Modelling Softwood Lumber 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.

Industry Review

Softwood Lumber and the Canadian Economy

Since 1997, Canada's Agriculture, Forestry, Fishing and Hunting Industries make up an average of 1.94% with Forestry making up 1.2% on its own.

**Agriculture, Forestry, Fishing and Hunting as % of Total GDP (1997-2024)**
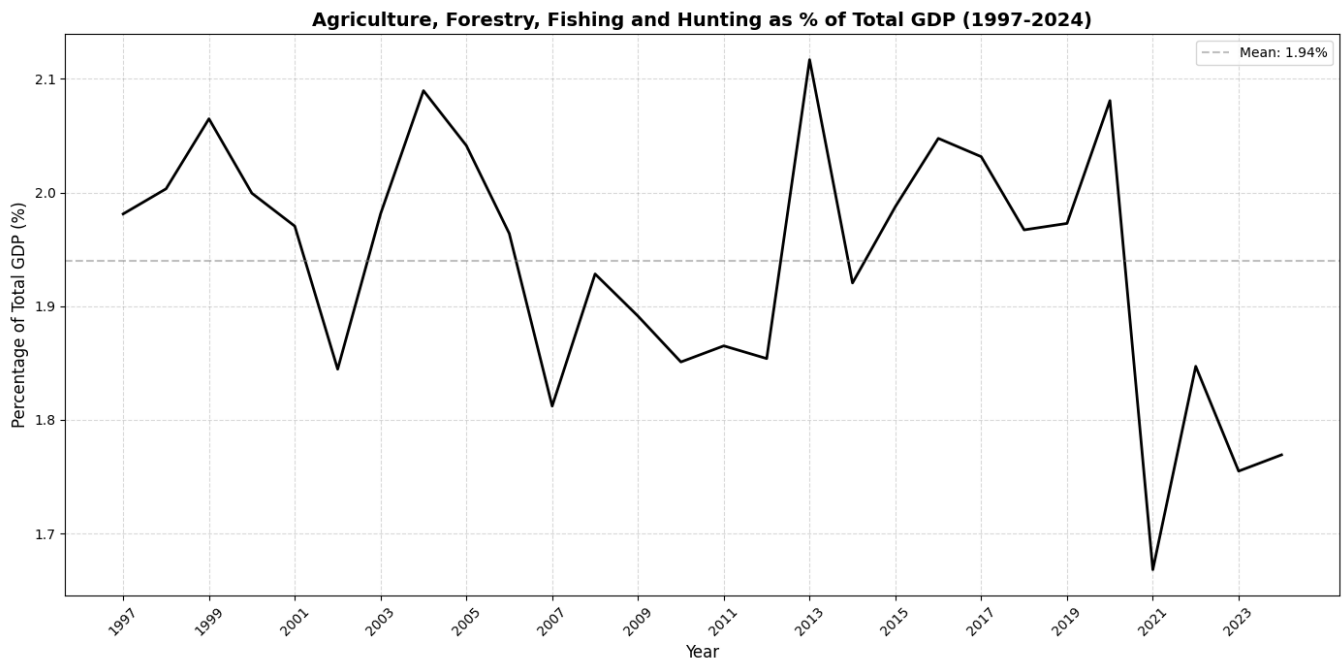
Within the Forestry there are a number of components. For this paper we will focus on softwood lumber, which made up 98% of all lumber production in 2020. Lumber Production in Canada has been down since 2004. There was a large downward shock on production following the 2008 financial crisis, it began to recover until 2017, when Donald Trump took office, and has been on the decline since then.


Total Lumber Production in Canada (2003-2025)
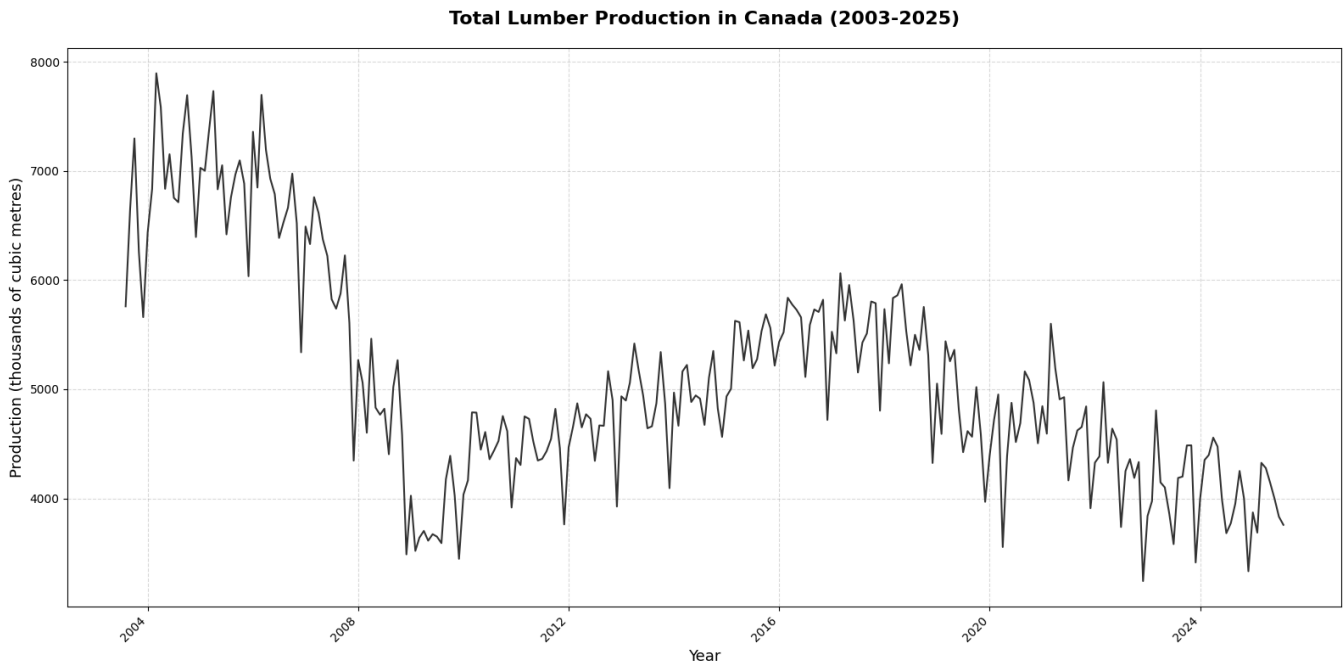
Meanwhile revenues for sawmills have increased even through this downturn, reaching a peak in 2021, and since declining..

