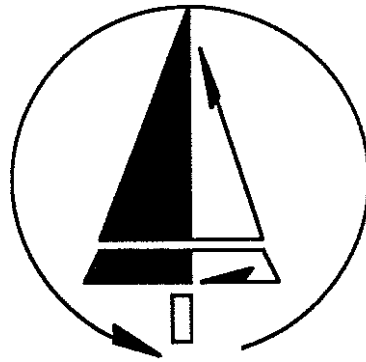


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**THE SOFTWOOD LUMBER DISPUTE
AND ITS IMPACT ON THE ECONOMY
OF BRITISH COLUMBIA:
A GENERAL EQUILIBRIUM ANALYSIS**

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The Forest Economics and Policy Analysis (FEPA) Research Unit specializes in the development of advanced, computer-based analytical systems for investigating economic and policy problems in Canada's forest sector. It provides a Canadian focus for research in forest economics and modelling of forest resources, industrial production and international trade. The Research Unit also supports the training of graduate students in forest economics and policy analysis. Funding is provided by the Canadian Forestry Service, provincial forest ministries, and other agencies.

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by

M.B. Percy and L. Constantino¹

ABSTRACT

This paper investigates the effects of the softwood lumber dispute between Canada and the United States on the economy of British Columbia. It has been suggested in the literature that the export tariff imposed by Canada amounts to Canada exerting monopoly power over trade, and results in a net welfare gain to the softwood lumber producing provinces. Our general equilibrium analysis reveals that in the case of British Columbia, the largest softwood lumber producer in Canada, real income may have risen in the short run, but this result is very sensitive to the value of the U.S. excess demand for Canadian softwood lumber exports. For some plausible values of this parameter, real income in the province declines as a consequence of the export tariff. The long-run impact of the softwood lumber export tariff is more complex. Real per capita income rises in the province, but this increase comes about from a fall in economic activity accompanied by even greater out-migration. Our general equilibrium analysis captures the interaction of three key features of the impact of the export tariff on British Columbia: (1) the fact that the export tariff (or countervail if it had been imposed) acts as tax on capital at the margin both in the short run and long run; (2) the redistribution of American consumer surplus to residents of Canadian softwood lumber producing provinces, and (3) the economy-wide effects when the economic base of a regional economy is shocked.

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INTRODUCTION

In October 1986 the International Trade Administration of the United States Department of Commerce found that Canadian timber pricing and allocation policies constituted a countervailable subsidy. In December 1986 the Canadian government, after intense negotiations with the U.S. government and the U.S. Coalition for Fair Softwood Lumber Imports, imposed a 15 percent tariff on lumber exports to the U.S. Through the export tariff, the Canadian Federal government avoided a likely 15 percent countervail duty, the proceeds of which would have accrued to the U.S. Treasury.

Although the resolution of the dispute was contentious in Canada, some of the participants viewed themselves as having "won" the trade dispute. The Canadian provinces were potential winners, since the proceeds of the export tariff were to be redistributed to them in proportion to their share of the value of softwood lumber exports to the United States. The Canadian Federal government was also satisfied with the outcome for two reasons. First, the Memorandum of Understanding which ended the softwood lumber dispute also suspended the proceedings before the International Trade Administration and the International Trade Commission. The Federal government assumed that none of the preliminary determinations in the softwood lumber case could now serve as precedents in other potential countervail suits against Canadian resource exports to the U.S. Second, the resolution of the dispute removed a major irritant from Canada-U.S. trade relations at a time when discussions of the now signed Canada-U.S. Free Trade Agreement were in their preliminary stages.

The Canadian wood products industry viewed itself as a loser since from their perspective any tariff -- countervail or export -- reduced their

competitiveness in the United States. Moreover, under the terms of the agreement, none of the proceeds of the export tariff could be redistributed back to the industry either directly or indirectly.

