

Mountain Pine Beetle, Global Change and the British Columbia Forest Economy

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Research Objective

- Supply-side Model
- What effect do the following have on prices and output in the B.C. forest sector?
 - Mountain pine beetle
 - Russian export tax
 - Changes in global timber supply

Supply cuts induced by mountain pine beetle

- Annual allowable cut (AAC) to be reduced by approximately 12 million m³ below pre-outbreak levels
- Increased salvage harvests led to 2006 harvest that was 8.7 million m³ above the pre-outbreak AAC
- Thus, expected drop of approximately 20 million m³ below 2006
 - 20% of B.C. timber supply
 - 4.5% of North America timber supply
 - 1.5% of global timber supply.

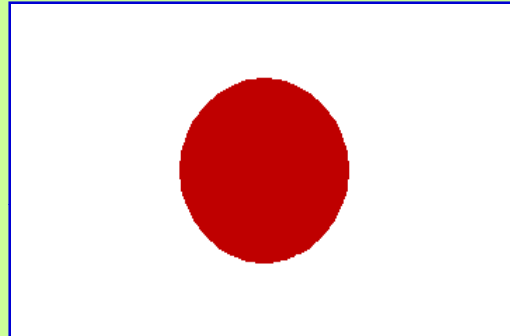
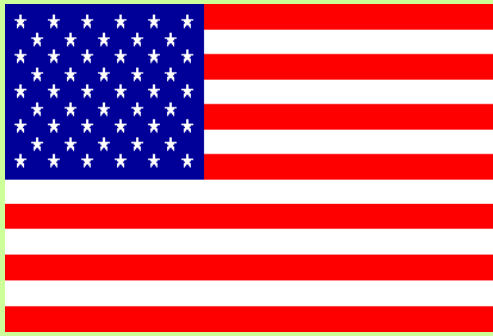
Reduction in log supply from Russia

- Export tax of 6.5% started in 2006
- Tax reached 25% April 1, 2008
 - Chinese and Japanese mills dependent on Russian logs reported difficulties in finding sufficient fiber
 - Some mills have approached B.C. suppliers
- Export tax to reach 80% by 2009

Changes in global timber supply

- In 15 years (1990 to 2004), supply of industrial roundwood increased by: 53% in Australia; 160% in New Zealand; 205% in Chile (FAO)
- MAI is 18-30 m³/ha in Chile but only 1.5-5.3 m³/ha in B.C. (Sedjo)

