Offsetting U.S. Tariffs on Canadian Softwood Lumber: A DSGE Analysis of Domestic Subsidies

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Abstract

The United States has imposed increasing tariffs on Softwood Lumber Exports from Canada. In order to offset the effect of the tariffs, this paper proposes a direct subsidy for domestic softwood lumber usage. Using a semi open dynamic stochastic general equilibrium model, we can model the subsidies ability to offset the loss of export demand. By exploring the relationship of softwood lumber to Canada's economy and demand from the United States, we have calibrated the model to simulate the softwood lumber industry. This model will stimulate output from softwood lumber from sawmills, towards construction firms. Construction has high elasticity of substitution between building components, and as such downwards price pressures will increase outputs. This will have the secondary effect of increasing the housing stock in Canada, at a time where the country is facing a housing crisis.

1 Introduction

1.1 Weakness in the Softwood Lumber Industry

The softwood lumber industry is a prominent part of the Canadian economy. Over the past 20 years it has displayed an inability to self correct against negative demand shocks. Since 1997 Agriculture, Forestry, Fishing and Hunting industries made up an average of 1.94% [20], with Forestry making up 1.2% on it's own in 2022 [11]. This has declined slightly in recent years, with the industries only making up 1.76% in 2024 [20]. Within Forestry there are many components, however softwood lumber production made up 98% of lumber production in 2020 [16]. In aggregate softwood lumber production has decreased since 2004 [23]. The industry is declining in output in the long run [14].

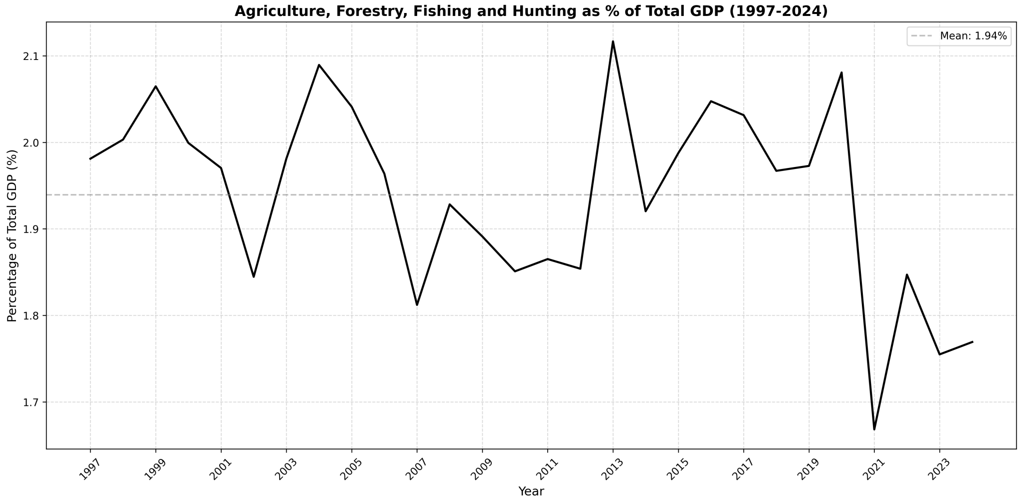

Figure 1: Agriculture, Forestry, Fishing and Hunting as Percentage of Total GDP (1997–2024). Source: Statistics Canada [20], Table 36-10-0434-03. Notes: Author's calculations.

When looking at employment levels since 2001 [19], we can see that there was a large negative shock to employment around the great recession. The sawmill industry has been unable to meaningful recover it's employment levels since then [19]. While it has seen an increase in output per worker, it has not made up for the overall lack of labour inputs to the sector.