In the case of the American participants, the U.S. Federal government appeared satisfied, as the agreement removed a major irritant in trade relations with Canada at a time when the U.S. was promoting greater trade liberalization in world trade. From the perspective of the U.S. industry, the export tariff increased the price of Canadian softwood lumber exports in the American market and thus afforded some protection to domestic producers. The main losers of the Agreement were American consumers, but they were not active participants in the dispute in any case.

These observations on the broad distribution of gains and losses resulting from the agreement are supported by several partial equilibrium analyses of the softwood lumber dispute (Kalt, 1987; Boyd and Krutilla, 1987; Anderson and Cairns, 1988). Through the export tariff, Canada is able to exert market (monopoly) power over Canada/U.S. trade in softwood lumber. The result is a redistribution of income from Canadian producers and U.S. consumers to U.S. producers, Canadian consumers, and Canadian softwood lumber producing provinces, amounting to a net gain to Canada.

This paper assesses the impact of the agreement on a Canadian region where the forest sector accounts for a significant share of economic activity: the province of British Columbia. The perspective of our analysis is different from that of previous studies. Rather than a short-run partial equilibrium analysis in which the focus is only on lumber supply and demand, we undertake a general equilibrium analysis and focus both on the short-term and long-term adjustment of the industry and region to the imposition of an

export tariff.

While it is quite possible that in the short run, when the existing capital stock is fixed, real income in British Columbia may have risen as a result of the export tariff, a focus on the short run neglects the fact that returns to capital in the industry decline, and that in the long run, capital can exit the industry. Since the lumber industry is the single largest component of the province's economic base, the contraction of the industry due to the outflow of capital may more than offset the gains to the provincial economy of capturing a portion of American consumer surplus via the export tariff. The export tariff acts as an imperfect tax on capital. Even if the allegation that the Canadian softwood lumber industry was receiving "under-priced" timber and capturing a portion of the economic rents of the forest base was correct, the fact remains that the export-tariff solution adversely affects the return to capital on the margin. That is, the export tariff captures rents but also taxes capital. Thus in the long run, capital will tend to move to other sectors or exit the region.

Our paper consists of four sections. In the first section, we review the softwood lumber dispute in the context of monopoly and monopsony rent capturing. It also includes a brief summary of the agreement and of its implications. Section two provides an overview of the British Columbia economy and of the importance of the forest products sector. On the basis of this description, the constraints related to regional economic structure that the modelling exercise must incorporate are derived. The third section provides the outline of a Johansen (1960) type computable general equilibrium model used to simulate the consequences of the agreement. The final section provides the results of the simulation exercise for a range of parameter

values to which the model is particularly sensitive.

1. THE SOFTWOOD LUMBER DISPUTE

In 1985 Canadian softwood lumber imports accounted for over 33 percent of American consumption, a rise in market share of 11 percentage points from 1976 (British Columbia, 1987, 6). In May 1986, the U.S. Coalition for Fair Lumber Imports filed a petition before the International Trade Commission alleging that Canadian timber pricing and allocation policies constituted a countervailable subsidy and requesting the imposition of a duty. The Canadian industry responded that a combination of an appreciating U.S. dollar and higher efficiency levels of Canadian mills particularly in the Interior of British Columbia were responsible for the increase in Canadian market share. The Canadian industry also argued that the allegations of subsidized timber had already been dealt with in a virtually identical case decided in Canada's favour in 1983.

Our interest does not lie in the merits of the American and Canadian cases in the dispute; this aspect of the problem has been reviewed elsewhere (Percy and Yoder, 1987; Anderson and Cairns, 1988). Rather, our focus is on the consequences of the agreement ending the dispute. In December of 1986 the Canadian and American governments signed a Memorandum of Understanding under which Canada agreed to impose a 15 percent duty on softwood lumber exports to the United States. Under the terms of the agreement, the provincial governments could replace the tariff on softwood lumber exports from their jurisdiction if they revised their timber pricing policies such that they raised the amount of stumpage revenues equivalent to that raised by the export tax. Two provinces have subsequently chosen this option - Quebec and British Columbia.²

Another important provision of the agreement was that none of the revenues accruing to the provinces could be remitted back to the softwood lumber industry either directly or indirectly. Although the provinces would receive lump-sum payments from the federal government as their share of the export tariff revenues, the subsequent redistribution within the provincial economy could not result in the softwood lumber industry being a direct beneficiary. The revenues accruing to British Columbia under the tax for 1987/88 were estimated to be \$350 million (British Columbia, 1987, 6).

