RANDOM VARIABLES IN FOREST POLICY: A SYSTEMATIC SENSITIVITY ANALYSIS USING CGE MODELS

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ABSTRACT

Computable general equilibrium (CGE) models are extensively used to simulate economic impacts of forest policies. Parameter values used in these models often play a central role in their outcome. Since econometric studies and best guesses are the main sources of these parameters, some randomness exists about the "true" values of these parameters. Failure to incorporate this randomness into these models may limit the degree of confidence in the validity of the results. In this study, we conduct a systematic sensitivity analysis (SSA) to assess the economic impacts of: 1) a 1% increase in tax on Canadian lumber and wood products exports to the United States (US), and 2) a 1% decrease in technical change in the lumber and wood products and pulp and paper sectors of the US and Canada. We achieve this task by using an aggregated version of global trade model developed by Hertel (1997) and the automated SSA procedure developed by Arndt & Pearson (1996). The estimated means and standard deviations suggest that certain impacts are more likely than others. For example, an increase in export tax is likely to cause a decrease in Canadian income, while an increase in US income is unlikely. On the other hand, a decrease in US welfare is likely, while an increase in Canadian welfare is unlikely, in response to an increase in tax. It is likely that income and welfare both fall in Canada and the US in response to a decrease in the technical change in lumber and wood products and pulp and paper sectors.

Keywords: Computable general equilibrium, global trade model, parameters, uncertainty.

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INTRODUCTION

Computable general equilibrium (CGE) models are extensively used to examine economic impacts of changes in forest policies.[1] Shoven & Whalley (1992) noted that CGE mod-

[1] See Alavalapati *et al*. (1997), Waters *et al*. (1997), Binkley *et al*. (1994) and Percy (1986).

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els provide an ideal framework for appraising the effects of policy changes on resource allocation and assessing the welfare effects. CGE models permit the prices of inputs employed to vary with respect to changes in output prices and accommodate the indirect effects of policy variables on the overall economy (Constantino & Percy, 1988). In spite of these attractive features, some researchers are skeptical about the validity of results derived from CGE models.[2] One of the main concerns is the problem associated with *parameter* specification in these models. Parameters are often used with an assumption that they are correct and deterministic in nature. However, these values are invariably obtained from either econometric analysis or from "coffee table conversations" (Harrison & Vinod, 1992). Therefore, some uncertainty exists about their "true" values and they must be viewed as random variables. Since key parameter values play a pivotal role in CGE model outcomes, it is not appropriate to consider them as deterministic values.

Researchers have proposed three types of methods to account for randomness associated with parameters in CGE analysis.[3] First, Pagan & Shannon (1987) proposed an approach based on a local approximation of the model results expressed as a function of the model parameters. Second, Harrison & Vinod (1992) introduced a method which focuses on drawing a MonteCarlo sample from a chosen distribution of parameters, evaluating the model at these points, and approximating expectations as a weighted sum of the endogenous variables. Arndt (1996) presented an alternative approach based on Gaussian quadrature. Arndt & Pearson (1996) have further automated this procedure for use with the GEMPACK software.[4] Arndt & Hertel (1997) have applied this procedure and found that Batra's (1992) assertions that technical change in Japanese manufacturing necessarily reduces US real wages are unlikely.

In this paper, we introduce CGE systematic sensitivity analysis to the forest economics literature and illustrate the importance of incorporating parameter variation in forest policy analysis. We examine the impacts of: (1) a 1% in-

[2] See Hazledine & MacDonald (1992) for a critique on CGE models.

[3] See DeVuyst & Preckel (1997) for more details on these three approaches.

[4] See Harrison & Pearson (1994) for more details on the GEMPACK software.

crease in tax on Canadian lumber and wood products exports to the US and (2) a 1% decrease in technical change in the lumber and wood products and pulp and paper sectors of the US and Canada to show that results differ with variation in key parameters. We have achieved this task using a modified version of the global trade model formulated by Hertel (1997) and an automated systematic sensitivity analysis (SSA) procedure developed by Arndt & Pearson (1996). In the analysis, elasticities of substitution between domestic and imported goods and elasticities of substitution among imports from different destinations are considered random variables. We derive means and standard deviations of economic impacts of the proposed changes to see if some impacts are more likely than others. Information about the likelihood of impacts of forest policies helps policy makers in making decisions about forest products trade and sustainable forest management practices.