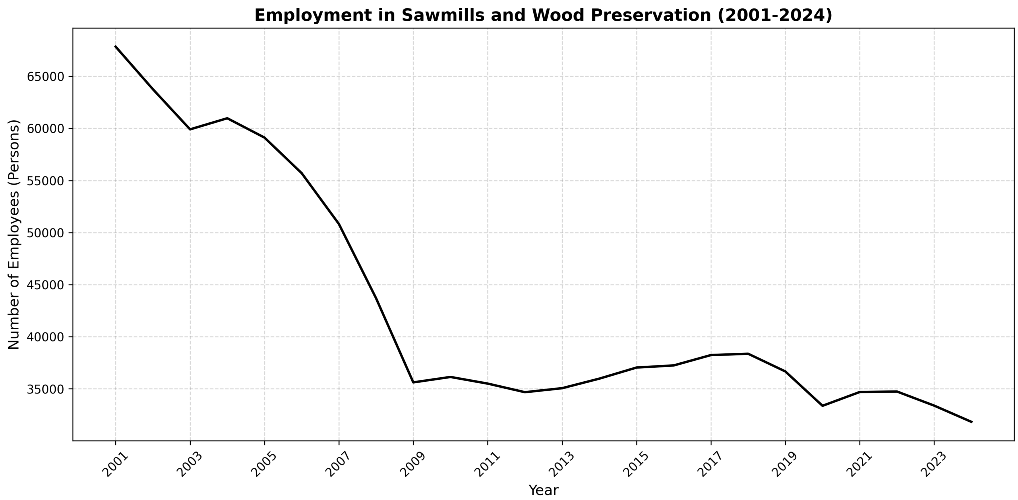

Figure 2: Sawmill Employment (2021–2024). Source: Statistics Canada [19], Table 14-10-0202-01

[did the sawmills shut down and is that why employment failed to recover]

Despite the declining output, sawmills have seen large spikes in revenue in the past 10 years [17]. In 2021, lumber prices spiked dramatically [24], leading to this higher revenue. This shows a divergence between price and output, where if a price spike can't cause a recovery in employment or output in the industry. After the crisis there was an increase in the output per worker, peaking around 2016 [14] [19]. However this was not associate with an increase in employment.

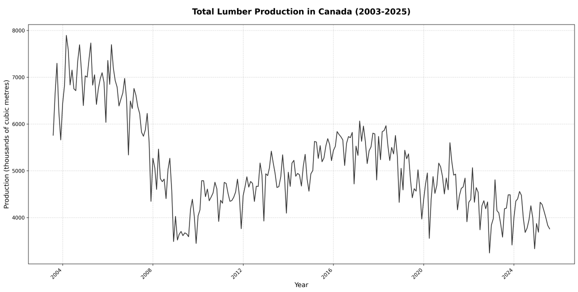

Figure 3: Lumber Production (2003–2025). Source: Statistics Canada [14], Table 16-10-0017-01, Table 16-10-0045-01.

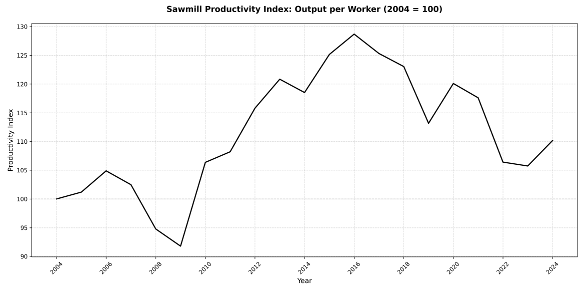

Figure 4: Sawmill Productivity Index (2004–2024), Source: Statistics Canada [14], Table 16-10-0017-01, Table 16-10-0045-01, Table 14-10-0202-01. Notes: Author's calculations

Despite the falling employment and production, the industry saw a large spike in revenue around 2021. This was correlated with a massive price spike in lumber. This massive spike in revenue would be expected to be correlated with a long term decaying increase in production and employment in order to take advantage of the price opportunities.

However this recovery in employment never came. Showing that the lumber industry in Canada can not self correct to its pre financial crisis levels of production and employment, even given massive price spikes in its output goods.

This suggests that the industry is unable to self correct. Given the possibility of additional negative demand shocks on exports, the industry needs to find a way to make up for the losses in a way that domestic demand currently cannot.

[Ideas for why the]

1.2 Reliance on Exports to the U.S.

The softwood lumber industry is particularly reliant on exports to the United States. In both 2006 and 2020 around 67% of all softwood lumber production was exported [16]. [how much goes to construction] With the United States making up 75.8% of those in January 2017 [15]. This means the industry is at risk due to its large dependence on exports to the US.