Kalt (1987) and Constantino and Percy (1988) among others have argued that the lumber trade war can be conceptualized as a dispute between two trading partners with monopsony and monopoly power over trade. Where we have two nations trading in a commodity and where the value of bilateral trade is large compared with the size of the domestic markets, other sources of supply and demand are not readily available, and the commodity has few substitutes, the two countries possess market power which can be exerted at the other's expense. By restricting imports, the importing country can drive up the domestic price of the commodity. Producers gain and consumers lose, and if the government of the importing country is able to capture the monopsony rents, for example, through the imposition of a quota or by auctioning import quotas, the result may be an increase in welfare at the expense of the exporting country. As long as the importing nation has monopsony power, and the exporting country cannot or does not retaliate, it is at least potentially possible for the government of the importing country to redistribute the revenues so that everybody is left better off with the trade restrictions. Producers in the exporting country lose and consumers gain, the overall result being a net welfare loss, as measured by the sum of producers' and consumers'

surplus. This scenario thus results in a redistribution of income from the exporting to the importing nation. Within the exporting country, producers lose and consumers gain while in the importing country, consumers lose and producers and government gain.

An alternative scenario is that the exporting country exerts its monopoly power through, for example, the imposition of an export tariff. In this case the exporting country would capture monopoly rents. This outcome would result in a redistribution of income from the importing to the exporting country and, if the monopoly rents are redistributed, from consumers in the importing region to consumers and producers in the exporting region and producers in the importing region. The exporting country increases welfare while the importing country is left worse off. Although both countries taken together lose from the trade restrictions, that is, there are efficiency losses, one country may actually gain from its exercise of market power.

The ability of each country to exert its monopsony or monopoly power, and the optimum magnitude of the trade barriers, depends on, among other things, the elasticities of demand and supply, in particular on the elasticity of import supply, when a monopsonistic action is being considered, or on the elasticity of excess demand, when a monopsonistic action is at stake. The more inelastic the excess demand and supply curves, the greater the monopoly and monopsony power of the two countries. The range of elasticities available in the literature for the U.S. demand for imports from Canada gives support to this view of the trade dispute. Kalt (1987) reports an elasticity of demand for lumber in the U.S. of -0.15 percent, which, coupled with an elasticity of supply of 0.42 percent and an elasticity of excess supply from Canada of 0.92 percent, gives considerable market power to both the U.S. and Canada. Other

studies support this order of magnitude of elasticities (Adams and Haynes, 1980a; Boyd and Krutilla, 1987; Chen et al., 1988). In section three of this paper we deal with the issue of plausible elasticity values for the simulation exercise.

Given that the outcome of the softwood lumber dispute was an export tariff, Canada can be said, in a sense, to have won the trade war. Kalt (1987), Boyd and Krutilla (1987) all provide evidence which is consistent with the agreement yielding a net income gain to Canada. However, the earlier studies of the trade dispute discussed above used simple partial equilibrium and static analyses to assess the gains and losses from the lumber trade restrictions. That framework was sufficient to calculate the "first round" income distribution consequences among the main players in the dispute and to explain their actions. However, it abstracted from the longer-term adjustments that would arise from the efficiency and income redistribution consequences of the agreement on the industry and regional economies where the softwood lumber industry was a key element of the economic base. Unlike previous analyses, we acknowledge the importance of the forest sector in the regional economy of British Columbia, and investigate the impacts of the export tariff on all sectors of the provincial economy and on aggregate economic activity.