**Sawmill Revenue from Goods Manufactured in Canada (2013-2023)**
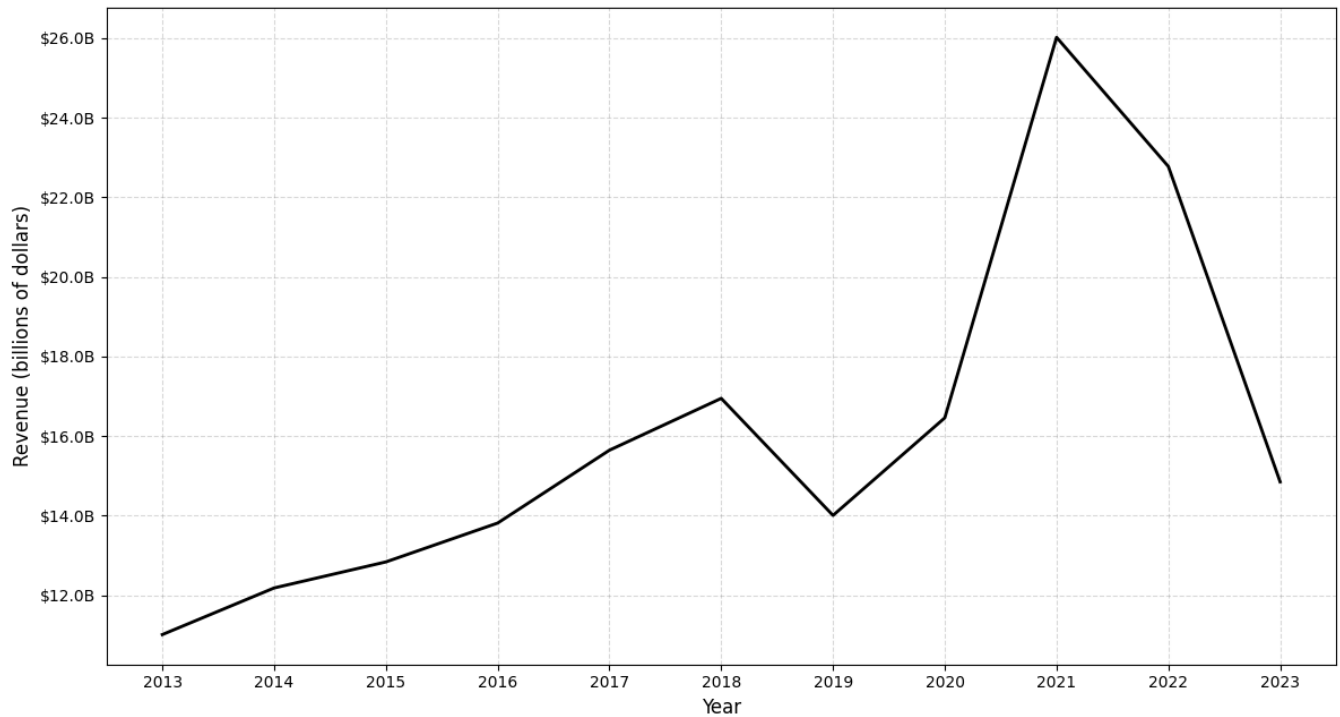
This decreasing production and increasing revenue can be explained by spikes in the price of lumber, also reaching peaks in 2003.

Softwood Lumber Price Index in Canada (2003-2025)
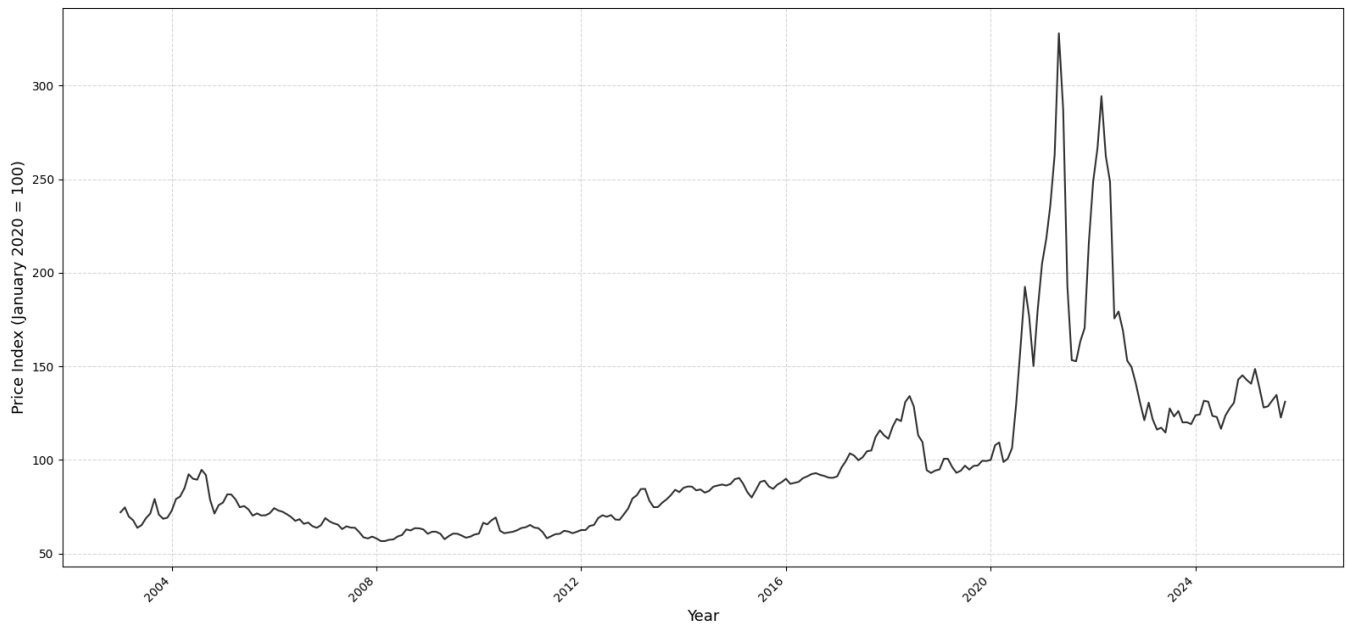
This spike came during the Covid 19 pandemic. It came as employment in Sawmills and Wood preservation is sitting far below its levels in the early 2000s.

