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Beetles, trees, and people: Regional economic impact sensitivity and policy considerations related to the mountain pine beetle infestation in British Columbia, Canada

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Abstract

This article investigates the regional economic impact sensitivity to the current mountain pine beetle infestation in five study areas of British Columbia, Canada, using a computable general equilibrium framework. Baseline general equilibrium economic databases are constructed for each region using a hybrid data collection approach involving primary and secondary sources. A computable general equilibrium model is constructed for each region and used to simulate the sensitivity of a suite of economic indicators to changes in forestry sector exports resulting from the impacts of mountain pine beetle on the available timber supply. The computable general equilibrium models constructed for each region provides an indication of economic vulnerability to the infestation and can assist decision-makers with the identification of policy considerations and priority areas for mitigation planning in response to the anticipated fluctuations in timber supply.
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Keywords: Computable general equilibrium; Mountain pine beetle; Natural disturbance; Economic impact analysis; Transition; Community stability

1. Introduction

British Columbia's forest sector has experienced significant policy change. The adaptation of the 1994 *Forest Practices Act* and the implementation of the controversial Forest Practices Code[2] was in direct response to strong international environmental pressures and public opinion to change forest management practices on lands that are 96% publicly-owned (Cashore et al., 2000). The adoption of the substantive

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[2] The British Columbia Liberal party formed the government in 2001 and adopted an agenda of regulatory reform including streamlining the Forest Practices Code and a "New Era of Sustainable Forestry" (Hoberg, 2002).

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changes to forest management policy subscribed in the *Act* was a departure from many years of policy stability. Ten years later and with a new government in power, the mountain pine beetle (MPB) infestation may be a crisis event that is a tipping point in British Columbia's forest policy-making, in particular policies relating to forest-dependent communities. In order to understand the policy relevance of the MPB outbreak, we investigate the economic impact sensitivity to the infestation in five regions facing different intensities of beetle damage. We argue that economic impact models can aid BC's forest policy community in the formulation of new policy instruments and develop programs.

The current mountain pine beetle (MPB) infestation in British Columbia (BC), Canada, is the largest outbreak in the province's recorded history (BCMOF, 2005b). The acute impacts associated with the future loss of timber supply may lead to a number of significant policy changes. One potentially affected policy area is rural community development of forest-dependent economies within the province's interior. The policy importance of forest-dependent communities in the MPB crisis is reflected in the "Minister's Community Advisory Group" consisting of representatives from local government, First Nations, academia, industry and environmental organizations. This group has recommended wide sweeping policy changes to the BC forest sector, particularly regarding community-based forestry (BCMOFR, 2004). These proposed changes in response to augmented levels of standing dead timber as a result of the beetle infestation included new investments for roads, bioenergy investments, and increased allowable annual cut levels. Two other relevant examples of policy reform proposed by the BC Liberal government are: A) the elimination of utilization requirements thereby allowing companies to sell timber within BC instead of processing it and; B) the elimination of appurtenance provisions that tie harvesting rights to requirements to process the timber in company-owned mills (Markey et al., 2005). These policy reforms combined with the beetle infestation will have implications for community stability and local economies that cannot be identified from a broad provincial stance.

This paper has two objectives. First it provides a baseline snapshot of the economies of the small forest-dependent regional economies in BC that are experiencing the mountain pine beetle infestation. Second it provides the results of a sensitivity analysis performed using a computable general equilibrium model for each study region. The sensitivity analysis is used to simulate the percent change in each of the indicators given a 1.0% change in forest sector exports (i.e., the elasticity of response). From these two objectives, we argue that the economic impact model, and its results, is an important policy tool for understanding the potential for significant and potentially varied policy responses tailored to regional circumstances.

The mountain pine beetle (*Dendroctonus ponderosae*) is an endemic forest insect that is part of the natural disturbance regime in western Canadian pine forests. When favourable climatic and landscape conditions exist, the endemic population is able to expand exponentially until reaching epidemic proportions leading to widespread forest disturbance. This particular form of natural disturbance has drastically influenced the forest landscape and as a result the available timber supply that supports many communities in BC, Canada. For example, the area affected by the mountain pine beetle increased exponentially over the period of 1999 to 2004 from an initial disturbed area of 165,000 ha of visual tree mortality in 1999 to 7,021,886 ha in 2004 (BCMOF, 2005a). The impacted area represents just over 10% of the entire forest and other wooded land in the province (65.4 million ha) and accounts for a volume of beetle-killed timber of 400 million m^3 (i.e., approximately four times the potential annual allowable cut for the entire province) (BCMOF, 2005a; Canadian Forest Service, 2005).