2. THE ECONOMY OF BRITISH COLUMBIA

In 1986, British Columbia produced 50 percent of all lumber in Canada and accounted for 74 percent of all Canadian lumber exports to the U.S. (Canadian Forestry Service, 1987, Tables 117-7, 11-11). Thus British Columbia lumber producers were, in aggregate, the main Canadian producers affected by the

dispute. The forest industry is dominant in the British Columbia economy and, within the industry, the lumber sector accounts for a large share of the value of all goods produced. The forest industry accounted for approximately 45 percent of the value of shipments by British Columbia manufacturing industries and for more than 50 percent of the province's exports in 1986 (British Columbia, 1987, 98).

Although the lumber duty affected only one sector in the industry -- softwood lumber -- it is one of the most important components of the forest industry in British Columbia. In 1984, the softwood lumber sector accounted for 37 percent of all forest industry employment, 32 percent of industry value added and 35 percent of industry factory shipments.

With the exception of the forest products industry, where as we have shown earlier the province undoubtedly possesses some market power, British Columbia is the epitome of a small, open economy. The province is a price-taker for its non-forest products exports, and certainly faces fixed prices for its imports of primary and secondary manufactured goods from the rest of Canada and the world.

In terms of economic activity and population, the province is a relatively small component of the Canadian economy. In 1986 British Columbia's Gross Domestic Product was \$56.5 billion or 11.3 percent of the Canadian total (Canada, 1987, 100). The population of the province in 1986 was 2.4 million or 11.4 percent of the Canadian population (ibid., 90). The province like the rest of Canada faces a cost of capital that is set in world markets. Investment activity in British Columbia is thus very responsive to changes in returns to capital in the province relative to those elsewhere. With respect to interprovincial migration, the province is extremely open and subject to

large swings. In the period 1976-1981 net interprovincial migration to British Columbia amounted to 111,000 persons. Net migration in the period 1981-86 was only 9,500, but the volume of in- and out-migration was large -- in-migration of 151,500 and out-migration of 142,000 (Canada, 1988, 4).

A general equilibrium analysis of the effects of the trade dispute is particularly important for regions such as British Columbia in which the forest sector is the economic base. Import or export tariffs, if they seriously depress a sector in the economic base, can have important indirect effects on other economic activities, and the welfare gains or losses may be substantially different from those revealed by a partial equilibrium analysis. In this context the arguments advanced in the literature about monopsonistic and monopolistic trade behaviour may be simplistic and the estimated income distribution effects misleading. Even if the export tariff redistributes wealth from the U.S. to Canada, it can lead to sizable declines in employment and income.

The key to modelling the impact of trade shocks on a regional economy is to ensure that the constraints imposed by the "openness" of factor and commodity markets are incorporated into the structure of the model. Our perspective of a regional economy is that the short-run response to economic shocks is primarily through price adjustments in factor and commodity markets. The long-run adjustment is primarily through shifts in the quantity of output produced and the volume of labour and capital employed. The short-run period of adjustment is characterized by shifts in quasi-rents -- positive and negative -- which induce factor movements in the long run until no quasi-rents remain. In the so-called short-run adjustment period, labour can move between sectors in response to differential economic opportunity while the longer-term

adjustment is through shifts in the direction of, and magnitude in, inter-provincial migration. Capital in the short run is sector-specific but very responsive in the long run to returns in the region relative to those elsewhere.

Moreover, in the case of a province like British Columbia, which has a tradition of active unions, and which today remains one of the more unionized provinces, the assumption of complete nominal or real wage flexibility is not realistic. We view wages in the province as "sticky", at least in the short run, because of the heavy unionization of labour. Thus our view of the provincial economy departs from the neoclassical view of the world, implicit in the partial equilibrium analyses mentioned above, in which labour markets clear. Under the "Keynesian" scenario, the softwood lumber tariff will lead to a more drastic reduction in industry output, because declines in profits cannot be passed on to labour through lower wages. Moreover, other sectors of the economy will expand less than in a neoclassical scenario as they will not benefit from a reduction in the wage rate. For the same reasons, a redistribution of tariff revenues to the residents of the province may not be as beneficial as suggested under a neoclassical labour market scenario.

