004)***	(0.006)	(0.005)	(0.012)*	(0.004)	(0.01)***
Indonesian	-0.001	-0.002	0.006	0.003	0.003	0.002	-0.010	0.000	-0.002	-0.002	-0.003	0.000	0.005
Lumber	(0.001)	(0.001)	(0.001)***	(0.003)	(0.001)	(0.002)	(0.002)***	(0.001)	(0.001)**	(0.001)**	(0.002)	(0.001)	(0.002)**
Russian	0.013	0.000	-0.001	0.042	-0.002	-0.006	0.010	0.002	-0.006	-0.003	0.001	0.000	-0.002
Lumber	(0.003)***	(0.004)	(0.003)	(0.01)***	(0.005)	(0.006)	(0.009)	(0.003)	(0.005)	(0.004)	(0.009)	(0.003)	(0.008)
Thai Lumber	0.005	-0.001	-0.001	-0.009	0.026	-0.015	-0.010	-0.003	-0.003	-0.016	0.000	0.005	-0.001
	(0.002)**	(0.003)	(0.002)	(0.007)	(0.004)***	(0.004)**	(0.007)	(0.002)	(0.004)	(0.003)***	(0.007)	(0.002)*	(0.006)
U.S. Lumber	0.001	-0.013	-0.001	0.002	-0.002	0.013	-0.031	0.011	0.005	0.003	-0.013	-0.003	-0.001
	(0.002)	(0.004)***	(0.003)	(0.008)	(0.004)	(0.005)***	(0.007)***	(0.003)***	(0.004)	(0.003)	(0.007)*	(0.003)	(0.007)
ROW Lumber	0.000	-0.018	-0.006	0.005	0.009	-0.014	0.020	0.002	0.004	-0.005	-0.022	-0.003	0.006
	(0.002)	(0.004)***	(0.003)*	(0.008)	(0.004)**	(0.005)***	(0.008)**	(0.003)	(0.004)	(0.003)*	(0.008)***	(0.003)	(0.007)
Canadian	0.003	0.004	0.003	-0.018	-0.003	0.003	-0.004	-0.002	0.002	0.000	0.002	0.005	-0.007
Logs	(0.002)	(0.003)	(0.002)	(0.006)***	(0.003)	(0.004)	(0.006)	(0.002)	(0.003)	(0.002)	(0.006)	(0.002)**	(0.005)
New Zeal.	0.001	0.011	-0.014	0.010	-0.018	0.000	-0.001	0.009	0.016	-0.004	0.010	-0.001	-0.013
Logs	(0.003)	(0.005)**	(0.004)***	(0.012)	(0.006)**	(0.007)	(0.010)	(0.004)*	(0.006)***	(0.004)	(0.012)	(0.004)	(0.010)
Papua NG	0.001	0.001	0.003	-0.017	-0.004	0.006	0.013	0.001	-0.010	0.005	0.016	-0.003	-0.008
Logs	(0.002)	(0.004)	(0.003)	(0.009)*	(0.005)	(0.006)	(0.008)	(0.003)	(0.005)**	(0.003)	(0.009)*	(0.003)	(0.008)
Russian Logs	-0.022	-0.006	0.011	0.058	0.001	0.000	0.016	-0.007	-0.022	0.006	0.054	-0.018	0.003
	(0.005)***	(0.008)	(0.006)*	(0.018)***	(0.010)	(0.011)	(0.015)	(0.006)	(0.009)**	(0.007)	(0.018)***	(0.006)***	(0.016)
U.S. Logs	0.000	-0.005	-0.002	-0.009	-0.016	0.027	0.019	0.003	0.010	0.009	0.004	0.000	-0.023
	(0.004)	(0.006)	(0.004)	(0.013)	(0.007)**	(0.008)***	(0.011)*	(0.004)	(0.007)	(0.005)*	(0.013)	(0.005)	(0.011)***
ROW Logs	0.006	-0.003	-0.002	-0.062	-0.005	-0.010	-0.016	-0.028	-0.001	0.006	-0.023	0.019	0.084
	(0.006)	(0.01)	(0.007)	(0.022)***	(0.012)	(0.013)	(0.017)	(0.007)***	(0.011)	(0.008)	(0.022)	(0.008)**	(0.019)***

Note: New Zeal. is *New Zealand*, Papua NG is *Papua New Guinean*, and ROW is *rest of world*. Homogeneity and symmetry constrained estimates. Asymptotic standard errors are in parentheses.

\*\*\* Significance level = 0.01.

\*\* Significance level = 0.05.

\* Significance level = 0.10.

Table A.3  
Unit Root Test Statistics.

Import Prices	Phillips-Perron statistics	
	Levels	Annual differences
Canada lumber	-9.56[0.47]	-33.32[0.00]*
Indonesia lumber	-9.71[0.46]	-26.45[0.02]*
Russia lumber	-6.21[0.73]	-40.26[0.00]*
Thailand lumber	-1.8[0.98]	-26.60[0.02]*
U.S. lumber	-8.95[0.51]	-23.12[0.04]*
ROW lumber	-7.05[0.66]	-38.18[0.00]*
Canada logs	-160.47[0.00]*	-139.69[0.00]*
New Zeal. logs	-12.09[0.31]	-26.58[0.02]*
Papa NG logs	-24.4[0.03]*	-33.76[0.00]*
Russia logs	-2.45[0.96]	-28.63[0.01]*
U.S. logs	-120.11[0.00]*	-302.8[0.00]*
ROW logs	-4.24[0.87]	-61.73[0.00]*

Note: New Zeal. is *New Zealand*, Papua NG is *Papua New Guinean*, and ROW is *rest of world*. P-values are in brackets.

\*denotes significance level  $\leq 0.05$ .

(substitutes versus complements) and the adjustment behavior of buyers (habits persistence versus stocking behavior). Overall, the cross-lag estimates indicate that current demand for a product not only depends on past imports of that product, but also depends on past imports of related products.

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