The large rate of tree mortality has resulted in a significant increase in the annual allowable cut (AAC, i.e., the amount of timber that can be sustainably harvested annually) in order to capture the value of standing dead timber through salvage cutting. For example, the current AAC for the combined five study regions is 31.2 million m^3, an increase of 12.1 million m^3 or 63.0% over the baseline (pre-infestation) AAC of 19.2 million m^3 (BCMOFR, 2006). However, it is anticipated that the uplifted harvest is above a sustainable level (i.e., a departure from the sustained yield calculation) and that the future AAC level will fall down in 10–15 years due to a lack of economically viable standing dead and green wood and the length of time required to regenerate mature forest stands (60–80 years) (BCMOFR, 2006). It is expected that in

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the shorter term, the uplift in the timber harvest will result in a period of economic boom followed by an economic downturn due to timber shortages in the longer term.

2. Methods

Quantifying the potential impacts of the natural disturbance in a general equilibrium (GE) framework may assist decision-makers in designing policies for mitigation and sustainable regional development. The GE framework is one in which every sector of an economy is linked to other sectors, whether directly through transactions (purchases and sales), or indirectly through competition for labour, capital, and land used in the production process (Parmenter, 1982). Two theoretical streams exist within the GE approach: fixed price approaches and flexible price approaches (Partridge and Rickman, 1998).

Computable general equilibrium (CGE) models fall within the flexible price stream and are a mathematical representation of the monetary flows, or supply and demand transactions that occur among and between sectors and institutions (i.e., such as households) in an economy under investigation. For example, households provide labour to a producing sector in return for a wage. A contraction in the producing sector will lead to the release of labour and potentially reduced household income. The essence of the theoretical structure is that consumers and producers maximize their utility and profits, respectively (Shoven and Whalley, 1992). In equilibrium, a set of prices and production levels in each sector is achieved such that the total supply of commodities equals the total demand for commodities (Alavalapati et al., 1996). Similar to the input–output (I–O) models of the fixed price stream, CGE models account for intersectoral linkages through the direct transactions among the sectors. Unlike conventional I–O models, CGE models are not restricted to the limiting assumptions that: prices of inputs and outputs are fixed, production is based on a technology in which fixed amounts of inputs are required to produce a unit of output, and an unlimited supply of inputs (Alavalapati et al., 1998).

CGE models are less common than their I–O counterparts, but allow a limitless relaxation of the assumptions in fixed price models (Partridge and Rickman, 1998). Partridge and Rickman (1998) critically assess the contributions that CGE models have made to regional economic analysis. The authors discuss the increasingly widespread use of regional CGE models despite their complexity and cost of implementation and find that they have provided unique insights into the workings of regional economies and the possible effects of policy change, and that regional CGE models represent a significant advancement in regional economic analysis. However, despite the advancement, they also identify functional form and parameter specification as two areas that require further research in regional CGE model development.

More recently, Berck and Hoffman (2002) provide a state of the economic impact assessment literature in the context of estimating the employment impacts from environmental and natural resource policy changes. The authors examine the use of fixed and flexible price approaches to evaluating the effect of a policy action on employment, outline the basic modeling structures and data requirements, and discuss examples of their application and relative merits. They find that CGE models permit a more realistic representation of the adjustment process and result in less extreme assessments of employment impacts by allowing for substitution among inputs in production and goods in consumption compared to fixed-price methods.

While Berck and Hoffman (2002) are optimistic about the growing practical application of the CGE class of models, they also recognize that there are some drawbacks. For example, CGE models require considerably more effort to build or customize, and similar to the findings of Partridge and Rickman (1998), they find that more decisions must be made about the choice of functional form and parameter values. They suggest that in practice these choices are often drawn from the modeller's judgement and a stylized understanding of the economy being examined. Both studies agree that the choice of functional form is not a unique problem to CGE specification and in choosing the alternative fixed price models the functional form is arbitrarily linear (Partridge and Rickman, 1998; Berck and Hoffman, 2002).