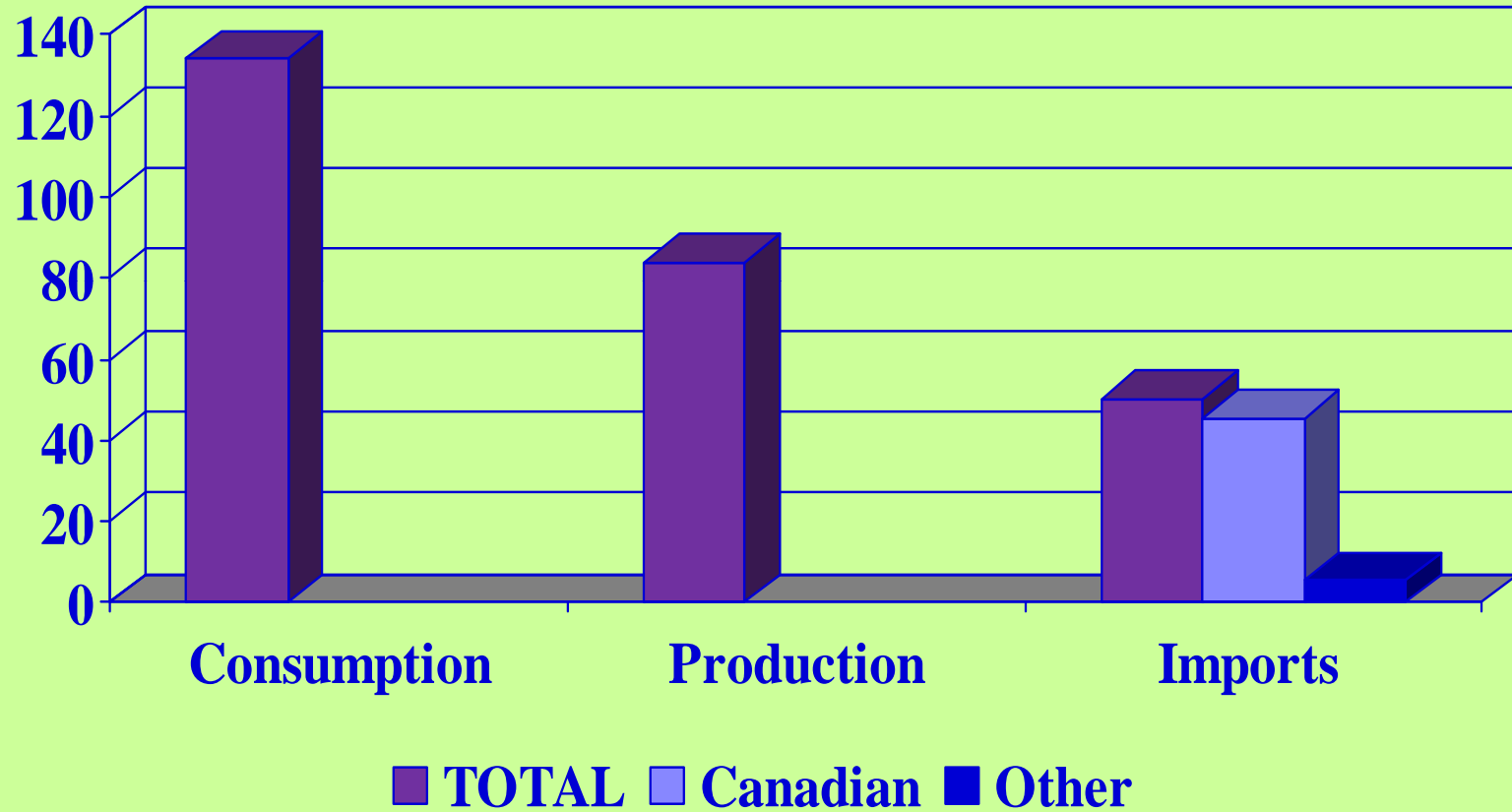
Canadian Softwood Lumber Export Markets 1990-2003