The outcome is even less clear when a long-run view of the adjustments is taken. Even if the province is able to exert monopoly power over the lumber trade with the United States, it may still be left worse off with the export tariff, contrary to the evidence from partial equilibrium analyses. This is partly because the Memorandum of Understanding forbids a direct redistribution of tariff revenues to lumber producers, which would look like a different form of subsidy. Thus, even if the proceeds are redistributed as a lump sum to the residents of the province, the export tariff remains equivalent to a tax on

capital employed in the softwood lumber sector. That is, even if the industry were in fact capturing a portion of the economic rent from the resource base, the export tariff still reduces the return to capital at the margin. Capital will move to other sectors of the economy, or even leave the province, the overall effect possibly being a contraction of aggregate economic activity.

On the other hand, the release of resources from the softwood lumber sector may increase the profitability of other sectors of the economy enough to induce an inflow of capital from outside the province. This impact combined with the positive income effects of the export tariff revenues may lead to an overall expansion of the provincial economy. In short, when one takes a general equilibrium view of the world, abandons the assumptions of clearing labour markets, and is dealing with an industry in the economic base, it is not clear that the exercise of monopoly power over trade will lead to a net gain to the exporting region.

The main objective of this paper is to empirically investigate this issue of regional gains and losses. Hence, to analyze the effects of trade restrictions in light of the comments above, we develop a general equilibrium model of the British Columbia economy, which is described in the next section.

3. MODEL SPECIFICATION

Computable general equilibrium (CGE) models are increasingly the approach adopted in a wide range of contexts involving economic policy analysis. An excellent survey of this literature is found in Shoven and Whalley (1984). These models are "bottom-up" in that they specify economic relationships at the level of the economic agents and aggregate up to the level of the macro-economy. The models operate at the level of relative prices, factor endow-

ments, and production technologies. Within the CGE modelling framework there are two basic approaches that can be followed. In one approach the specification is in terms of the level of the variables, e.g., quantities in physical units, prices in monetary units. This path requires considerably more data than the approach to be described. Moreover, the level of specification often requires the solution of non-linear relationships that absorb considerable computer time and, in some cases, demand solution algorithms specific to the policy shock in question.

The alternative approach, and the one we have adopted, is to specify the model in the form of proportional rates of change. That is, the equations relate percentage changes in one variable to percentage changes in those other variables that determine it. This approach was first popularized by Johansen (1960) and highlighted in the applied general equilibrium work of Dixon et al. (1982). The policy applications of this modelling exercise for Australia have been reviewed in detail by Powell and Lawson (1986). This specification is very parsimonious with respect to data, and the results can be interpreted in terms of elasticity relationships -- both features which are desirable from the perspective of policy makers and researchers. Because the model is linear in the variables, the solutions are obtained by simple matrix inversions and are obtained quickly.

For the purposes of modelling, the British Columbia economy has been disaggregated into nine sectors: (1) Coast logging, (2) Interior logging, (3) Coast wood products, (4) Interior wood products, (5) Pulp and paper, (6) other primary products, (7) Manufacturing, (8) Services, and (9) Government. The primary factors of production consist of labour, used in all sectors; capital, which is specific to each sector; and land, used in sectors 1, 2, 6

and 8. All sectors use intermediate inputs produced by other sectors.