A variety of applied studies exist that either compare impact simulation under fixed and flexible approaches or that use a GE approach, or a comparison of GE approaches, to simulate the impacts of policy changes, global market fluctuations, and natural disturbance in

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regional economies (Seung et al., 1997; Partridge and Rickman, 1998; Schreiner et al., 1999; Berck and Hoffman, 2002). A handful of applied studies explore the simulation of economic impacts using GE techniques in natural resource and forest-dependent regional economies (Alavalapati et al., 1996; Marcouiller et al., 1996; Alavalapati et al., 1999; Patriquin et al., 2003).

The model adopted in this paper is a customized version of the Johansen stylized model and is specified following Johansen (1974), Parmenter (1982), and more recently Alavalapati et al. (1996). From reviewing the literature, the Johansen stylized model offers a practical balance between the added theoretical complexity of the flexible price approach and the rigidity of the linear functional forms and assumptions inherent in the fixed price approach. The model structure is deterministic in nature and is based on the small, open economies of the five study regions. The CGE model developed for each region affected by MPB contains six sectors and three primary factors of production (land, labour, and capital). The six producing sectors include: agriculture, forestry, service, public, visitor (tourism), and a composite sector comprised of the 'rest of the economy'.

Various assumptions are made with respect to the treatment of the primary factors of production in the model. The labour supply is assumed fixed (i.e., the migration of labour between the region and the rest of the world is not considered). The labour market is modeled under the shorter-term assumption of a rigid wage rate. Under this assumption, adjustments in the labour market occur from changes in employment levels. It is assumed that over the long run, unemployed individuals will migrate out of the region to find employment. The other two primary inputs, capital and land, are assumed to be sector-specific.

The creation of a region-specific economic database for each study area follows the hybrid data collection methodology reported in Patriquin et al. (2002). On a regional scale, data are readily available from the Canadian Census on employment, household income levels and distribution, and population. Alternatively, the input–output (I–O) tables that contain the detailed transactions (and levels of activity) within an economy exist only at the national and provincial level. Survey data collection techniques can provide the most reliable up-to-date information available when there are gaps in secondary data. However, survey approaches are expensive in terms of money and time. A hybrid approach to data collection using both targeted primary surveys and secondary data sources provides a good balance of accuracy and expense and is adopted in this study.

This hybrid approach involves a series of steps starting with the provincial input–output tables (a set of three tables that detail the annual transactions in, and structure of, a market economy) as a base. The provincial input–output tables are then transformed into a social accounting matrix (SAM, a double entry, square accounting framework that ensures data consistency when using hybrid sources). The provincial database (SAM) is then mathematically regionalized using location quotients (the proportion of regional employment divided by the proportion of provincial employment for each sector). This step results in a preliminary region-specific SAM. Superior (primary) data is then inserted with data consistency being cross-checked with secondary sources throughout the above steps.

The economic databases are snapshots of economic activity and as such, they are best considered to be "on average" representations of the economy. For example, the provincial SAM is based on the 1999 (the most recent available) economic structure of the province. Secondary data on employment and income is derived from a 2001 custom census profile from Statistics Canada. Finally, primary data is based on 2002 activity. As a result, the region-specific economic database should be considered as an annual average of the period of 1999–2002. For the purpose of this analysis the regional economic databases are tied to the 2001 pre-uplift AAC reported for the study regions.

3. Baseline conditions

Table 1 displays the population statistics for the five study regions from 1991 to 2001. From 1991 to 1996 the study inter-regional population growth varied. This was followed by a period of no growth or decline from 1996 to 2001. The population statistics demonstrate the variety in the extent of urbanization in each region. For example, Table 1 indicates that the Prince George region and the Kamloops region are characterized by larger 2001 population levels of 102,170 and 95,790, respectively, and would be expected to better absorb shocks in the forestry sector. On the other hand, the

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Table 1
Population statistics for the study regions

	1991	1996	% Change	2001	% Change
Nadina	11,640.0	12,150.0	4.4	12,170.0	0.2
Prince George	96,930.0	105,795.0	9.1	102,170.0	−3.4
Quesnel	22,685.0	24,890.0	9.7	24,100.0	−3.2
Kamloops	82,000.0	94,645.0	15.4	95,790.0	1.2
Rocky Mountain	52,240.0	56,240.0	7.7	56,375.0	0.2

largely rural regions, Nadina and Quesnel with 2001 population levels of 12,170 and 24,100, respectively, are more acutely dependent on the forestry sector's well being. For example, the forest sector employment levels reported in Table 2 for Nadina and Prince George comprise 24.5% and 12.0% of their respective total employment levels.