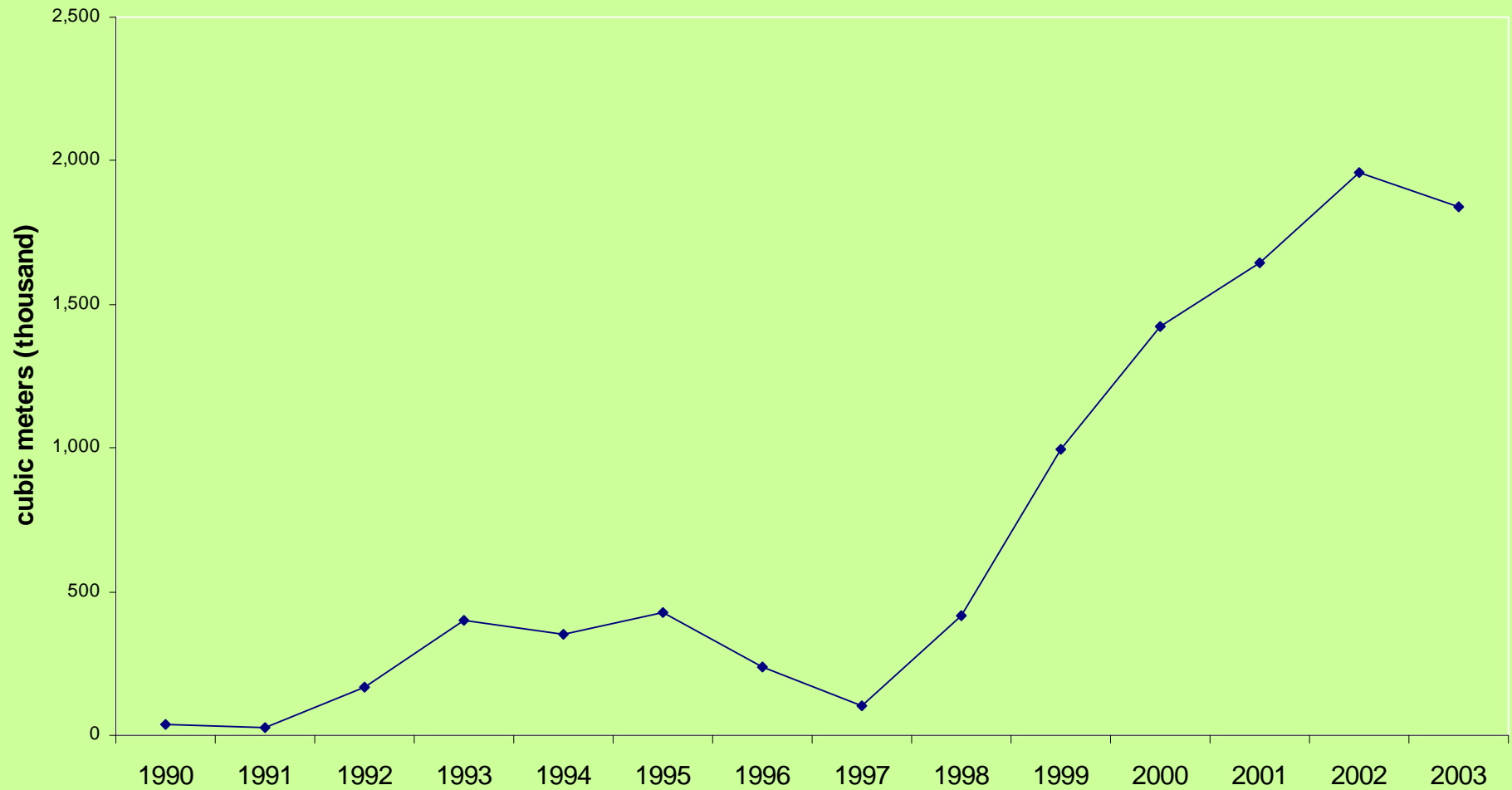
1990	75%	11%	11%
1995	84%	12%	2%
1999	88%	9%	1%
2003	90%	7%	1%