The first two sectors, Coast and Interior logging, respectively, produce logs for the wood products, and paper and allied products industries, and a small proportion of the harvest is exported. A regional disaggregation has been adopted because the resource base, the derived demands for timber, the production technology, and level of stumpage values differ significantly between the two regions. The third and fourth sectors, Coast and Interior wood products industries, respectively, produce mainly sawmilling products such as construction grade lumber. It is assumed that the Interior wood products industry uses only Interior logs, while the same holds for the Coast wood products industry. The wood products industry has been disaggregated for much the same reasons as the two logging sectors. The pulp and paper industry produces mainly for the export market and is not regionally differentiated either in output or input markets.

The sixth sector, other primary products, consists of the other renewable and non-renewable resource industries. This sector is heavily export oriented. The seventh sector consists of all manufacturing industries other than wood products and pulp and paper, which have been modelled separately. The eighth and ninth sectors consist of services and government, respectively. These sectors are non-traded in the sense that their production is consumed entirely within provincial boundaries. The government sector produces publicly provided private goods and has been modelled separately from services because of differences in factor intensity.

Price determination is a key aspect of any regional or national model. In our model of British Columbia we have made the following assumptions regarding prices. Prices in the Coastal and Interior logging sectors are

endogenously determined by derived demands from the two wood products sectors, the pulp and paper sector and the Annual Allowable Cut set by the Ministry of Forests. The two wood products sectors' prices are also determined endogenously. The province accounts for approximately 30% of domestic softwood lumber consumption in the United States, and the evidence clearly suggests that the B.C. industry faces a downward sloping excess demand curve by U.S. purchasers. The price elasticity of U.S. demand for Canadian softwood lumber is a key parameter in the simulations to follow, thus all results include sensitivity analysis to its values. Similarly, the pulp and paper industry of the province accounts for a significant share of world production, and thus its production has an influence on price.

The sixth sector, other primary products, is small in world export markets, and thus we treat it as a price-taker. Sector seven represents import-competing manufacturing and the province is a small importer relative to world supply. Thus it is assumed to be a price-taker. Since we are dealing with a regional economy that imports from the rest of Canada as well as from the rest of the world, we have decided to treat domestically produced import-competing goods and imports as perfect substitutes. The two non-traded sectors, services and government, have prices which are endogenously determined. The government is treated as a 'fee-for-service' producer of private goods.

In this section we describe the "levels" form of the equations underlying the model. These equations often embody nonlinear relationships which make computation of solution values for simulation difficult and costly to obtain. In the appendix, linear versions of the equation of the model in a "rate of change" format are provided. These are the equations actually employed to

obtain the simulation results of Tables 2-3. The linear version is far more computationally tractable than the underlying levels form, and the data requirements are more easily satisfied.

The model is not dynamic despite the use of the terms "short run" and "long run" in the simulation scenarios and in the description of the model that follows. The concept of "time" embodied in the model relates to the speed of adjustment of the market for labour and capital. The short run is that period of time during which the stocks of labour and capital available to the region are fixed. In the so-called "long run", however, the supplies of labour and capital available in the province are responsive to differences between the region and the rest of the country in the rate of return to capital and real wages.

Structural Equations in Levels Form

Production in each of the nine sectors is characterized by the following production relationship given by:

$$X_i = x(L_i, K_i, R_i, X_{ji}) \quad j, i = \dots, 9 \quad (1)$$

where X_i represents the output of sector i , L is labour, K_i is sector-specific capital, R_i is sector-specific resource input and X_{ji} is a vector of intermediate inputs. Production is assumed to be Cobb-Douglas and to exhibit constant returns to scale.

Factor Supplies

The supply of labour in the region in the short run is fixed:

$$L = \bar{L} \quad (2)$$

Labour is assumed to allocate itself across sectors so that nominal wages are equalized. Nominal wages in the short run are treated as highly rigid by the assumption that the willingness of workers to be employed is highly responsive to changes in the nominal wage rate.

$$ELF + U = L \quad (3)$$

where ELF is employed labour, U is unemployed labour and L is the labour supply.