The paper is organized as follows. In the next section, a brief description is provided explaining why tax and technology changes are considered for examination. A brief overview of the global trade model and data used in the analysis is given in the third section. The SSA procedure is briefly described in the fourth section. SSA results are presented and discussed in the fifth section. A brief summary and discussion concludes the paper.

PROPOSED FORESTRY CHANGES IN CANADA AND THE US

The Canada-US softwood lumber trade dispute is an important forest issue which has been going on for the past 15 years. The dispute started in 1982 when the Coalition for Fair Lumber Imports (CFLI) in the US filed a petition stating that Canadian stumpage prices conferred a subsidy and materially injured US lumber producers.[5] In 1986 the US and Canada agreed to a Memorandum of Understanding (MOU) where the Canadian government imposed a 15% export tax on softwood lumber exports to the US. The MOU also envisaged measures to lower the export tax if stumpage rates were increased in Canada. Many Canadian provinces increased their stumpage rates to offset the 15% export tax. By 1990, more than 92% of Canadian lumber exports to the

[5] See Cashore (1997) for details on the causes and history of the dispute.

US were duty free and Canada asked the US to terminate the MOU. However, in 1991, the CFLI filed another petition stating that the Canadian lumber industry was getting unfair advantages not only from lower stumpage prices but also due to lax environmental regulations. After a series of enquiries and negotiations, in 1996, a five-year agreement was reached between Canada and the US which allowed the first 14.7 billion board feet of softwood lumber from British Columbia, Alberta, Ontario, and Quebec to enter the US duty free. The rest would be subject to a tax. The first 650 million board feet over this amount is subject to a \$50 tax per thousand board feet and further quantities are subject to a \$100 tax per thousand board feet. Careful analysis of the history of Canada-US softwood lumber dispute suggests that the dispute has not ended and so long as the US market is important to Canadian lumber and wood exporters, protectionist sentiments in the US may lead to the imposition of tariffs or quotas on their exports (Percy, 1986; Cashore, 1997). This has prompted us to examine the impacts of a 1% increase in export tax on Canadian lumber and wood exports to the US.

Second, countries throughout the world and Canada and the US in particular, are undertaking efforts to abide by sustainable forest management principles and to devise plans to achieve forest sustainability (Murray & Casey, 1998). These efforts include various initiatives to reduce the size of harvest sites, protect endangered species, conserve wildlife habitat, and protect water resources (Price Waterhouse, 1997). Implementation of these initiatives means that firms require additional resources (labor, capital, and land) for each unit of timber production and thus an increase in the unit cost of forest products production. Alternatively, the growing demand for non-market benefits from forests may increase the opportunity cost of forest land thereby raising the stumpage prices and the cost of lumber and wood products production. Furthermore, certification of lumber and other wood products may also impose additional costs on producers. On the other hand, historically, pulp and paper companies were required to install pollution abatement technologies, follow emission standards, and/or pay pollution taxes to the government. With growing concerns for the environment, we believe that public agencies may impose additional restrictions on pulp and paper production.[6] Compliance with these regulations might increase the unit cost of pulp and paper production.[7] In this study, we model the increase in the cost of production associated with sustainable forest management initiatives and additional environmental regulations as negative Hick's neutral technical change in the lumber and wood products and pulp and paper products sectors in both Canada and the US.[8]

MODEL SPECIFICATION AND DATA

The model used in this study is an aggregated version of a model released by the Global Trade Analysis Project (1997).[9] The global economy is aggregated into 7 regions: Canada (CAN), the USA, South American Countries (SAM), European countries (EUC), Japan (JPN), Southeast Asian Countries (SEA), and the Rest of the World (ROW). Each region consists of 7 sectors: food products (FOOD), forestry (FORE), lumber and wood products (LWPS), pulp and paper products (PPPS), other resources (ORES), manufacturing (MANU), and services (SERV).