Employment in Sawmills and Wood Preservation (2001-2024)
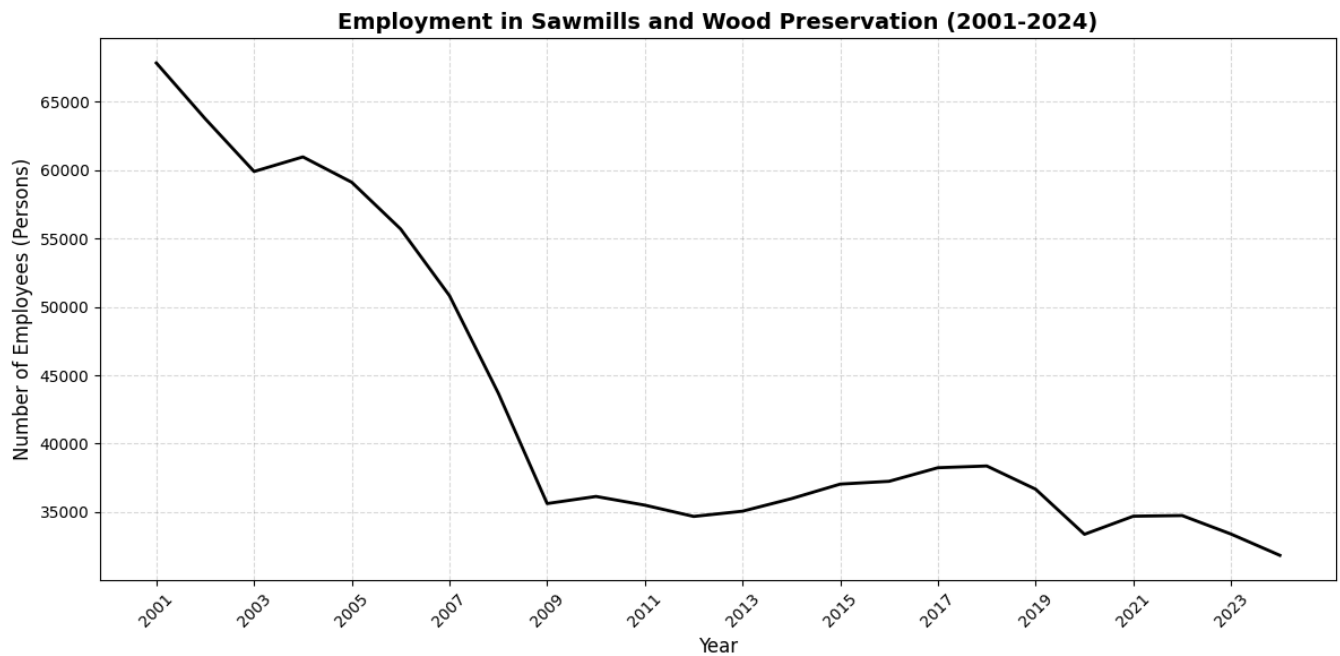
Since production was not spiking during the revenue spikes in 2021, we can say that the output per worker was not the reason for the increasing revenue.

**Sawmill Productivity Index: Output per Worker (2004 = 100)**
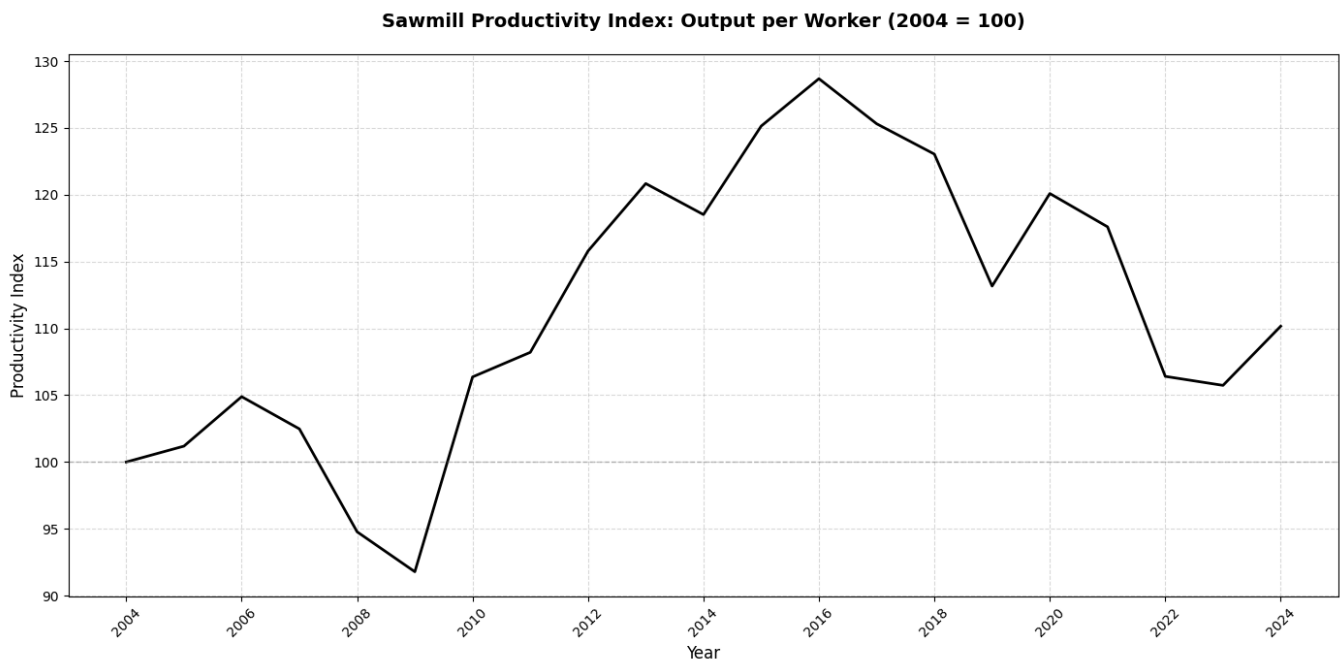
However during the increasing revenue and production after the financial crisis, there was a noticeable uptick in per worker output. This may explain the recovery of the softwood lumber industry from its 2009 lows. This has trended downwards since 2017 alongside stable employment and decreasing output.

Softwood Lumber Exports

Canada relies on exporting a large portion of the lumber it produces. In both 2006 and 2020 ~67% [TODO] of all softwood lumber production was exported. With the United States being

Canada's largest trading partner, they made up 75.8% [TODO] of softwood lumber exports in January 2017.

Canadian Softwood Lumber Export Share by Destination (January 2017)