Source: COFI, Statscan

U.S. Softwood Lumber (cu. m.)



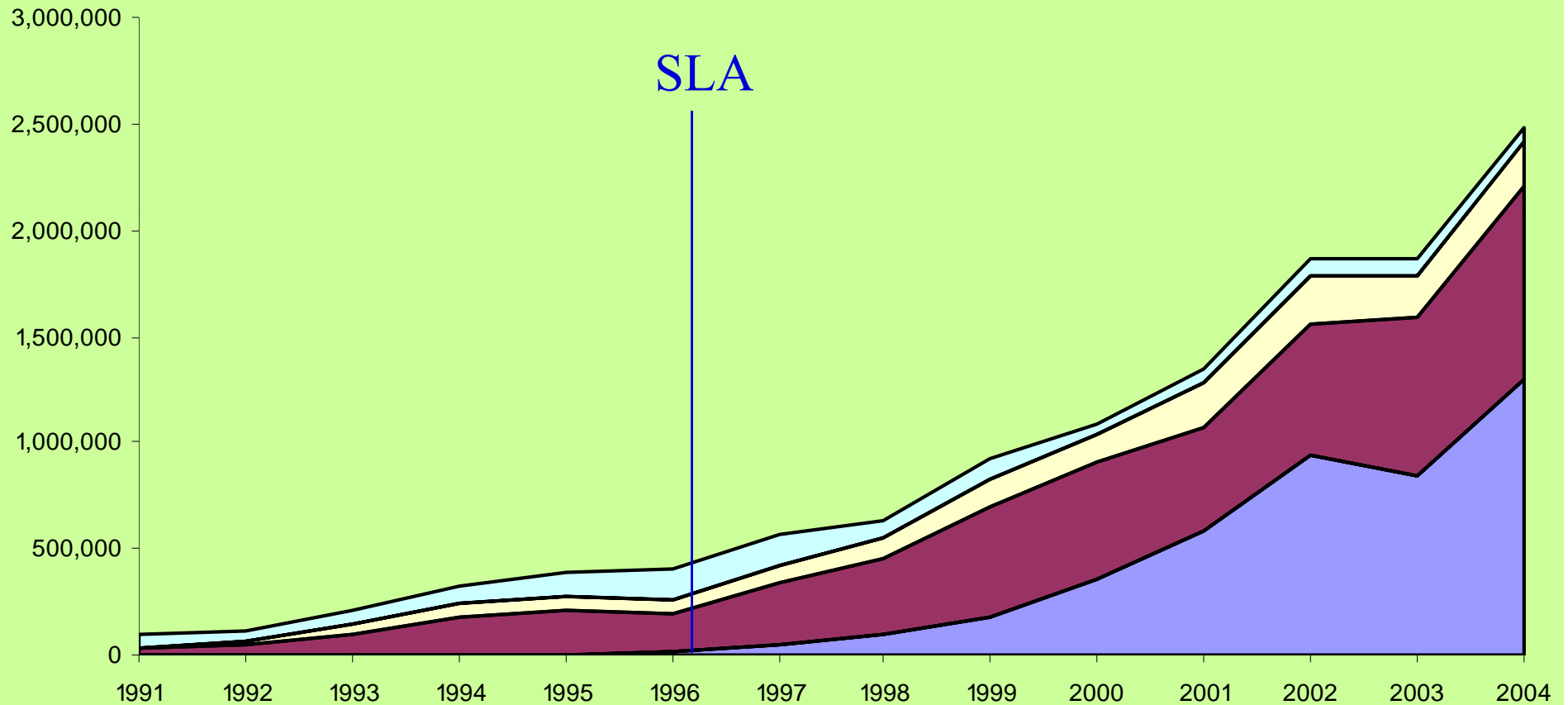
B.C. Log Exports to the U.S.