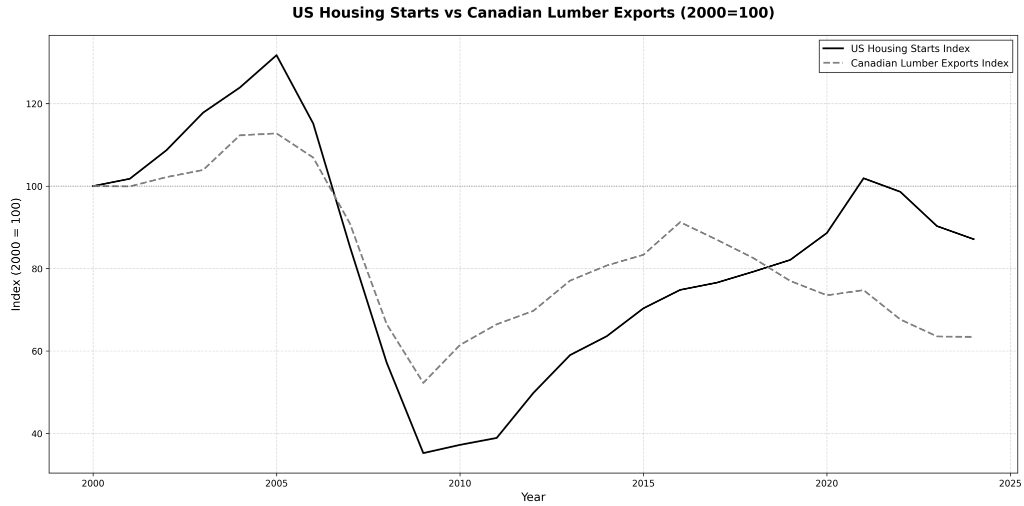

Figure 5: US Housing Starts vs Canadian Lumber Exports (2000–2024). Sources: Statistics Canada [15], Table 16-10-0045-01. Federal Reserve Bank of St. Louis [3]. Notes: Author's calculations

Historically the demand for softwood lumber in the US has been correlated with the number of housing starts in the US [3] [23] [14]. When housing starts fell in 2006-2009 during the financial crisis in the United States [TODO], employment in the sawmill industry also fell sharply. Since then employment has sat steady at 50% of its peaks [19]. Even as US housing starts have recovered, this was not correlated with an increase in employment in the industry

While employment had not recovered, from 2010 to 2016 there was a resurgence in sawmill production [23] [14], mirroring the increase in housing starts in the US. This was mostly driven by an increase in output per worker. Showing that the industry has been stabilized in the past by this demand by the United States.

1.3 Tariffs on Canadian Softwood Lumber

From 2006 to 2015 lumber trade between the US and Canada was governed by the Softwood Lumber Agreement (SLA 2006) [26]. This agreement contained no countervailing duties or anti-dumping tariffs. Instead it relied on export taxes and quotas which varied alongside the price of lumber in the United States [26]. [GET A GRAPH TO SHOW HOW THIS IS DIFFERENT] [Compare effective rates of export taxes]

Following the end of this agreement, there was no deal in place, meaning no tariffs, export quotas, or export taxes. This period corresponded with the a local peak in lumber production [23].

Since 2017 the correlation between US housing starts and lumber exports has shown increased residuals as seen in Figure 7. Indicating that housing starts are no longer an accurate indicator of export demand for softwood lumber in the United States. This implies that an increase in housing starts in the US will not correspond strongly with increased production or employment in the industry.

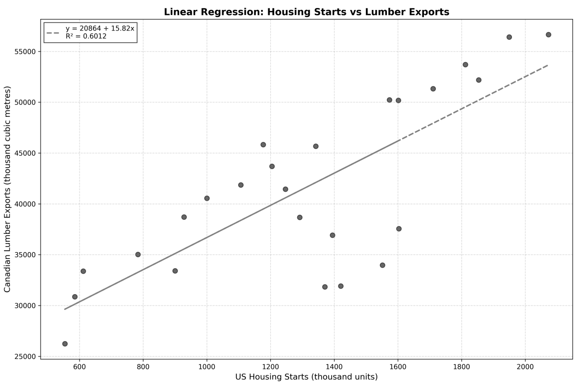

Figure 6: Linear Regression: Housing Starts vs Lumber Exports. Sources: Statistics Canada [15], Table 16-10-0045-01. Federal Reserve Bank of St. Louis [3]. Notes: Author's calculations

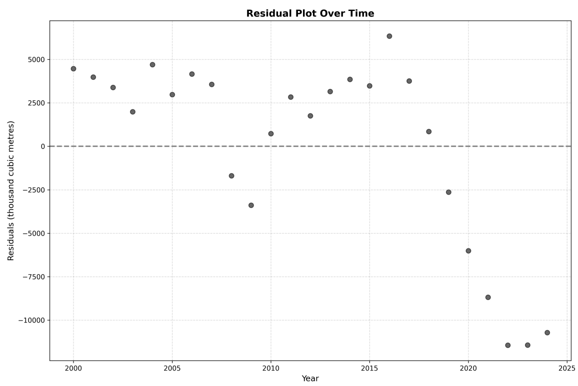

Figure 7: Residual Plot Over Time. Sources: Statistics Canada [15], Table 16-10-0045-01. Federal Reserve Bank of St. Louis [3]. Notes: Author's calculations

In 2017 the United States began investigating Canadian softwood lumber producers, accusing them of being unfairly subsidized [28]. The first investigations began in January 2017 [TODO]. This investigation concluded that Canadian softwood lumber producers are subsidized by the stumpage fees that they pay on government land [TODO]. It was assessed that the subsidy amounted to 3.34%-18.19% [27] depending on the firm. As a result the United States began imposing two types of tariffs on Canadian lumber producers [7]. Anti-dumping rates and Countervailing duty rates. Anti-dumping rates are intended to offset the effect of low cost commodities bringing down the domestic price of the goods. Countervailing duties are meant to offset the subsidies given by foreign governments to their domestic firms.