The production structure is an important aspect of CGE models. Figure 1 shows that output is produced by combining the value added aggregate and intermediate input aggregate at fixed proportions. In other words, a Leontief technology is assumed in combining value added aggregate and intermediate input aggregate. A constant elasticity of substitution (CES) functional form is assumed in combining primary factors (land, labor, and capital) to produce the value added aggregate. In producing an intermediate input aggregate, the Armington assumption that domestic intermediate inputs are not perfect substitutes for foreign

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[6] The American Forest and Paper Association estimates that new controls on non-combustion sources under the Clean Air Act and the development of revised waste water effluentlimitations under the Clean Water Act could cost the U.S. forest industry over $10 billion in capital expenditures, the closure of approximately 30 plants and the loss of an estimated 19,000 mill jobs (Price Waterhouse, 1997).

[7] Sedjo & Botkin (1997) also pointed out that as society's view of forests and their role continues to change, cost of production will surely rise.

[8] Hicks neutral technical progress implies that given constant factor prices, fewer factors of production are needed to produce a given level of output while factor ratios remain unchanged over time. Alternatively, this can be interpreted as a reduction in the unit cost of production (See Chambers, 1988 for more details).

[9] For extensive details of the model specification, see chapter 2 of Hertel (1997).

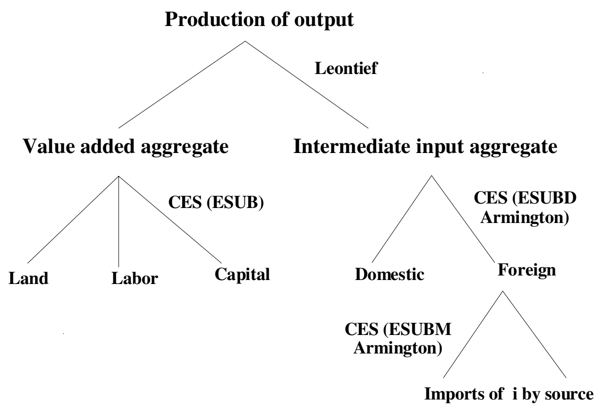

FIGURE 1. PRODUCTION STRUCTURE SPECIFIED IN THE MODEL.

intermediate inputs is made. Also, it is assumed that imports of commodity *i* from region *j* are not perfect substitutes to imports of commodity i from region *k*. The substitutability at both these levels is assumed to be governed by CES functional form. Later in the study, we consider that elasticities of substitution between domestic and import intermediate inputs (ESUBD) and elasticities of substitution between imports of different origin (ESUBM) are random and conduct sensitivity analysis for these parameters. Cobb-Douglas functional forms are used to specify final demands. This implies that the shares of commodities in final demand are invariant to changing relative prices. The model accounts for global savings and investment via the inclusion of a capital goods sector. The database used in calibrating the model is drawn from GTAP. The sources of regional database are published input-output tables. The

TABLE 1. MEAN AND MINIMUM VALUES OF TRADE ELASTICITIES USED TO CONDUCT SSA.

	FOOD	FORE	LWPS	PPPS	ORES	MANU	SERV
Mean of ESUBD	2.41137	2.80000	2.80000	1.80000	2.63527	3.04032	1.94374
Min of ESUBD	0.50000	0.25000	0.25000	0.25000	0.25000	0.25000	0.50000
Mean of ESUBM	4.72779	5.60000	5.60000	3.60000	5.41074	6.35108	3.80831
Min of ESUBM	0.50000	0.75000	0.75000	0.75000	0.75000	0.75000	0.50000

original data are for 1992 with values expressed in $US millions.