Rest of World

24.2%

75.8%
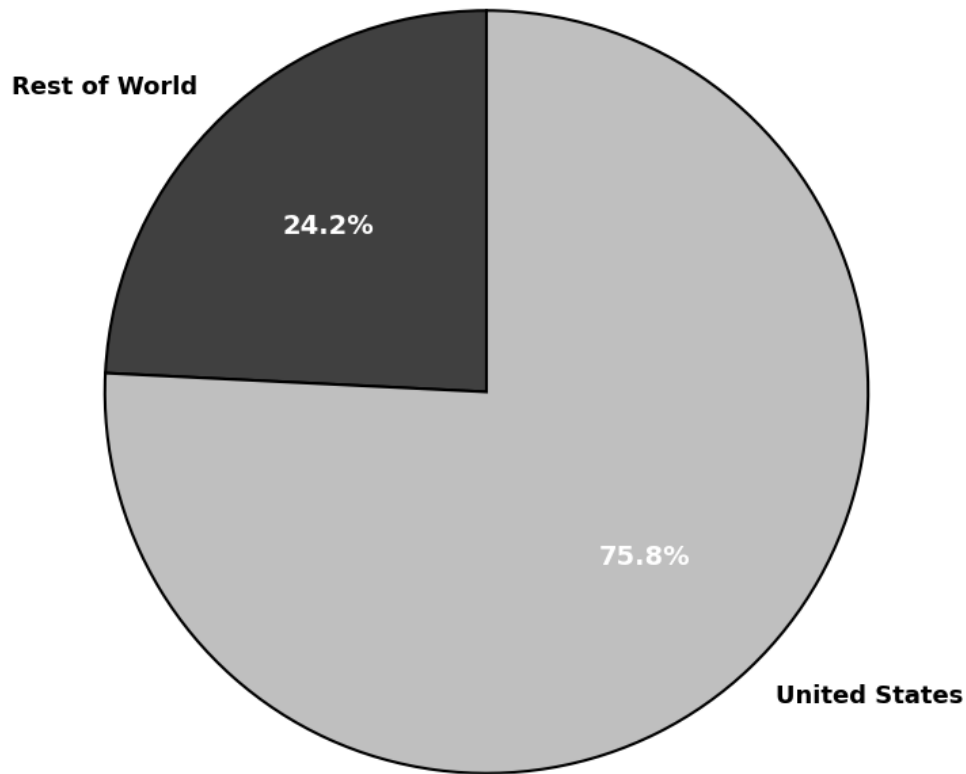
United States

This reliance on exports to the United States has made the softwood lumber industry especially susceptible to negative demand shocks from the United States. We can observe this relationship when we examine and indexed chart of Canadian Lumber Exports vs United States

Housing Starts

US Housing Starts vs Canadian Lumber Exports (2000=100)
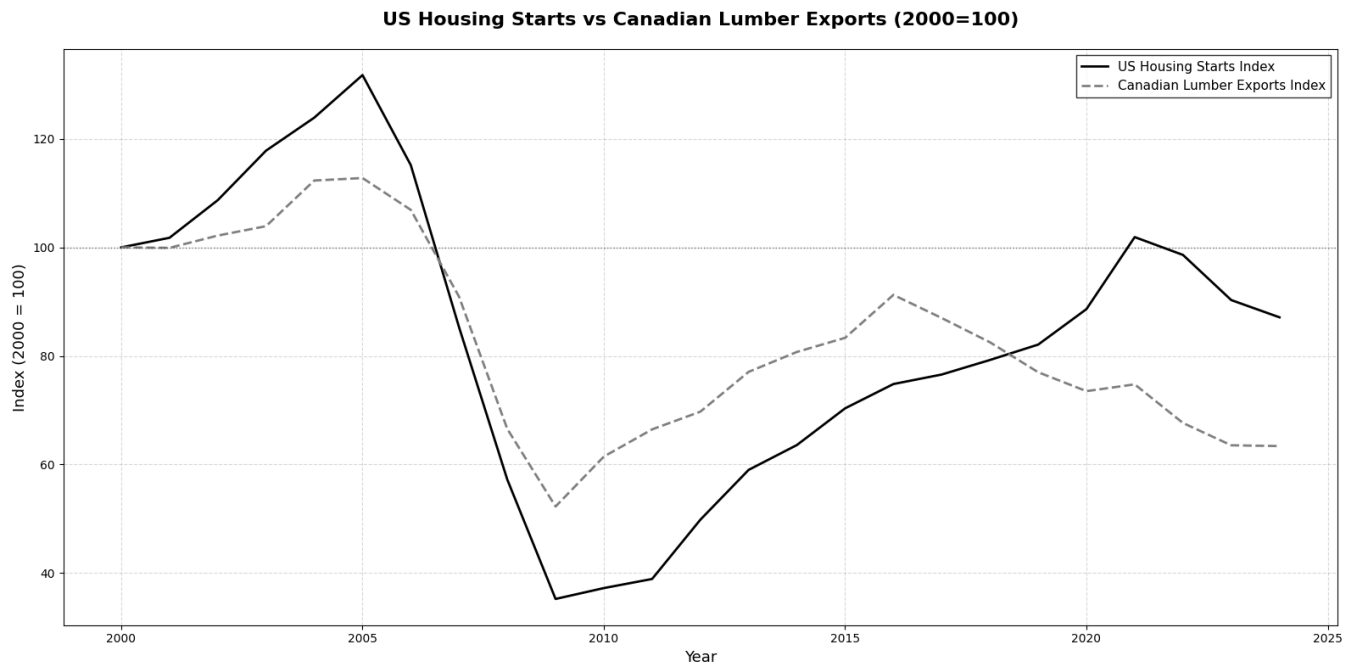
This chart illustrates the rapid decline of housing starts during the 2008 financial crisis. This demand shock had a large negative impact on Canadian Lumber Exports. We can further explore this relationship by running a regression between the two variables.