Several macroeconomic indicators of the "state of the economy" in the regions are used in this report and consist of net domestic product (NDP), royalties and indirect taxes, labour income, and employment. Table 2 displays the baseline indicator levels for each of the five study regions. The Prince George and Kamloops regions show the greatest amount of economic activity followed by the Rocky Mountain region, Quesnel, and the Nadina region.

The MPB infestation will have an influence on the available timber supply, and will therefore, impact the exports originating from the forestry sector. Table 3 displays the anticipated short-term and longer-term changes in the timber supply of each of the five study regions in British Columbia.

In the short term, timber supply is expected to increase in an effort to cope with salvage timber and to address the spread of the infestation; this will result in augmented forestry sector exports. In the longer term, timber supply and the resulting forestry sector exports are expected to significantly decline from the baseline as the forest regenerates. For example, the baseline AAC in the Nadina region is 3.5 million m^3/year and was uplifted by 1.6 million m^3/year to a current level of 5.1 million m^3/year (BCMOFR, 2006). The predicted AAC level for the Nadina region is 1.3 million m^3/year representing a 61.5% decline from the baseline (BCMOFR, 2006). Table 3 also shows that the extent of the mountain pine beetle impacts varies by region.

4. Simulation results and discussion

A 1% change in forestry sector exports (as a result of the influence of the mountain pine beetle) is simulated in order to simulate the structural responsiveness of the economy of each study region. The simulated values can be interpreted as elasticities of the endogenous indicators with respect to forestry

Table 2
Baseline indicator levels for the five study regions

	Nadina	Prince George	Quesnel	Kamloops	Rocky Mountain
Agriculture	1.5	30.2	4.9	10.0	3.3
Forestry	240.0	1,149.9	383.0	386.9	169.7
Services	9.6	597.6	232.6	1,354.9	582.9
Public	36.6	506.3	64.2	410.1	203.1
Visitor	34.0	178.1	55.8	213.3	207.5
Rest of the economy	81.8	698.8	64.9	709.4	475.4
Total NDP ($ millions)	**403.6**	**3160.8**	**805.5**	**3084.7**	**1641.9**
Agriculture	0.6	5.3	1.6	3.3	1.1
Forestry	88.3	394.9	117.5	118.7	52.0
Services	1.7	206.1	79.0	460.2	198.0
Public	6.9	22.8	4.9	31.5	15.6
Visitor	2.8	41.7	7.0	26.8	26.1
Rest of the economy	5.1	62.9	8.1	88.8	59.5
Total royalties ($ millions)	**105.5**	**733.8**	**218.2**	**729.4**	**352.3**
Agriculture	0.7	19.5	1.7	3.5	1.1
Forestry	113.5	346.2	200.7	202.7	88.9
Services	7.6	294.5	77.9	453.8	195.2
Public	24.2	450.7	52.2	333.4	165.1
Visitor	25.0	108.6	44.1	168.5	164.0
Rest of the economy	60.8	385.8	42.0	459.3	307.8
Total labour income ($ millions)	**231.7**	**1605.3**	**418.6**	**1621.2**	**922.1**
Agriculture	100.0	1435.0	471.0	1173.0	600.0
Forestry	1310.0	6675.0	3054.0	2860.0	2535.0
Services	429.0	11,145.0	3140.0	13,955.0	7145.0
Public	454.0	12,845.0	2385.0	11,740.0	5780.0
Visitor	1188.0	4925.0	1185.0	4625.0	3525.0
Rest of the economy	1864.0	18,715.0	2270.0	15,857.0	10,385.0
Total employment (#)	**5345.0**	**55,740.0**	**12,505.0**	**50,210.0**	**29,970.0**

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Table 3
Summary of anticipated changes in timber supply (Cubic metres)