In the long run, the supply of labour is a function of expected relative real wages between British Columbia and the rest of Canada.

$$L = L_0 \left[\frac{(w/p)}{\bar{w}} \right]^\beta \quad \beta \geq 0 \quad (4)$$

Here \bar{w} is the expected before-tax real wage of labour in the rest of Canada, w is the nominal before-tax wage of labour, p is the consumer price index of the province, and β is the elasticity of supply of labour with respect to relative real wages.

Capital in the model is treated as specific and fixed in each sector in the short run. In the long run, the supply of capital is treated as highly responsive to changes in rental rates in the region relative to those outside the region. The short supply of labour is given by equation (5).

$$K_i = \bar{K} \quad i = 1, \dots, 9 \quad (5)$$

The long-run capital supply specification is given by equation (6)

$$K_i = K_0^i (r_i / \bar{r})^{\beta_{xi}} \quad \beta_{xi} > 0 \quad (6)$$

Here r_i is the rental rate of capital, \bar{r} is the exogenous rental rate of capital in the rest of the world, and β_{xi} is the elasticity of capital supply with respect to relative nominal returns. Since the owners of capital need not reside in British Columbia, nominal rather than real charges of capital are the appropriate argument in equation (6). All sector-specific capital is assumed to be produced outside the province, thus investment is met entirely by imports.

Land or resource inputs are also treated as sector-specific like capital. But land is truly specific in the sense that it has no use other than in the particular industry within the region. The supply of the forest resource to Coast and Interior logging is assumed responsive to changes in rental rates of land:

$$R_i = R_{oi} (v_i / \bar{v}_i)^{\beta_{Ri}} \quad \beta_{Ri} \geq 0 \quad (7)$$

$$i = 1, 2$$

The government will permit additional forest land to be brought into production if the value of stumpage exceeds or is equal to the minimum stumpage level for the region, \bar{v} . The nominal rent of land is given by v_i , and β_{Ri} is the elasticity of supply with respect to stumpage. In the case of land employed in the other primary products and service sectors, the supply

function is given by:

$$R_i = R_{oi} (v_i)^{\beta_{Ri}} \quad \beta_{Ri} \geq 0 \quad (8)$$

$$i = 6, 8$$

Here v_i is the nominal rental charge for land, and β_{Ri} is the elasticity of supply with respect to nominal rent.

Zero Economic Profit Constraint

The assumptions of perfect competition and constant returns to scale ensure that unit costs in each sector just equal producer prices.

$$C_i^1(w, r_i, v_i, P_j) = P_i \quad j, i = 1, \dots, 9 \quad (9)$$

Here C_i^1 is the cost function corresponding to the production function given by equation 1, w is the wage rate of labour, r_i is the rental rate of capital specific to sector i , v_i is the rental rate of resource input to sector i , P_j is the vector of prices of intermediate inputs, and P_i is the producer price of the i^{th} sector. The government sector is treated as a fee-for-service sector that differs from the service sector only in terms of factor intensities.

Factor Market Equilibrium

Equilibrium also requires that factor demands equal factor supplies (i.e., full employment).

$$C_{r_i}^1(w, r_i, v_i, P_j) \cdot X_i = K_i \quad j, i = 1, \dots, 9 \quad (10)$$

$$\sum_{i=1}^9 C_w^i(w, r_i, v_i, P_j) \cdot X_i = ELF \quad (11)$$

OR

$$\sum_{i=1}^9 C_w^i(w, r_i, v_i, P_j) \cdot X_i = L \quad (11a)$$

$$C_{v_i}^i(w, r_i, v_i, P_j, P_c) \cdot X_i = R_i \quad (12)$$

The general term $C_b^i(\cdot)$ is the cost-minimizing input of the factor associated with the factor price b in sector i (Epstein, 1974; and Diewert, 1974). The other terms are as defined previously. The left-hand side of equations (10) to (12) represents the factor demands and the right-hand side, factor supplies. Equation (11) represents the short-run specification of the labour market, equation (11a), the long run.