Linear Regression: Housing Starts vs Lumber Exports

y = 20864 + 15.82x
R² = 0.6012
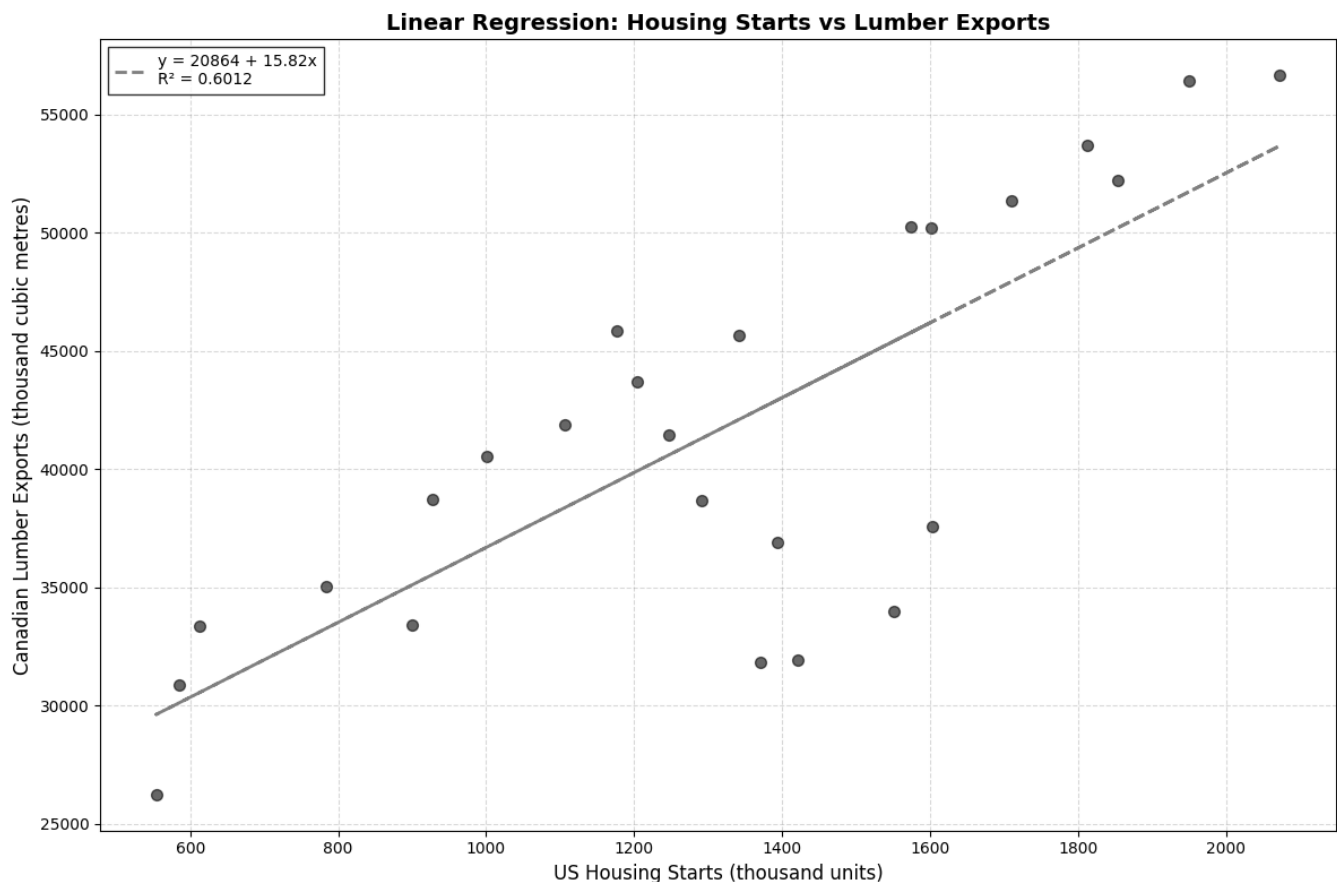
We can see that there is a strong positive relationship, with an R^2[TODO] value of 0.6012. While the two indices follow each other very closely, they begin to diverge around 2017. We can

see this more clearly when we graph the residuals over time.
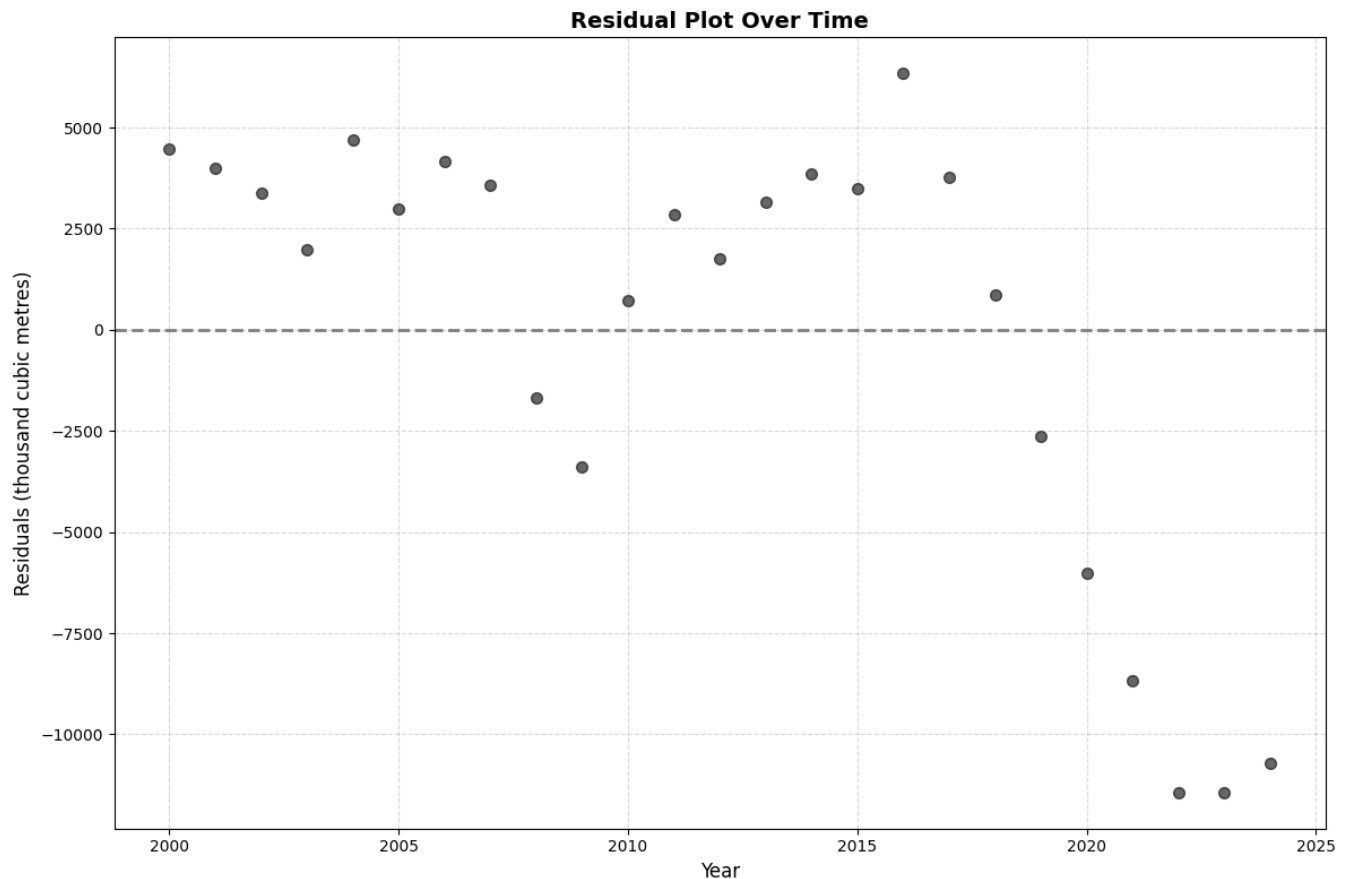
The residuals have grown in the past few years and may support our hypothesis that tariffs are a significant cause of negative pressure on Canadian softwood lumber exports.

Trump and Softwood Lumber Tariffs

In 2017 the United States began investigating Canadian softwood lumber producers, accusing them of being unfairly subsidized. The first investigations began in January 2017.

This investigation concluded that Canadian softwood lumber producers are subsidized by the stumping fees that they pay on government land. It was assessed that the subsidy amounted to 3.34%-18.19% [TODO] depending on the firm. As a result the United States began imposing two types of tariffs on Canadian lumber producers. 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. 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, we have calculated an effective tariff rate on the

industry.