Region	Baseline	Current	Uplift	% Change	Future AAC	% Change
Nadina	3,485,815.0	5,123,117.0	1,637,302.0	47.0	1,341,000.0	−61.5
Prince George	9,360,000.0	14,944,000.0	5,584,000.0	59.7	7,880,000.0	−15.8
Quesnel	2,340,000.0	5,280,000.0	2,940,000.0	125.6	900,000.0	−61.5
Kamloops	2,680,000.0	4,352,770.0	1,672,770.0	62.4	2,000,000.0	−25.4
Rocky Mountain	1,291,500.0	1,522,570.0	231,070.0	17.9	1,164,500.0	−9.8
Total	19,157,315.0	31,222,457.0	12,065,142.0	63.0	13,285,500.0	−30.7

BCMOF (2005b).

export change. Table 4 reports the simulated change in the endogenous indicators (elasticity) in response to a 1% change in forestry sector exports. Simulating the elasticity of response will also demonstrate the relative sensitivity of each region to a 1% change in forestry sector exports, independent of the extent of MPB influence. This should help broaden the policy relevance of the economic impact simulation analysis whether or not natural disturbance is present at high levels. The simulation results are a linear approximation and as such represent the absolute value of a change that could be positive or negative. In addition, the elasticity from the linear approximation is constant meaning that for each added percentage point change in forestry exports, income and employment will respond at a fixed rate of change.

The exogenous shock to forestry sector exports yields a varied response for each region. For example, the Nadina region has by far the most elastic response to the shock with the 1% change in forestry exports causing net domestic product (NDP), royalties, labour income and employment to change by 0.88%, 1.12%, 0.78% and 0.54% respectively. The Nadina region is the only region to reveal an aggregate indicator elasticity of greater than 1% (i.e., total royalties 1.12%).

Quesnel, a somewhat more populated region than the Nadina region, is the next most responsive region to the shock with NDP, royalty, labour income, and employment elasticities of 0.66%, 0.72%, 0.63%, and 0.46%, respectively. While the economy of the Quesnel region is relatively highly responsive to the shock, it would also be expected to better absorb the negative shock of a future timber supply shortage compared to the Nadina region.

The Prince George and Kamloops regions show relatively similar baseline economic indicator and population levels, however, the responsiveness of each region to a forestry export shock is markedly different. In Prince George, the forestry export shock causes NDP, royalties, labour income and employment to

Table 4
Sensitivity simulation (% elasticity) results for the five study regions

	Nadina	Prince George	Quesnel	Kamloops	Rocky Mountain
Agriculture	0.33	0.05	0.26	0.07	0.12
Forestry	1.29	1.15	1.05	0.96	1.02
Services	0.48	0.30	0.39	0.12	0.14
Public	0.16	0.10	0.13	0.04	0.04
Visitor	0.07	0.09	0.10	0.04	0.03
ROE	0.42	0.21	0.32	0.16	0.13
Total NDP	**0.88**	**0.55**	**0.66**	**0.22**	**0.20**
Agriculture	0.33	0.05	0.26	0.07	0.12
Forestry	1.29	1.15	1.05	0.96	1.02
Services	0.48	0.30	0.39	0.12	0.14
Public	0.16	0.10	0.13	0.04	0.04
Visitor	0.07	0.09	0.10	0.04	0.03
ROE	0.42	0.21	0.32	0.16	0.13
Total royalties	**1.12**	**0.73**	**0.72**	**0.26**	**0.26**
Agriculture	0.33	0.05	0.26	0.07	0.12
Forestry	1.29	1.15	1.05	0.96	1.02
Services	0.48	0.30	0.39	0.12	0.14
Public	0.16	0.10	0.13	0.04	0.04
Visitor	0.07	0.09	0.10	0.04	0.03
ROE	0.42	0.21	0.32	0.16	0.13
Total labour income	**0.78**	**0.39**	**0.63**	**0.21**	**0.18**
Agriculture	0.33	0.05	0.26	0.07	0.12
Forestry	1.29	1.15	1.05	0.96	1.02
Services	0.48	0.30	0.39	0.12	0.14
Public	0.16	0.10	0.13	0.04	0.04
Visitor	0.07	0.09	0.10	0.04	0.03
ROE	0.42	0.21	0.32	0.16	0.13
Total employment	**0.54**	**0.30**	**0.46**	**0.15**	**0.18**

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change by 0.55%, 0.73%, 0.39%, and 0.30%, respectively – compared to Kamloops with respective changes of 0.22%, 0.26%, 0.21%, and 0.15%. Despite similarities in size, the Prince George economy is clearly more dependent on forestry than that of Kamloops and therefore, less able to absorb the negative shock of a future timber shortage.