These rates took effect in 2017, and have been under annual review since then [8]. The rates were assessed for individual firms, based on their calculated subsidy rate, as well as a rate for all other firms. By using market share in 2023 [5], we have calculated an effective tariff rate on the industry.

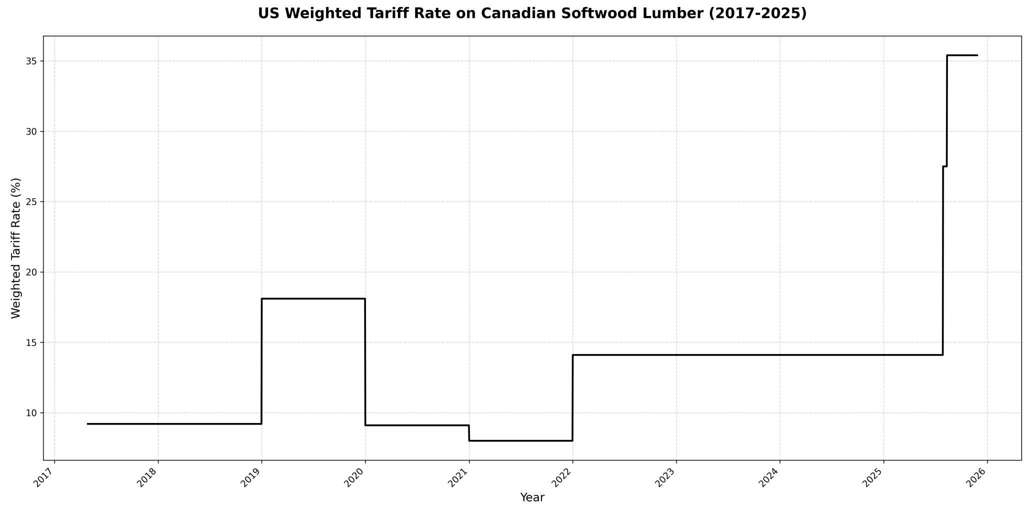

Figure 8: US Weighted Tariff Rate on Canadian Softwood Lumber (2017–2025) Source: Government of British Columbia [9]. ForestNet [5]. Notes: Author's calculations; see Appendix 8.2

While these rates varied slightly from 2017 to 2025, they have spiked upwards this year with the re-election of Donald Trump [9]. It is hard to assess the full impact of these tariffs, but with the anti-dumping rates almost tripling this year [9], they must be considered when looking forward in the softwood lumber industry.

1.4 Inducing Domestic Demand through Subsidies

In the face of these increased tariffs, there is a risk that the industry will face another negative demand shock that it cannot recover from.

In order to compensate for this demand loss, this paper proposes a model for inducing demand through subsidies for the construction industry.

This is in line with Prime Minister Mark Carney's proposals to offer loans to sawmills and ensure government construction projects use Canadian lumber [12].

[housing starts in canada?]

In 2024 the construction industry contributed $165 Billion to Canadian GDP [20], compared to $40 Billion by the entire agriculture, forestry, fishing and hunting industries [20]. The scale of this industry makes it a strong target for inducing demand in the much smaller lumber industry.

Construction firms can often substitute between concrete, steel, and lumber for different projects depending on prices [TODO]. Figure 9 shows a large spike in lumber prices around covid 2019, and that its current price is now closely comparable to ready mix concrete when indexed from 2010 prices [24]. This gives the government the opportunity to make lumber a more appealing material for construction by lowering its real price to be in line with steel and concrete.