SYSTEMATIC SENSITIVITY ANALYSIS

Three basic steps are involved in Arndt & Pearson (1996) SSA procedure.[10] The first step involves developing distributions for key parameters which are chosen for the sensitivity analysis. In this study, we assumed a symmetric triangular distribution. The second step requires developing discrete approximations to the chosen distributions. Since we assumed a triangular distribution, one set of discrete approximations is the minimum, mean, and maximum values of each parameter. This implies that we need to provide either the mean and minimum or the mean and maximum values of each parameter for SSA analysis. If the mean and minimum values are given, the model computes the maximum values assuming that the maximum is as far above the mean as the minimum is below. The final step is solving the model for each point in the discrete distribution and weighting the results appropriately. While the weighted sum of results from each solution provides the mean of the model results, the weighted sum of the square of the difference between results from individual model evaluations and mean results provides the variance. This procedure solves the model 2N times, where N is the number of parameters varied. Table 1 shows that 14 ESUBD and ESUBM elasticities are varied in the model thereby indicating the requirement of solving the model 28 times.[11]

RESULTS OF THE SSA ANALYSIS

The proposed changes described in the foregoing discussion are simulated. Table 2 reports the means and standard deviations of the output changes by sector and by region and changes in the trade balance, income, and welfare by region in response to a 1% increase in tax on Canadian lumber and wood products exports into the US. If an addition or a subtraction of one standard deviation from its mean value changes the sign of the mean, we consider the im-

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[10] See Arndt & Pearson (1996) for details.

[11] It should be noted that other parameters or exogenous variables such as elasticities of substitution between primary factors and other tax variables can be considered for sensitivity analysis.

TABLE 2. CHANGES IN SELECTED VARIABLES BY SECTOR AND BY REGION IN RESPONSE TO A 1% TAX ON CANADIAN LUMBER AND WOOD PRODUCTS EXPORTS TO THE USA.

	CAN	USA	SAM	EUC	JPN	SEA	ROW
FOOD	0.0327	−0.0018	−0.0007	−0.0001	−0.0000	−0.0014	−0.0001
(%)	0.0138	0.0011	0.0006	0.0001	0.0001	0.0011	0.0001
FORE	−0.6258	0.0560	0.0194	0.0055	0.0038	0.0628	0.0055
(%)	0.1598	0.0250	0.0124	0.0037	0.0024	0.0415	0.0036
LWPS	−1.0684	0.1126	0.0704	0.0119	0.0042	0.1472	0.0213
(%)	0.2736	0.0474	0.0453	0.0079	0.0030	0.0977	0.0139
PPPS	0.0309	−0.0030	−0.0018	−0.0007	−0.0002	−0.0035	−0.0003
(%)	0.0133	0.0014	0.0013	0.0004	0.0001	0.0022	0.0002
ORES	0.0529	−0.0027	−0.0029	−0.0004	−0.0001	−0.0051	−0.0010
(%)	0.0219	0.0018	0.0019	0.0002	0.0001	0.0035	0.0006
MANU	0.0735	−0.0030	−0.0014	−0.0000	−0.0000	−0.0056	0.0002
(%)	0.0276	0.0020	0.0016	0.0003	0.0002	0.0044	0.0005
SERV	0.0066	−0.0005	−0.0002	−0.0000	−0.0000	−0.0008	−0.0001
(%)	0.0010	0.0001	0.0001	0.0000	0.0000	0.0004	0.0000
TB	1.3774	−3.3217	−0.0806	0.3527	0.2880	1.5290	−0.1448
($US M)	1.6046	0.9770	0.0762	0.2354	0.2922	1.2679	0.1962
Y	−0.0182	0.0009	0.0009	0.0001	−0.0001	0.0020	−0.0001
($US M)	0.0117	0.0016	0.0009	0.0002	0.0001	0.0017	0.0002
EV	12.901	−27.587	1.5229	0.6807	−0.3544	8.8826	−1.825
($US M)	18.893	17.523	2.8843	4.188	1.9903	7.7661	1.300

Note: TB = trade balance; Y = regional income; EV = equivalent variation or welfare

pact unlikely.[12] Alternatively, in terms of statistical argument we consider the impact is insignificant at one standard deviation confidence interval. On the other hand, if there is no change in the sign of the mean, it implies that the impact is likely or significant.