US Weighted Tariff Rate on Canadian Softwood Lumber (2017-2025)
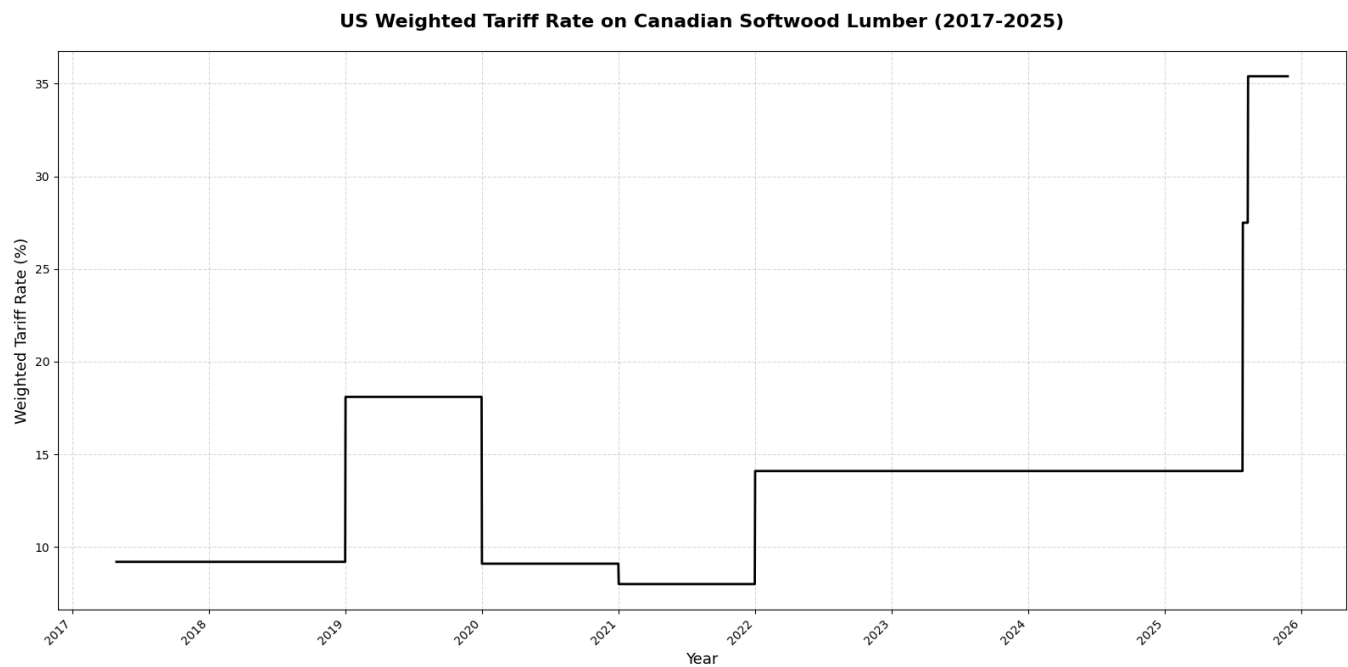

While these rates varied slightly from 2017 to 2025, they have spiked upwards this year with the reelection of Donald Trump. It is hard to assess the full impact of these tariffs, but with the anti-dumping rates almost tripling this year, they must be considered when looking forward in the softwood lumber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

## Substituting Lumber in the Construction Industry.

In order to offset these tariffs, domestic demand must be stimulated. The construction industry is a strong candidate for generating this demand, as it is four times larger than the entire Agriculture, Forestry, Fishing and Hunting segment of the economy.

Canadian Industry GDP Comparison (2024)
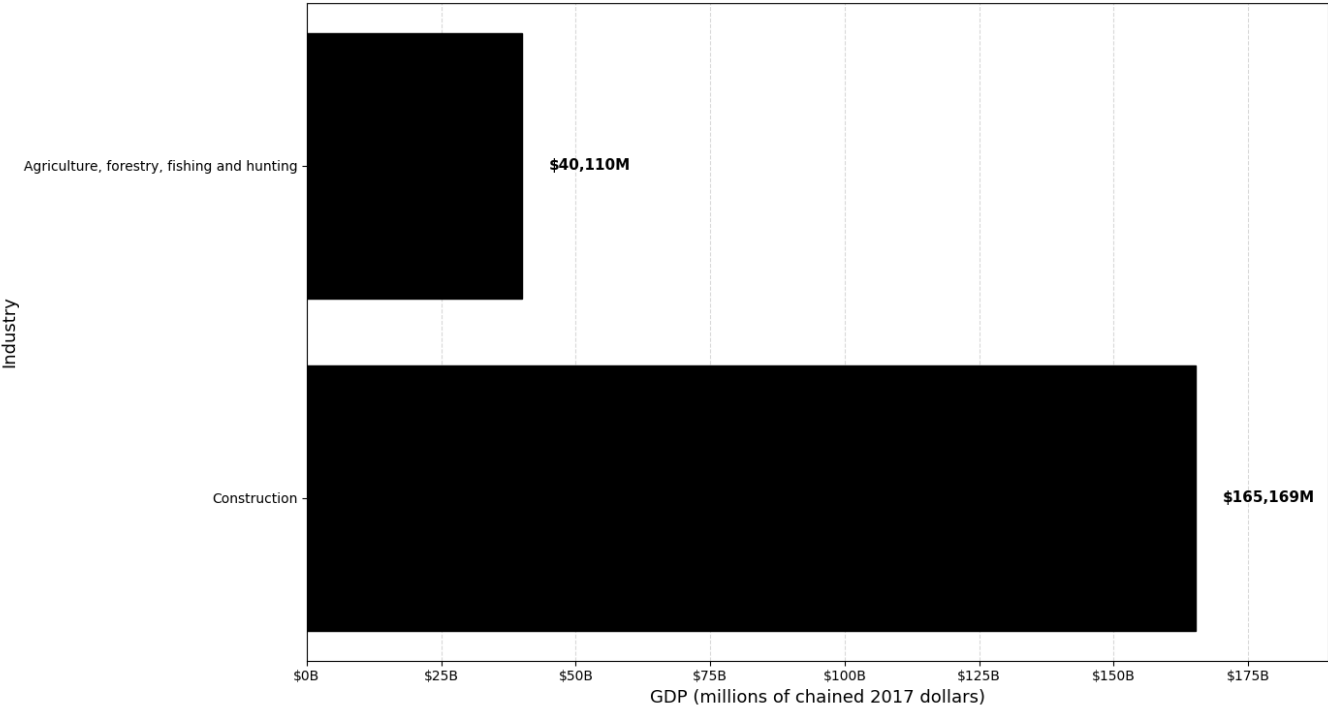
Construction can substitute between concrete, steel, and lumber for different projects depending on the price. While there was a large price spike for lumber during the pandemic, the indexed price has comparably changed alongside steel and concrete.