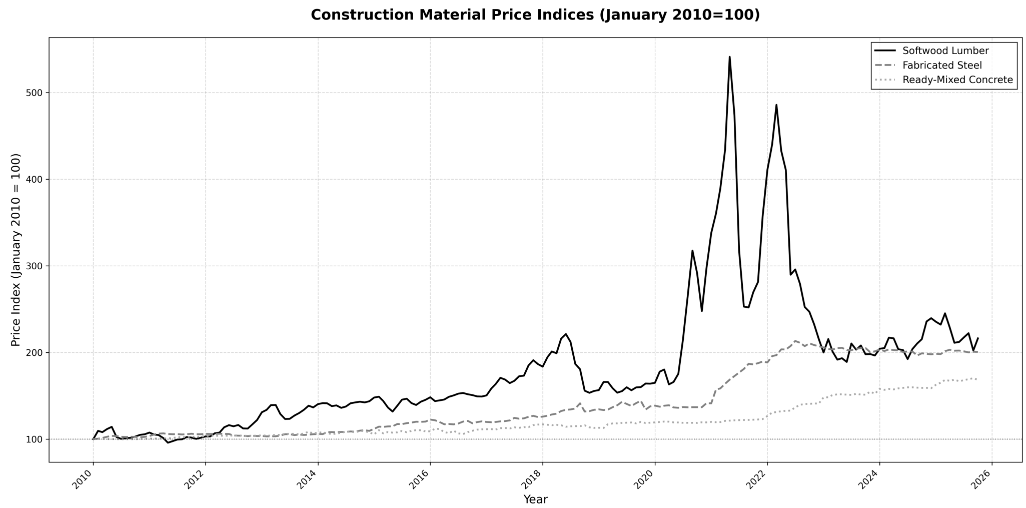

Figure 9: Construction Material Price Indices (2003–2025). Source: Statistics Canada [24], Table 18-10-0266-01. Notes: Author's calculations.

2 Literature Review

This paper relies on previous knowledge of DSGE models, and the techniques for adjusting them to the specific use cases. Gomme and Midrigan [6] outlines the method of calibration for DSGE models which will be attempted to be recreated in this paper. A methodology for extending the standard DSGE model to include intermediary goods can be found in Christiano et al. [2].

For general background on the lumber dispute between the United States on Canada, there are two recommended papers. van Kooten [29] covers the original SLA, and more historical background on the trade dispute. Hoover and Fergusson [10] is about the effects and details of the SLA aggreement in place from 2006-2015.

3 Theoretical Model

3.1 Overview

The model proposed in this paper is a small open economy DSGE model. It relies on two types of firms, sawmills and construction firms, with softwood lumber being an intermediary good between them. Additionally it has a household consumer, and a government.

The sawmills produce softwood lumber from capital and labour using a Cobb-Douglas production function. Technology is provided as a static parameter. $\alpha \in (0, 1)$ denotes the share of income spent on each input.

$$Y_t^W = A^S K_t^\alpha L_t^{1-\alpha} \tag{1}$$

Sawmill firms will be constrained by the cost of their inputs and the value of their outputs. They pay the market rates for wages and the rental rate of capital, and earn income based on their output quantity and the price of softwood lumber. Sawmills will choose K_t and L_t to maximize output.

$$P^W Y_t^W = r_t K_t + w_t L_t \tag{2}$$

The output of the sawmill firms will be used as an input for the construction firms. Whom will use softwood lumber alongside alternatives to lumber in order to create the final good. The production function for construction firms is a Constant Elasticity of Substitution function. Allowing the model to fine tune the ability of the model to adjust how substitutable lumber and it's alternatives in construction are. Technology is provided as a static parameter.

$$Y_t^F = A^C \left(\theta \, W_t^\phi + (1-\theta) \, \Psi_t^\phi\right)^{1/\phi}. \tag{3}$$

The construction firms will be constrained by the cost of their inputs and the value of their outputs. They pay below the market rate for lumber based on the size of the government subsidy.

$$\mathcal{P}_t^W = (1-\omega) \, P_t^W. \tag{4}$$

They pay the static price for alternatives to lumber. They receive revenue based on their output. They choose W_t^{θ} and Ψ_t^{θ} to maximize output.

$$Y_t^F = \mathcal{P}_t^W \, W_t + P_t^{\Psi} \, \Psi_t. \tag{5}$$

The government pays the lumber subsidy based on the set rate ω. They only pay this subsidy on the portion of lumber which is used as in input for the construction firms.

$$G_t = \omega \, P_t^W \, W_t. \tag{6}$$

The government pays for this policy by collecting a lump sum tax on the consumers. Such that their budget is balanced.