The results show that output decreases in Canadian forestry and lumber and wood products sectors and increases in the corresponding sectors of the US and other regions of the world. General equilibrium effects are shown to cause an increase in output of other sectors in Canada and a decrease in the corresponding sectors of other regions. How-

[12] One could tighten these confidence bands with two standard deviation values.

ever, the decrease in the manufacturing sectors of SAM, EUC, and the regions is not significant.

The results show that an increase in the Canadian trade balance is not significant in response to a 1% increase in tax on Canadian lumber and wood exports to the US. On the other hand, the decrease in the US trade balance is significant. This is largely because the contraction of other sectors in the US was not fully offset by the expansion in lumber and wood products. Results suggest that an increase in the trade balance and income in the SEA region and a decrease in income in Canada are significant as a result of a proposed tax. However, an increase in US income is not significant. The results reported in the last two rows of column 3 suggest that a decrease in US welfare (27.58 $US millions) is significant while an increase in Canadian welfare is not significant. This may be the reason why consumers in the US oppose the arguments of the Coalition for Fair Lumber Imports on Canada-US softwood lumber dispute. The global welfare in response to a 1% increase in tax is shown to drop by 5.780 $US million with a standard deviation of 3.337 $US million.

Table 3 presents changes in export prices and the trade balance by sector for Canada and the US. The results suggest that prices are likely to drop in all sectors except in the lumber and wood products in Canada in response to an increase in tax. On the other hand, the prices in all sectors are shown to rise in the US. However, only the rise in

TABLE 3. CHANGES IN SELECTED VARIABLES BY SECTOR IN RESPONSE TO A 1% TAX ON CANADIAN LUMBER AND WOOD PRODUCTS EXPORTS TO THE USA.

	FOOD	FORE	LWPS	PPPS	ORES	MANU	SERV
PE CAN	−0.0221	−0.0279	0.0703	−0.0261	−0.0232	−0.0210	−0.0264
(%)	0.0087	0.0107	0.0109	0.0100	0.0091	0.0082	0.0102
PE USA	0.0009	0.0014	0.0113	0.0014	0.0005	0.0011	0.0013
(%)	0.0014	0.0015	0.0014	0.0014	0.0012	0.0014	0.0015
TB CAN	11.696	2.6095	−136.80	6.1414	22.0188	76.4225	19.2885
($US M)	6.148	0.7116	50.847	3.6483	11.918	31.430	9.6634
TB USA	−5.493	−1.6124	77.2136	−3.3037	−5.5329	−47.343	−17.249
($US M)	4.0794	0.4814	48.0835	2.2836	5.4859	30.992	11.0277

Note: PE = aggregate exports price index the price of lumber and wood products is significant. The results indicate that there would be a 136.8 $US million decrease and 77.21 $US million increase in trade balance in the lumber and wood products sectors, respectively, in Canada and the US. This explains why lumber producers in the US are persistent in the Canada-US softwood lumber trade dispute.

Table 4 reports the means and standard deviations of the output changes by sector and by region and the trade balance, income, and welfare changes by region in response to a 1% decrease in technical change in the lumber and wood products and pulp and paper sectors in Canada and the US. This implies that the unit cost of production increases in these sectors in Canada and the US. The results

TABLE 4. CHANGES IN SELECTED VARIABLES BY SECTOR AND BY REGION IN RESPONSE TO A 1% DECREASE IN TECHNICAL CHANGE IN LUMBER AND WOOD PRODUCTS AND PULP AND PAPER SECTORS.