Construction Material Price Indices (January 2010=100)
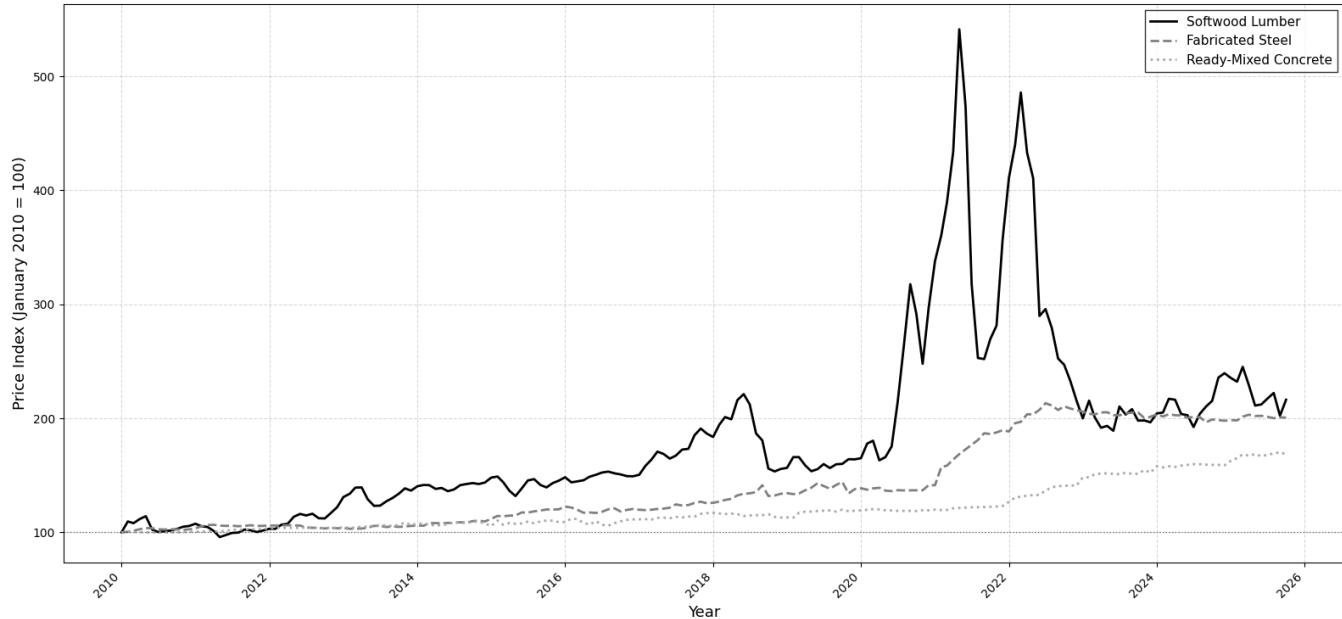
This gives the government the opportunity to make lumber a more appealing material for construction by lowering its real price to be in line with steel and concrete.

Modeling Softwood Lumber Subsidies

Agents

Sawmill Firms

These firms will represent the base supplier of Lumber, for which the tax incentive with induce demand. They will take Labour and Capital as inputs and produce lumber as an output.

Construction Firms

These firms will represent the purchaser of Lumber. They will take in Lumber and Alternatives to Lumber as inputs and produce the final output good.

Government

Will collect taxes and spend on the tax incentive.

Household

Will consume the output of construction firms. And provide labour and capital to the sawmill firms.

Variables

Sawmill Firms

Y^W = Lumber Output
A^S = Technology Multiplier for Sawmill Firms
K = Capital Input to Sawmill Firms
L = Labour Input to Sawmill Firms
α = Share of Capital Input to Sawmill Firms
r = Rental rate of Capital
w = Wage rate of Labour
P^W = Price of Lumber

Construction Firms

Y_F = Final Output
A^C = Technology Multiplier for Construction Firms
W = Lumber Input for Construction Firms
Ψ = Alternatives to Lumber Input for Construction Firms
θ = Construction Inputs Multiplier
ϕ = Elasticity of Substitution between Inputs
$\mathcal{P}^W$ = Effective price of Lumber
P^Ψ = Price of Alternatives to Lumber

Government

G = Government Expenditure

T = Lump Sum Tax on Households

ω = Tax Credit on Lumber Input

Household

C = Consumption of the Final Output

L = Labour Supplied

External Demand

X = External demand for Lumber

Market Clearing Conditions

In order to reach equilibrium in this model we would need to meet the following market clearing conditions:

$Y^W = W + X$
$G = T$
$L_s = L_d$
$K_s = K_d$
$Y^F = C$

Model

Sawmill Firms

Production Function:

$$Y^W = A^S K_t^\alpha L_t^{(1-\alpha)}$$

Budget Constraint:

$$TC = r_t K_t + w_t L_t$$

Construction Firms

Production Function:

$$Y^F = A^C (\theta \cdot W^\phi + (1 - \theta) \cdot \Psi^\phi)^{1/\phi}$$

Budget Constraint:

$$TC = P_W^{eff} \cdot W + P_\Psi \cdot \Psi$$

Effective Price of Lumber:

$$\mathcal{P}^W = (1 - \omega) P^W$$

Government

Government Costs:

$$G = \omega \cdot P_W \cdot W$$

Government Budget Constraint:

$$G = T$$

Household

Household Utility:

$$U = log(C) + \gamma \cdot log(1 - L)$$

Household Budget Constraint:

$$C + K_{t+1} = wL + rK - T$$

External Demand

External Demand Function:

$$X = X(P^W)$$

Calibration

The model will be calibrated by setting the following variables and parameters. The goal will be to simulate real world conditions as best as possible.

Parameters

A^S = Technology Multiplier for Sawmill Firms
α = Share of Capital Input to Sawmill Firms
A^C = Technology Multiplier for Construction Firms
θ = Construction Inputs Multiplier
ϕ = Elasticity of Substitution between Inputs
P^Ψ = Price of Alternatives to Lumber
ω = Tax Credit on Lumber Input

Exogenous Variables

X = External demand for Lumber

Solving the Model

Household Problem

$$\max_{\{C_t,L_t,K_{t+1}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t [log(C) + \gamma \cdot log(1-L)]$$

$$s.t. C_t + K_{t+1} - (1-\delta)K_t = w_t L_t + r_t K_t - T_t$$

$$\mathcal{L} = \sum_{t=0}^{\infty} \beta^t [log(C) + \gamma \cdot log(1-L)] + \sum_{t=0}^{\infty} \lambda_t [w_t L_t + r_t K_t - T_t - C_t - K_{t+1} + (1-\delta)K_t]$$

$$\frac{\partial \mathcal{L}}{\partial C_t} = \frac{\beta^t}{C} - \lambda_t = 0$$

$$\frac{\partial \mathcal{L}}{\partial L_t} = \frac{-\beta^t \cdot \gamma}{(1-L)} + \lambda_t w_t = 0$$

$$\frac{\partial \mathcal{L}}{\partial K_{t+1}} = -\lambda_t + \lambda_{t+1}[r_{t+1} + 1 - \delta] = 0$$