The households will provide labour and capital to the sawmills firms. They will earn income on their provided capital and labour which they will spend on consumption, investment, and lump sum transfers to the government.

$$C_t + K_{t+1} = w_t L_t + r_t K_t - T_t. \tag{7}$$

The households will derive utility from leisure and consumption of the final good. The utility function has been defined as a summation of logs. Where γ represents the preference weight between the two goods.

$$U = \log(C_t) + \gamma \log(1 - L_t). \tag{8}$$

At each time step the consumer will make the choice between consumption and investment based on the Euler equation.

$$\frac{1}{C_t} = \beta \frac{1}{C_{t+1}} (r_{t+1} + 1 - \delta). \tag{9}$$

They additionally will choose how much to work and consume based on the given wage.

$$\frac{\gamma C_t}{1 - L_t} = w_t. \tag{10}$$

In order to model export demand, an additional exogenous variable X will be defined. This will be used to simulate shocks due to tariffs.

4 Calibration

4.1 Base Year and Steady State

In 2016 there were no tariffs, export taxes, or quotas [26]. This will be used as the base year for model calibration.

Initial Values

Parameter	Value	Description
L	0.33	Time spent working
i^*	0.0197	Real net interest rate
δ	0.0348	Depreciation rate
α	0.653	Capital share of income
ω	0	Initial subsidy level

Table 1: Sources: Feenstra et al. [4]. CEIC Data [1]. Notes: L and ω chosen by author. α calculations defined in Appendix 8.3

From these values, and the Euler in steady state. We can calculate $\beta \approx 0.98$.

$$1 = \beta(r + 1 - \delta). \tag{11}$$

In calibrating ϕ, research was conducted into the cross price elasticity between lumber, steel and concrete. In [13], the cross price elasticities were calculated to be negative. Implying that the value selected for the CES function should be low. For the purpose of this paper, $\phi = -1$ was selected. While substitutability was not identified as large, this could be due to aggregate demand across the industry increasing all material usage when housing starts are high. This does not dispute the fact that lowering the price of lumber will increase its usage in the construction industry as is shown in [13].

Based on the value of exports given by [16], this paper has normalized $Y^W = 1$, $X = 0.67$, $W = 0.33$ as its steady state values for the share of lumber output.

$$Y^W = W + X, \tag{12}$$

From [18], we can get investment in the forestry and lumber industry in 2016 as \$494 Million. In steady state from the law of motion of capital we can calculate capital stock as $K = \$14,200$ Million.

$$K = \frac{I}{\delta} \tag{13}$$

From [21] we can get the GDP contribution from the forestry and logging industry as \$4,592 Million. Given this we can calculate a $\frac{K}{Y}$ ratio and then normalize to $Y = 1$ to get $K \approx 3.09$

From the sawmill firm's first order condition with respect to capital we can derive.

$$\alpha P^W A^S K^{\alpha-1} L^{1-\alpha} = r, \tag{14}$$

$$P^W = \frac{rK}{\alpha}, \tag{15}$$

$$P^W \approx 0.258 \tag{16}$$

From the sawmill firm's first order condition with respect to labour we can derive.

$$(1-\alpha)P^W A^S K^\alpha L^{-\alpha} = w, \tag{17}$$

$$w \approx 0.269 \tag{18}$$

From the intratemporal labour leisure tradeoff we can calculate γ.

$$\frac{\gamma C}{1-L} = w. \tag{19}$$

$$\gamma = \frac{w(1-L)}{C} \tag{20}$$

$$\gamma \approx 0.179 \tag{21}$$

In order to calibrate θ to match expenditure shares, data on construction input costs were collected from [25].

$$E_W = P^W W, \tag{22}$$

$$E_\Psi = P^\Psi \Psi \tag{23}$$

Using these expenditure values, and P^Ψ normalized to 1, we can rewrite the ratio $\frac{W}{\Psi}$ as the following.

$$\frac{W}{\Psi} = \frac{E_W}{E_\Psi P^W} \tag{24}$$

The calibration uses the following expenditure values from the construction industry:

Component	**Value**	**Description**
E_W	1,514,818	Expenditure on lumber (thousands CAD)
E_Ψ	2,183,457	Expenditure on alternatives to lumber (thousands CAD)

Table 2: Construction Industry Expenditures on Materials (2016). Source: Statistics Canada [25] Notes: Author's calculations

With this ratio defined, using the first order condition from the construction firm, we can calibrate a value for θ.

$$\frac{P^W}{P^\Psi} = \frac{\theta}{(1-\theta)} \left(\frac{W}{\Psi}\right)^{\phi-1}, \tag{25}$$

$$R = \frac{P^W}{P^\Psi} \left(\frac{\Psi}{W}\right)^{\phi-1}, \tag{26}$$

$$\theta = \frac{R}{1+R}, \tag{27}$$

$$\theta \approx 0.6509. \tag{28}$$

Now we can calculate values for $\{A^S, A^C, \Psi\}$.