	CAN	USA	SAM	EUC	JPN	SEA	ROW
FOOD	−0.0098	−0.0262	−0.0035	−0.0003	0.0001	−0.0057	0.0007
(%)	0.0254	0.0049	0.0023	0.0012	0.0009	0.0033	0.0008
FORE	0.1258	0.4236	0.1307	0.0841	0.0826	0.3409	0.0464
(%)	0.2839	0.0629	0.0292	0.0192	0.0266	0.1044	0.0130
LWPS	−1.0545	−0.5488	0.4080	0.1266	0.1045	0.7820	0.2015
(%)	0.4721	0.1151	0.1057	0.0384	0.0347	0.2450	0.0592
PPPS	−0.4618	−0.3134	0.3188	0.1152	0.0624	0.2811	0.1094
(%)	0.2053	0.0576	0.0768	0.0350	0.0152	0.0705	0.0273
ORES	0.0451	0.0128	−0.0253	−0.0065	−0.0014	−0.0278	−0.0075
(%)	0.0452	0.0075	0.0068	0.0021	0.0012	0.0095	0.0021
MANU	0.0510	0.0225	−0.0292	−0.0121	−0.0055	−0.0464	−0.0084
(%)	0.0565	0.0084	0.0068	0.0035	0.0018	0.0123	0.0020
SERV	−0.0387	−0.0285	−0.0038	−0.0020	−0.0017	−0.0069	−0.0024
(%)	0.0011	0.0007	0.0006	0.0003	0.0001	0.0014	0.0002
TB	−29.3178	−172.669	9.2780	80.574	56.728	28.305	27.100
($US M)	3.0384	2.9334	0.4069	2.410	1.664	4.055	0.6375
Y	−0.0732	−0.0754	0.0047	0.0011	−0.0069	0.0049	−0.0029
(%)	0.0251	0.0085	0.0039	0.0027	0.0011	0.0052	0.0013
EV	−444.649	−3869.61	−21.062	−39.833	−104.709	5.8622	−41.499
($US M)	36.0649	71.1737	13.504	45.421	12.600	24.719	7.4248

Note: TB = trade balance; Y = regional income; EV = equivalent variation or welfare.

suggest that a reduction in output in these sectors in Canada and the US (1.054% and 0.548% respectively) is likely due to an increase in the cost of production. On the other hand, an increase in output of these sectors in other regions of the world is likely.

Both in Canada and the US, the service sector is shown to contract while the other resource and manufacturing sectors are shown to expand in response to the shock. However, the estimated standard deviations indicate that the expansion of these sectors in Canada is not significant. The results suggest that there would be a significant reduction in trade balance in Canada and the US and an improvement in other regions. Income is shown to drop in Canada, the US, Japan, and ROW regions and an increase in other regions in response to the shock. However, the increase is not significant in the EUC and SEA regions. The contraction in both forest products sectors of the US is shown to cause a reduction in US welfare by 3869.61 $US million. The shock is also shown to affect welfare of all the other regions except the SEA. As a result world welfare is likely to drop by 4515 $US million (11.78 $US million is the standard deviation) in response to 1% reduction in technical change in forest product sectors of Canada and the US.

Table 5 presents changes in supply prices and the trade balance by sector for Canada and the US. The results indicate that both in Canada and the US, there would be a significant increase in the price of lumber and wood products and pulp and paper products. In Canada, prices of other

TABLE 5. CHANGES IN SELECTED VARIABLES BY SECTOR AND BY REGION IN RESPONSE TO A 1% DECREASE IN TECHNICAL CHANGE IN LUMBER AND WOOD PRODUCTS AND PULP AND PAPER SECTORS.

	FOOD	FORE	LWPS	PPPS	ORES	MANU	SERV
PS CAN	−0.0070	−0.0423	1.1104	1.2435	−0.0361	−0.0308	−0.0070
(%)	0.0194	0.0235	0.0224	0.0226	0.0203	0.0187	0.0225
PS USA	0.0047	−0.0341	1.3334	1.2800	−0.0302	−0.0250	−0.0265
(%)	0.0075	0.0078	0.0079	0.0081	0.0070	0.0074	0.0080
TB CAN	5.5568	0.7055	−117.894	−34.871	25.0168	87.4609	4.7080
($US M)	10.6835	1.2107	87.2089	70.062	22.368	63.0696	17.0886
TB USA	−0.9610	4.7099	−432.79	−443.296	72.2259	486.19	141.259
($US M)	16.2918	1.4379	116.65	110.021	24.253	120.38	50.754