Source: COFI

Non-Canadian SW Lumber Exports to the United States

European Union South America New Zealand Other



Methods

- Construct a dynamic model similar to the Global Forest Products Model and calibrate it using data from the GFPM and other sources.
- We examine five scenarios:
 1. a base scenario (BAU without MPB)
 2. a B.C. timber supply decrease (related to MPB)
 3. a Russian log export tax
 4. growth of world timber supply
 5. all of these factors.

Methods (cont)

- Model separate B.C. Coast and Interior regions, which required modification of GFPM
- GFPM has many commodities, but, lacking details for Coast/Interior, we focus on lumber and logs
- Total surplus = total consumption benefits minus production & transportation costs and import/export taxes and tariffs.
- Demand and cost curves are linear so integrals are quadratic → quadratic programming
- Solved using Matlab with calls to CPLEX solver in GAMS

Methods (cont)

- Dynamic aspect: connect periods using an updating procedure (so not dynamic optimization) – similar to GFPM
- Program maximizes total surplus in each period, subject to constraints on total harvest and manufacturing capacity (assumed not to grow by more than 10% per year)
- Total harvest constraint is constant over time, except for the regions whose harvest assumed to grow exogenously – occurs in the ‘growth of world timber supply’ and ‘all factors’ scenarios
- Demand assumed constant over time for simplicity

Methods (cont)

- 19 regions
- Inter region trade flows, transport costs and tariffs, constitute 19×19 matrices.
- $(12,13)^{\text{th}}$ element of $X_{i,j}$ represents exports of **logs** from region 12 to region 13;
- $(15,15)^{\text{th}}$ element of $Y_{i,j}$ represents **lumber** produced and consumed in region 15.
- (i,j) elements of $\Omega_{y,i,j}$ are the total trade tariffs charged for exports from region i to region j . (Subscript y refers to lumber tariff)
- Elements of $T_{i,j}$ are lumber transport costs, and are based on volumes \rightarrow inflate $T_{i,j}$ by $4/\pi$ to compute log transportation costs

Model Parameters

Lumber demand/supply:	$\frac{y_{D,i}}{y_{S,i}}$
Saw log demand/supply:	$\frac{x_{D,i}}{x_{S,i}}$
Lumber demand:	$p_{y,i}(y_{d,i}) = a_i + b_i y_{D,i}$
Lumber manufacturing cost:	$c_{y,i}(y_{S,i}) = c_i y_{S,i}$
Saw log cost:	$c_{x,i}(x_{S,i}) = c_i x_{S,i}$
Recovery factor:	ϕ_i
Saw logs ÷ total harvest:	γ_i
Maximum harvest	h_i
Inter region flow:	$\frac{X_{i,j}}{Y_{i,j}}$
Ratio of lumber to log transport costs:	$\frac{\pi}{4}$
Ratio of lumber to log tariffs:	$\frac{\Omega_{x,i,j}}{Y_{y,i,j}}$