$$Y^W = A^S K^\alpha L^{1-\alpha}, \tag{29}$$

$$A^S \approx 0.7033. \tag{30}$$

$$\frac{W}{\Psi} = \frac{E_W}{E_\Psi P^W} \approx 2.689, \tag{31}$$

$$\Psi \approx 0.1227 \tag{32}$$

$$Y_t^F = A^C \left(\theta\, W_t^\phi + (1-\theta)\, \Psi_t^\phi\right)^{1/\phi}, \tag{33}$$

$$A^C = \frac{Y^F}{\left(\theta\, W_t^\phi + (1-\theta)\, \Psi_t^\phi\right)^{1/\phi}} \tag{34}$$

$$A^C \approx 4.82 \tag{35}$$

4.2 Complete Calibration Summary

The following table summarizes all parameter values used in the model calibration for the base year 2016:

Parameter	Value	Description	Source/Method
Exogenous Parameters			
L	0.33	Time spent working	Chosen
i^*	0.0197	Real net interest rate	CEIC Data [1]
δ	0.0348	Depreciation rate	Feenstra et al. [4]
α	0.653	Capital share of income	Statistics Canada [22]
ω	0	Initial subsidy level	Policy assumption
ϕ	-1	CES elasticity parameter	Shahi et al. [13]
Calculated Parameters			
β	0.98	Discount factor	From Euler equation
γ	0.179	Leisure preference weight	From labor-leisure FOC
θ	0.6509	Input share parameter	From construction FOC
A^S	0.7033	Sawmill technology	From production function
A^C	4.82	Construction technology	From production function
Steady State Quantities			
Y^W	1.0	Lumber output (normalized)	Base normalization
X	0.67	Export demand	Statistics Canada [16]
W	0.33	Domestic lumber consumption	Residual from market clearing
Ψ	0.1227	Alternative materials	From expenditure ratio
K	3.09	Capital stock	From investment data
C	1.0	Consumption	Normalized final good units
Y^F	1.0	Final goods output	From market clearing $Y^F = C$
Steady State Prices			
P^F	1.0	Price of final good (numeraire)	Normalization
P^W	0.258	Lumber price	From sawmill FOC
w	0.269	Wage rate	From sawmill FOC
r	0.0545	Rental rate of capital	From $i^* + \delta$
P^Ψ	1.0	Price of alternatives (normalized)	Normalization
Expenditure Data (thousands CAD)			
E_W	1,514,818	Expenditure on lumber	Statistics Canada [25]
E_Ψ	2,183,467	Expenditure on alternatives	Statistics Canada [25]

Table 3: Complete Model Calibration Summary (Base Year: 2016)

5 Results

6 Policy Implications

7 Conclusion

8 Appendix

8.1 Model

8.1.1 Model Definition

Sawmill Firms

Table 1: Notation for Sawmill Firms

	Symbol	Description
Variables	Y^W	Lumber output
	K	Capital input to sawmill firms
	L	Labour input to sawmill firms
Prices	r	Rental rate of capital
	w	Wage rate of labour
	P^W	Price of lumber
Parameters	A^S	Technology parameter for sawmill firms
	α	Capital share parameter, $\alpha \in (0, 1)$

Production Function:

$$Y_t^W = A^S K_t^\alpha L_t^{1-\alpha} \tag{1}$$

Budget Constraint:

$$TC = r_t K_t + w_t L_t \tag{2}$$

Construction Firms

Table 2: Notation for Construction Firms

	Symbol	Description
Variables	Y^F	Final output produced by construction firms
	W	Lumber input used in construction
	Ψ	Alternative inputs to lumber
Prices	$\mathcal{P}^W$	Effective price of lumber
	P^Ψ	Price of alternative inputs
	P^F	Price of final good
Parameters	A^C	Technology parameter for construction firms
	θ	Input share or scaling parameter in construction production
	ϕ	Elasticity of substitution between lumber and alternatives

Production

$$Y_t^F = A^C \left(\theta \, W_t^\phi + (1-\theta) \, \Psi_t^\phi \right)^{1/\phi}. \tag{3}$$

Budget Constraint

$$P_t^F Y_t^F = \mathcal{P}_t^W \, W_t + P_t^\Psi \, \Psi_t. \tag{5}$$

Effective price of lumber

$$\mathcal{P}_t^W = (1-\omega) \, P_t^W. \tag{4}$$

Government

Table 3: Notation for Government

	Symbol	Description
Variables	G	Government expenditure on lumber tax credits
Policy Instruments	T	Lump-sum tax levied on households
	ω	Tax credit rate applied to lumber inputs