sectors are shown to decrease. However, the decrease is not significant in the food and service sectors. Both in Canada and the US, forest product sectors are shown to take a big hit in terms of trade balance. One interesting observation is that the decrease in trade balance of the Canadian pulp and paper sector is not significant in spite of its contraction. Since Canada is the largest exporter of the pulp, with a significant increase in the price of pulp a reduction in trade balance is not likely. On the other hand, the US overall is an importer of pulp and the increase in the market price of pulp would affect the trade balance negatively. In Canada and the US, the results indicate that ORES, MANU, and SERV sectors would benefit in terms of trade balance. However, the increase in trade balance of the SERV sector in Canada is not significant.

SUMMARY AND CONCLUSIONS

Computable general equilibrium (CGE) models provide a convenient framework to analyze forest policies. Unlike fixed coefficient input-output and social accounting matrix models, CGE models allow prices of inputs and outputs to vary with respect to changes in their demand and provide substitutability among factor inputs and commodity outputs. In spite of these attractive features, many researchers are skeptical about the validity of the results. One of their main concerns is parameter specification in these models. It is a common practice to specify parameters with an assumption that they are correct and to consider them as deterministic values. However, these parameter values are often obtained from either econometric analysis or best guesses. Therefore, some uncertainty always exists about the "true" values of these parameters. Failure to incorporate this uncertainty will limit the degree of confidence in the validity of the results. In this study we introduce CGE systematic sensitivity analysis (SSA) to the forest economics. Specifically, we conduct SSA analysis on selected trade parameters and show that results differ with variation in parameters. Specifically we estimate economic impacts of: 1) a 1% increase in tax on Canadian lumber and wood products exports into the US and 2) a 1% decrease in the technical change in the lumber and wood products and pulp and paper sectors of Canada and the US. While the on-going Canada-US softwood lumber dispute provides the motivation for the choice of the first scenario, increasing costs associated with sustainable forest management initiatives, the growing demand for recreation and amenity values from forests, and the increasing public concerns for the environment have prompted us to consider the second scenario. An aggregated version of the global trade CGE model (Hertel, 1997) and an automated SSA procedure developed by Arndt & Pearson (1996) were used to simulate the proposed changes.

The estimated means and standard deviations suggest that certain impacts are more likely than others. For example, a 1% increase in tax on Canadian lumber and wood products into the US is likely to cause a significant decrease in Canadian income, while an increase in the US income is not significant. On the other hand, a decrease in US welfare is significant while an increase in the Canadian welfare is not significant in response to an increase in tax. The results show that the increase in output and trade balance in the US lumber and wood products sector is significant. This analysis explains why US consumers and lumber producers have conflicting interests about the Canada-US softwood lumber trade dispute. The increase in tax is shown to decrease global welfare by 5.78 $US million.

From the results of a deterministic CGE model, we would have concluded that protection of the US lumber and wood industry by rising the export tax on Canadian lumber and woodproducts causes an increase in US income and Canadian trade balance and welfare. This may appear to be a win-win solution for policy makers of both nations. However, the likelihood occurrence of impacts derived from a stochastic CGE model would tell a different story. Let the insignificant impacts be zero. In such a case, an increase in the export tax is shown to have no effect on US income and Canadian trade balance and welfare. Information about no change in income and a significant drop in welfare in response to the shock may prompt US policy makers search other alternatives to end the dispute.

It is likely that the trade balance, income and welfare drop both in Canada and the US in response to a 1% decrease in technical change in lumber and wood products and pulp and paper sectors. The decrease in technical change and associated contraction in the lumber and wood products and pulp and paper sectors of Canada and the US causes global welfare to decline by 4515 $US million. One interesting finding is that the decrease in trade balance of the Canadian pulp and paper sector is not significant. Export orientation and the increase in the market price of pulp may be responsible for this result. The shock is shown to benefit other regions in terms of trade balance.

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