Model

Maximize

$$\sum_i \left\{ a_i y_{D,i} - 1/2 (b_i y_{D,i}^2 + c_i y_{S,i}^2 + C_{S,i}^2 x_{S,i}) \right\} - \sum_i \sum_j \left\{ X_{i,j} \left[(4/\pi) T_{i,j} + \Omega_{x,i,j} \right] + Y_{i,j} \left[T_{i,j} + \Omega_{y,i,j} \right] \right\}$$

Subject to:

sawlogs in $i \leq$ fixed fraction of harvest in i :

$$x_{S,i} \leq \gamma h_i$$

supply from i to all \leq saw logs produced in i :

$$\sum_j X_{i,j} \leq x_{S,i}$$

lumber produced in $i \leq$ saw logs x recovery in i :

$$y_{S,i} \leq \phi \cdot x_{D,i}$$

lumber production in $i \leq$ capacity of i :

$$y_{S,i} \leq \bar{y}_i$$

supply from i to all \leq lumber production in i :

$$\sum_j Y_{i,j} \leq y_{S,i}$$

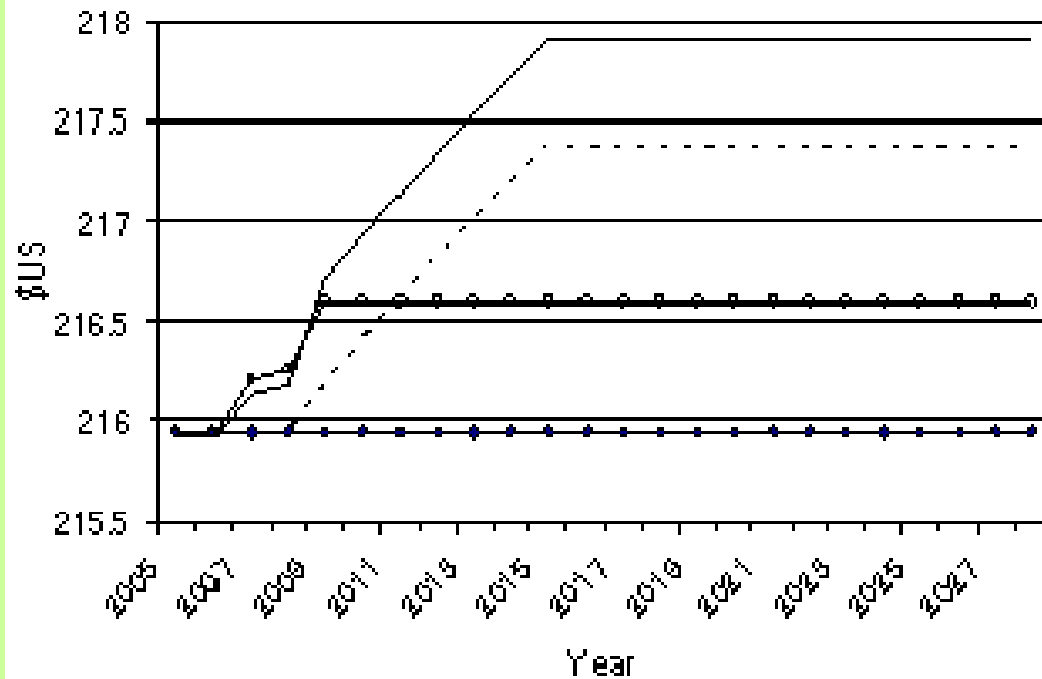
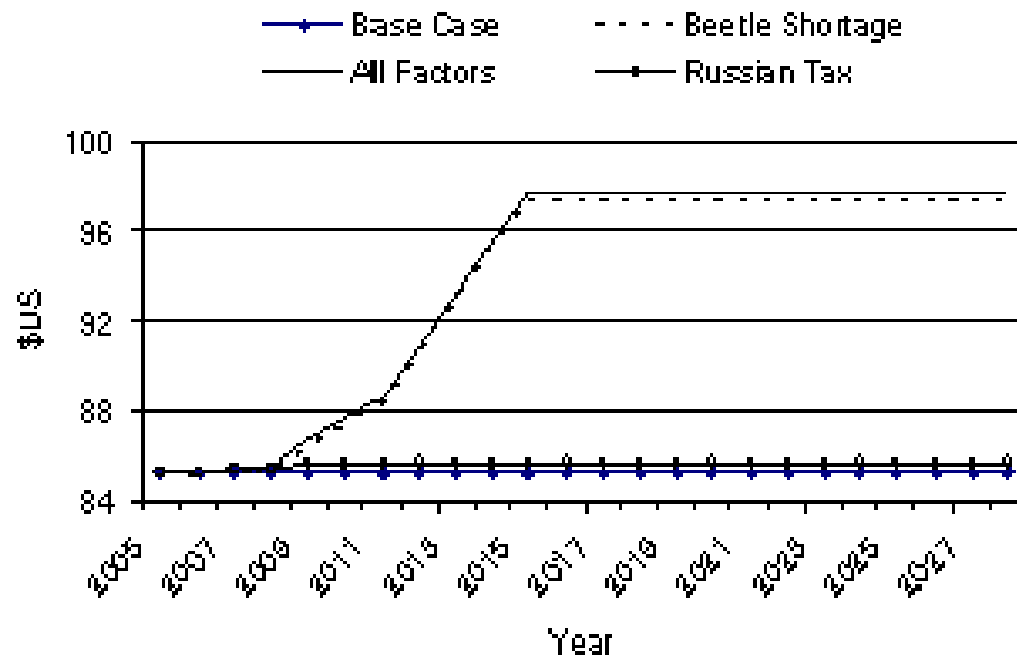
region i lumber demand \leq supply from all regions:

$$y_{D,j} \leq \sum_i Y_{i,j}$$

Scenarios

- Base Case: All parameters as in 2004,
- Beetle Shortage: B.C. interior maximum harvest decreases 6% from the previous period from 2009 to 2015
- Russian Tax: Russian log export tax rises to 20% in 2007, 25% in 2008 and 80% in 2009 and thereafter,
- Global Growth: Max harvests in Chile, New Zealand and Sweden grow 3% per year, in Australia at 1.5% per year, and in Rest of Latin America at 2.5%,
- All factors: All of the above.

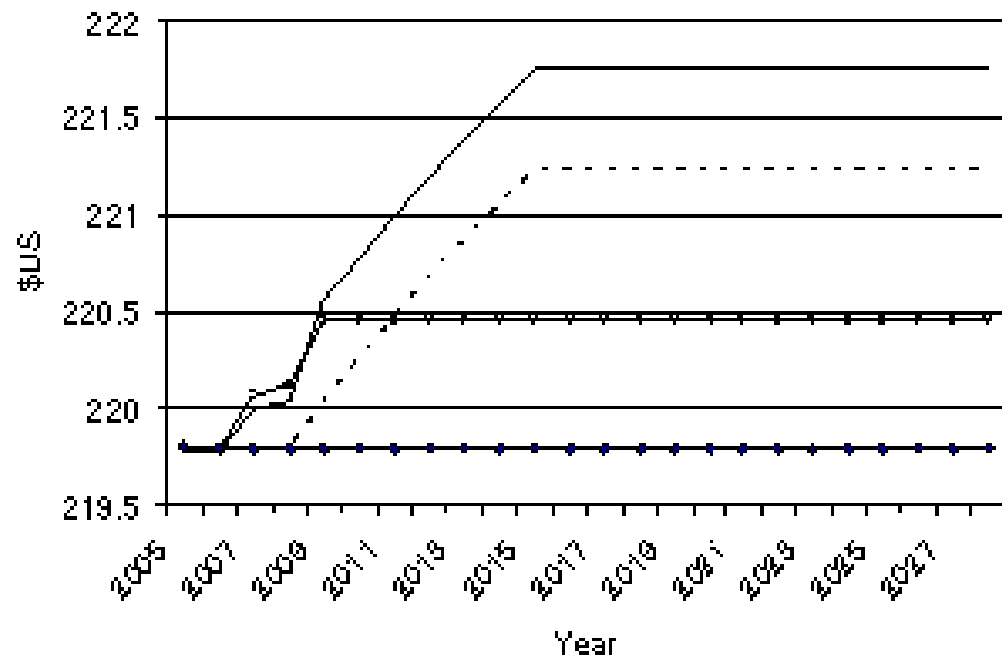
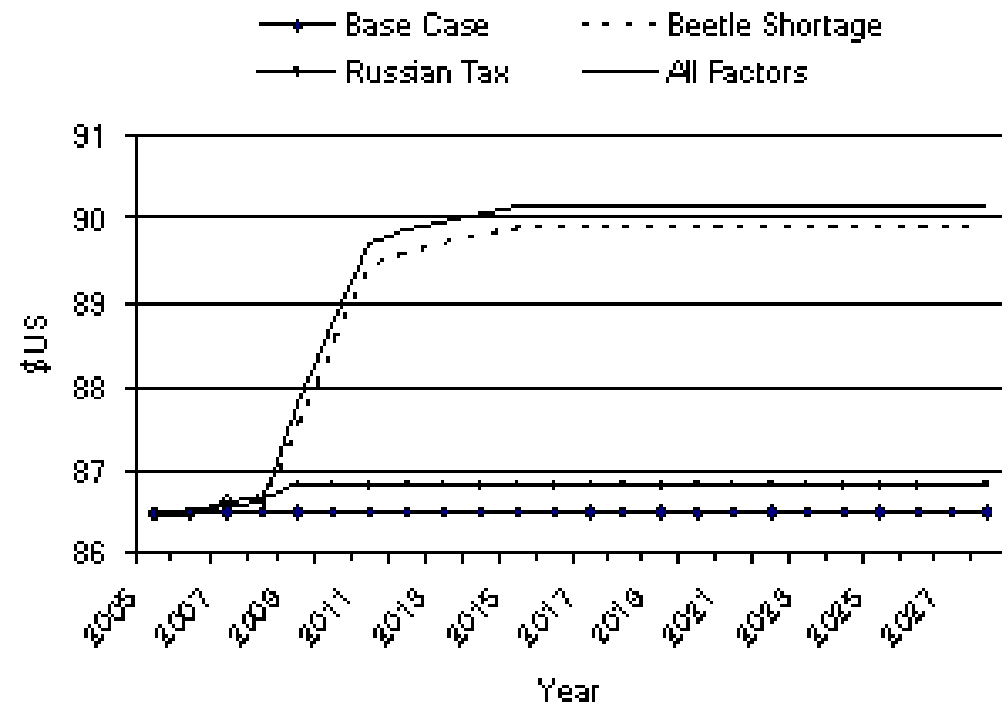
Results: Interior sawlog and lumber prices



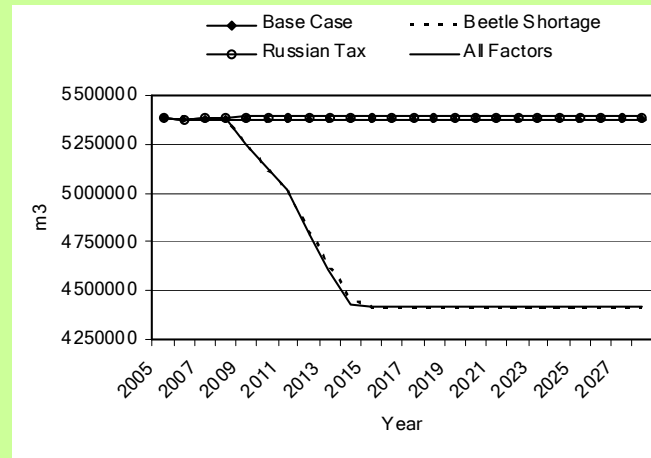
Results: B.C. Interior

- Beetle effect – log prices rise from just over \$85/m³ in 2004 to just under \$98 in 2015; lumber only rises \$1.50/m³
- Russian tax and global growth are almost indistinguishable from the base case.
- Russian tax actually causes a \$0.35 rise in the price of saw logs and global growth a \$0.01 decrease; Russian tax raises lumber price by \$0.65/m³; global changes have no effect on lumber price
- Total effect from all factors: \$2/m³ increase by 2015