Lumber tax credit expenditure

$$G_t = \omega \, P_t^W \, W_t. \tag{6}$$

Government budget constraint

$$G_t = T_t. \tag{36}$$

Households

Table 4: Notation for Households

	Symbol	Description
Variables	C	Consumption of the final good
	L	Labour supplied by the household
Parameters	γ	Preference weight on leisure in utility

Preferences

$$U = \log(C_t) + \gamma \log(1 - L_t). \tag{8}$$

Budget constraint

$$C_t + K_{t+1} = w_t L_t + r_t K_t - T_t. \tag{7}$$

External Demand

Table 5: Notation for External Demand

	Symbol	Description
Variables	X	External demand for lumber

8.1.2 Market Clearing Conditions

Table 4: Notation for Market Clearing Conditions

	Symbol	Description
Markets	Y^W	Lumber market clearing output
	Y^F	Final goods market clearing output
	L	Labour market clearing quantity

Market clearing in each sector requires:

$$Y^W = W + X, \tag{37}$$

$$Y^F = C, \tag{38}$$

$$L = L^D. \tag{39}$$

8.1.3 First Order Conditions

Households

The household chooses $\{C_t, L_t, K_{t+1}\}_{t=0}^{\infty}$ to maximize utility subject to the budget constraint. The first-order conditions are:

$$\frac{1}{C_t} = \lambda_t, \tag{40}$$

$$\frac{\gamma}{1 - L_t} = \lambda_t w_t, \tag{41}$$

$$\lambda_t = \beta \lambda_{t+1}(r_{t+1} + 1 - \delta). \tag{42}$$

These conditions imply the Euler equation:

$$\frac{1}{C_t} = \beta \frac{1}{C_{t+1}}(r_{t+1} + 1 - \delta). \tag{43}$$

And the Intratemporal Consumption Leisure Tradeoff

$$\frac{\gamma C_t}{1 - L_t} = w_t. \tag{44}$$

Sawmill Firms

Sawmill firms choose K_t and L_t to maximize profits given prices. The first-order conditions are:

$$(1 - \alpha) P_t^W A^S K_t^\alpha L_t^{-\alpha} = w_t, \tag{45}$$

$$\alpha P_t^W A^S K_t^{\alpha - 1} L_t^{1-\alpha} = r_t. \tag{46}$$

Construction Firms

Construction firms choose W_t and Ψ_t to minimize costs subject to the production function. The first-order conditions are:

$$\theta A^C \left(\theta W_t^\phi + (1-\theta)\Psi_t^\phi\right)^{\frac{1}{\phi}-1} W_t^{\phi-1} = \mathcal{P}_t^W, \tag{47}$$

$$(1-\theta) A^C \left(\theta W_t^\phi + (1-\theta)\Psi_t^\phi\right)^{\frac{1}{\phi}-1} \Psi_t^{\phi-1} = P_t^\Psi. \tag{48}$$

These conditions imply the price ratio between the goods.

$$\frac{\mathcal{P}_t^W}{P_t^\Psi} = \frac{\theta}{(1-\theta)} \left(\frac{W_t}{\Psi_t}\right)^{\phi - 1} \tag{49}$$

8.2 Effective Tariff Rate

Calculating the Rate

The effective U.S. tariff rate on Canadian softwood lumber is constructed as a firm-weighted average of countervailing and anti-dumping duties:

$$\tau_t = \sum_{i \in \mathcal{F}} \omega_i \tau_{i,t}, \tag{50}$$

where $\tau_{i,t}$ denotes the tariff rate applied to firm i at time t, and ω_i is firm i's share of Canadian softwood lumber exports.

Export Weights

Table 5: Production Weights Used in the Construction of the Effective Tariff Rate

Firm	**Weight**
West Fraser Timber Co. Ltd.	0.136
Canfor Corporation	0.111
Resolute Forest Products	0.096
J.D. Irving, Limited	0.055
All remaining Canadian softwood lumber producers	0.602
Total	**1.000**

Tariff rates are calculated based on the dates of actions taken as part of the Annual Reviews (AR) 1 through 6 [9]. Constant weights were used for this paper based on 2023 export quantities [5]. After AR3, resolute was not given individual tariff rates [9]. After AR5 J.D. Irving was not given individual tariff rates [9].

8.3 Capital Share of Income

Alpha was calculated from Statistics Canada [22], Table 36-10-0217-01. Using the labour compensation and capital cost for forestry and logging, and the following equation.

$$\alpha = \frac{Capital\ Cost}{Capital\ Cost + Labour\ Compensation} \tag{51}$$

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