$$\frac{\partial \mathcal{L}}{\partial \lambda_t} = 0 \implies C_t + K_{t+1} - (1-\delta)K_t = w_t L_t + r_t K_t - T_t$$

$$\frac{\beta^t}{C_t} = \frac{\beta^{t+1}}{C_{t+1}}[r_{t+1} + 1 - \delta]$$

$$w_t = \frac{\gamma C}{(1-L)}$$

Sawmill Firm Problem

$$\max_{\{L_t,K_t\}} P_t^W \cdot A^S K_t^\alpha L_t^{(1-\alpha)} - r_t K_t - w_t L_t$$

$$\mathcal{L} = A^S K_t^\alpha L_t^{(1-\alpha)} - r_t K_t - w_t L_t$$

$$\frac{\partial \mathcal{L}}{\partial L_t} = (1-\alpha)P_t^W A^S K_t^\alpha L_t^{-\alpha} - w_t = 0$$

$$\frac{\partial \mathcal{L}}{\partial K_t} = \alpha P_t^W A^S K_t^{(\alpha-1)} L_t^{(1-\alpha)} - r_t = 0$$

Construction Firm Problem

$$\max_{\{W_t,\Psi_t\}} A^C (\theta \cdot W_t^\phi + (1-\theta) \cdot \Psi_t^\phi)^{1/\phi} - \mathcal{P}_t^W \cdot W_t - P_t^\Psi \cdot \Psi_t$$

$$\mathcal{L} = A^C (\theta \cdot W_t^\phi + (1-\theta) \cdot \Psi_t^\phi)^{1/\phi} - \mathcal{P}_t^W \cdot W_t - P_t^\Psi \cdot \Psi_t$$

$$\frac{\partial \mathcal{L}}{\partial W_t} = \theta A^C \cdot (\theta \cdot W_t^\phi + (1-\theta) \cdot \Psi_t^\phi)^{1/(\phi-1)} \cdot W_t^{(\phi-1)} - \mathcal{P}_t^W = 0$$

$$\frac{\partial \mathcal{L}}{\partial \Psi_t} = (1-\theta)A^C \cdot (\theta \cdot W_t^\phi + (1-\theta) \cdot \Psi_t^\phi)^{1/(\phi-1)} \cdot \Psi_t^{(\phi-1)} - P_t^\Psi = 0$$

Variables

$$\{C_t, K_{t+1}, r_t, L_t, w_t, W_t, P_t^W, \Psi_t, P_t^\Psi, T_t, Y_t^W, Y_t^F\} [12]$$

System of Solution Equations

$$[1] \qquad C_t + K_{t+1} - (1-\delta)K_t = w_t L_t + r_t K_t - T_t$$

$$[2] \qquad \frac{\beta^t}{C_t} = \frac{\beta^{t+1}}{C_{t+1}}[r_{t+1} + 1 - \delta]$$

$$[3] \qquad w_t = \frac{\gamma C_t}{(1 - L_t)}$$

$$[4] \qquad \theta A^C \cdot (\theta \cdot W_t^\phi + (1-\theta) \cdot \Psi_t^\phi)^{1/(\phi-1)} \cdot W_t^{(\phi-1)} = \mathcal{P}_t^W$$

$$[5] \qquad (1-\theta)A^C \cdot (\theta \cdot W_t^\phi + (1-\theta) \cdot \Psi_t^\phi)^{1/(\phi-1)} \cdot \Psi_t^{(\phi-1)} = P_t^\Psi$$

$$[6] \qquad (1-\alpha)P_t^W A^S K_t^\alpha L_t^{-\alpha} = w_t$$

$$[7] \qquad \alpha P_t^W A^S K_t^{(\alpha-1)} L_t^{(1-\alpha)} = r_t$$

$$[8] \qquad Y_t^W = A^S K_t^\alpha L_t^{(1-\alpha)}$$

$$[9] \qquad Y_t^F = A^C(\theta \cdot W_t^\phi + (1-\theta) \cdot \Psi_t^\phi)^{1/\phi}$$

$$[10] \qquad T_t = \omega \cdot P_t^W \cdot W_t$$

$$[11] \qquad Y_t^W = W_t + X_t$$

$$[12] \qquad \mathcal{P}_t^W = (1-\omega)P_t$$

Shocking External Demand

By negatively shocking external demand to simulate the effect of rising tariffs there will be a negative pressure on Y_t^W given by $Y_t^W = W_t + X_t$. This negative pressure will reduce the output of Sawmill firms given by $Y_t^W = A^S K_t^\alpha L_t^{(1-\alpha)}$ which will in tern reduce the wages paid to sawmill employees $w_t = (1-\alpha)P_t^W A^S K_t^\alpha L_t^{-\alpha}$. Causing workers to opt for more leisure to derive utility to make up for the loss of consumption through loss of income. The goal of the subsidy is to keep P_t^W high, to ensure employment does not decrease in the sawmill firms, while also giving construction firms the benefit of the reduced price of lumber from the reduced demand.

This model will be run with multiple iterations to identify the effects of the subsidy in temporary and permanent shocks.

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Lumber exports to the US

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US Housing Starts

https://fred.stlouisfed.org/series/HOUST

Sources: U.S. Census Bureau; U.S. Department of Housing and Urban Development via FRED®

Lumber Output

https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1610001701&pickMembers%5B0%5D=1.1&cubeTimeFrame.startMonth=04&cubeTimeFrame.startYear=2014&cubeTimeFrame.endMonth=08&cubeTimeFrame.endYear=2025&referencePeriods=20140401%2C20250801

https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1610004501&pickMembers%5B0%5D=1.1&cubeTimeFrame.startMonth=08&cubeTimeFrame.startYear=2003&cubeTimeFrame.endMonth=12&cubeTimeFrame.endYear=2018&referencePeriods=20030801%2C20181201

REVENUE

https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1610011701&pickMembers%5B0%5D=1.1&pickMembers%5B1%5D=3.81&cubeTimeFrame.startYear=2012&cubeTimeFrame.endYear=2023&referencePeriods=20120101%2C20230101

GDP by industry:

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Employment Numbers

https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=1410020201

General Stats Page

https://www150.statcan.gc.ca/n1/pub/11-621-m/11-621-m2022023-eng.htm

98% of Lumber Production is Softwood

Commodity Prices

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Tariff Rates

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https://2017-2021.commerce.gov/news/press-releases/2017/11/us-department-commerce-finds-dumping-and-subsidization-imports-softwood.html

Stumping fees

https://www.congress.gov/crs-product/R42789

Subsidy Amounts

https://www.usitc.gov/press_room/news_release/2017/er0106ll702.htm

Types of Tariffs:

https://www.international.gc.ca/controls-controles/softwood-bois_oeuvre/recent.aspx?lang=eng