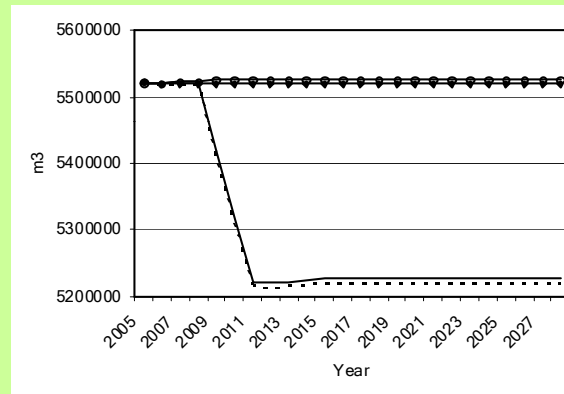
Coast sawlog and lumber prices



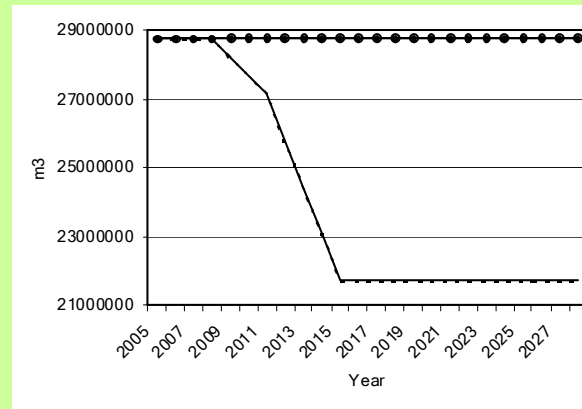
Results: Lumber production in western Canada



(a) Alberta Lumber Production

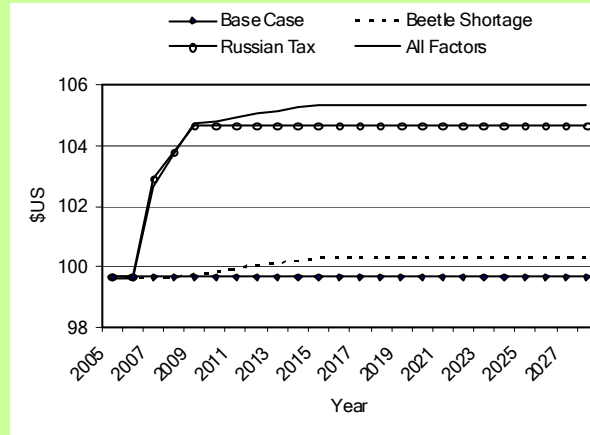


(b) BC Coast Lumber Production

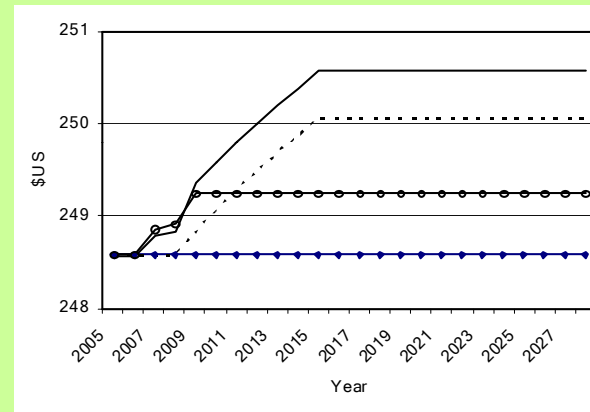


(c) BC Interior Lumber Production

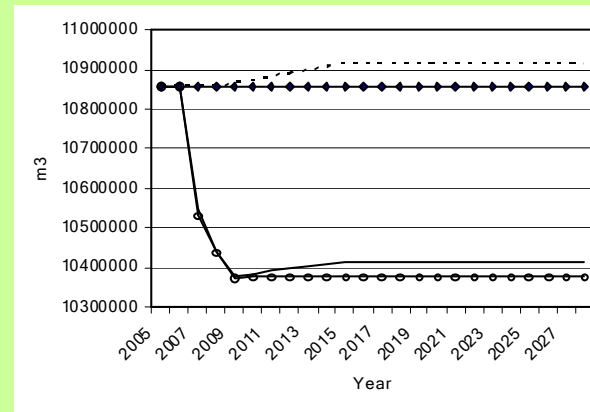
Results: Japan



(a) Japanese Saw Log Prices



(b) Japanese Lumber Prices



(c) Japanese Lumber Production

Conclusions

- Projected decline of the B.C. timber supply and the Russian log export tax will cause the prices of saw logs and lumber to increase in British Columbia
- Log prices in B.C. interior will increase by \$12/m³, or 13% (almost entirely due to beetle). This will offset losses to resource owner due to reduction in timber

THANK YOU