The Rocky Mountain region is a mid-size economy relative to the other regions in this study, but demonstrates the least responsiveness to changes in forestry exports. The forestry export shock yields a change in NDP, royalties, labour income, and employment of 0.20%, 0.26%, 0.18%, and 0.18% respectively. Compared to the other regions, the Rocky Mountain region may not suffer the negative consequences of future timber shortages to the same extent.

In the context of policy response to the MPB infestation, the regional economic impact sensitivity helps to inform decision-makers about the extent of vulnerability to the natural disturbance and may assist the development of a tailored policy response by region. For example, the combined information of the economic sensitivity, the population size, and the extent of the expected timber supply fluctuations suggests that the Nadina region is highly vulnerable to the beetle infestation and the extent of the vulnerability may require substantial mitigation policies such as government assistance and re-training programs for displaced workers, regional economic development initiatives and financing, or more likely a combination of policy instruments. In contrast, the Prince George region would be considered less vulnerable under the limited context of this analysis and therefore may not require the same extensive policy emphasis compared to the Nadina region.

5. Conclusion

The forest-dependent communities of five study regions in British Columbia, Canada are facing a period of transition resulting from the magnitude of the current mountain pine beetle infestation. Detailed baseline economic databases were constructed for each study region providing a snapshot of the state of the regional economies prior to the realization of mountain pine beetle impacts on annual allowable cut, and the information necessary to construct region-specific general equilibrium models.

A computable general equilibrium framework was employed for the purpose of simulating the sensitivity of the economic indicators for the five regions that are experiencing mountain pine beetle pressure. The results demonstrate regional differences in the sensitivity to forestry export shocks and highlight the potential need for region-specific policy development to address the impacts of the mountain pine beetle infestation and other natural disturbance. For example, the removal of the appurtenance clause means that wood can potentially flow more efficiently to different mill locations resulting in income and employment impacts across the regions of British Columbia in the near term as timber supply is uplifted to address the mountain pine beetle infestation and in the longer term as the amount of available timber is reduced. The regional employment and income sensitivity to timber supply changes may provide an argument to reinstate a policy that ties the wood supply of a given landscape to a particular mill location for the purpose of stabilizing a community during future timber supply shortages.

The shorter-term impacts will reflect a relative boom to the regional economies as forestry sector activity increases to handle the volume of available timber resulting from mountain pine beetle damage. This increased activity will cycle throughout the economy providing spin-off benefits to other sectors such as the service sector and retail trade. However, these spin-off impacts may be somewhat muted as individuals and industries brace for the expected future fall down in the timber supply or re-invest capital in order to transition to new forms of industry and employment.

The longer-term economic implications of the mountain pine beetle infestation are negative as the available timber supply is expected to fall below the baseline level. In other words, the economies will not return to a business-as-usual state once the beetle-kill timber runs out or no longer contains marketable value. At this turning point, the regional economies will be forced to transition or the level of gross economic activity will shrink – all else held constant.

The results found in the CGE model simulations should be considered by key provincial policy advisory groups such as the “Minister’s Community Advisory Group.” We argue that such policy-making groups will

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require information that is able to measure the extent of economic impacts on communities in order to develop effective programs that aim to overcome the devastation of this natural calamity.

The divergent simulation results indicate a degree of complexity that no single policy can address in response to this natural disaster. Decision-makers in the MPB infested area face considerable challenges in coordinating policies and developing programs that reflect the different economic needs of the many forest-based communities in British Columbia's interior. For policy scientists interested in understanding policy change, economic models such as the CGE permit a more sophisticated analysis of this issue and the determination whether or not the outbreak has provided a significant reverberation to British Columbia's turbulent forest policy environment.

Finally, the CGE framework used in this study is not without flaws and as a consequence, the sensitivity results should be interpreted with caution. For example, Cobb–Douglas production and consumption functional forms are used in this study to characterize producer and consumer behaviour in order to ease the burden of collecting primary data. It is recognized that more flexible functional forms and econometric estimation of the parameters needed in the model construction would likely improve the accuracy of impact estimates. However, in the absence of existing data for the regions, the simulation results obtained in this study demonstrate a snapshot of the sensitivity of each region to a forestry export shock – all else held constant – based on an initial snapshot of the baseline industrial structure that would otherwise be unobtainable via the alternative fixed-price methods.

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