Market Clearing Constraints

The next equilibrium condition is that product markets clear. The demand for output of each product within the region is the sum of final demand by consumer, intermediate use of firms, and net exports.

$$X_i = Q_i + \sum_j C_j^i(\cdot) X_j + E_i \quad j, i = 1, \dots, 9 \quad (13)$$

Q_i is final demand by consumers, $C_j^i(\cdot)$ is intermediate demands by firms and E_i is net exports. It is assumed that consumer spending on each of the final goods is a constant share of income, α_i , as is denoted by equation 14.

$$Q_i = \frac{\alpha_i Y_d}{P_i} \quad \begin{array}{l} i = 7, 8, 9 \\ 0 \leq \alpha \leq 1 \\ \Sigma \alpha_i = 1 \end{array} \quad (14)$$

Here Y_d is income available for consumption. The demand system is derived from a Cobb-Douglas utility function. The values of the income and price elasticities of the system satisfy the "adding up" constraints implied by demand theory. This specification of consumer demand is somewhat restrictive in that it implies that the income and own price elasticities equal 1 and -1, respectively, and that all cross-price elasticities equal 0. The specification of the demand for X_i as an intermediate input follows directly from the definition of the cost minimizing input of a factor per unit of output utilized.

The net export demand (E_i) for the traded sectors is a function of the sector's producer price, foreign tariffs and transport charges all relative to external prices.

$$E_i = E_i[(P_i + T_i + D_i)/\bar{P}_i]^{\phi} \quad \begin{array}{l} \phi < 0 \\ i = 3, 4 \text{ and } 5 \end{array} \quad (15)$$

Here \bar{P}_i is the exogenous foreign price, T_i represents the transport charges involved in delivering one unit of product to market, D_i is any tariff imposed, and ϕ_i is the export elasticity of demand. In the case of sector 6, 'Other Primary Products', the province is assumed to face a perfectly elastic world demand, and domestic prices are given by (15a).

$$P_6 = P_6^W + T_6 \quad (15a)$$

where P_6 is the British Columbia producer price, T_6 transportation costs and P_6^W is the world price.

British Columbia is a net importer of manufactured goods and, in this regional model, imports of these goods are treated as perfect substitutes for domestically produced goods in both final and intermediate demands. A substantial proportion of British Columbia's imported manufactured goods come from the rest of Canada. It is not realistic to assume that 'rest-of-Canada' imported manufactured goods are viewed by British Columbia residents as imperfect substitutes for local goods, as is the approach often adopted for national models (Armington, 1969).

Income, Savings and Prices

The remaining elements of the model can be described quite briefly. Regional GDP (Y) is the sum of payments to all factors of production.

$$Y = wL + \sum_{i=1}^9 r_i K_i + \sum_{i=1,2,6,8} v_i R_i \quad (16)$$

In the short-run scenarios, all income is assumed available for consumption. Although unrealistic, the alternative of assuming a fixed savings rate is little better. The problem is that in the short run, the capital stock is fixed, hence domestic savings play no role in the domestic economy. Assuming a positive savings rate would in the short term only reduce domestic absorption. In the long run, however, savings are endogenous and this specification is consistent with the assumption that the capital stock is endogenous. The issue of balance of payments constraints and model closure is discussed shortly.

The consumer price index (P) is defined inclusive of the price of government output and is defined as the cost of a representative basket of consumer goods:

$$P = \sum_{i=6}^9 \bar{Q}_i P_i \quad (17)$$

Here \bar{Q}_i is the fixed quantity of the i^{th} commodity of the consumer price index basket. The equation for the price deflator for national income (PI) is similar and weighted by base period sector output (\bar{X}_i):

$$PI = \sum_{i=1}^9 \bar{X}_i P_i \quad (18)$$

The issue of balance of payments constraints in a regional model is difficult to address, especially in the context of an economic union such as Canada. Undoubtedly, shifts in relative prices, capital and labour flows, and asset transfers help lead to regional economies achieving balance of payments equilibrium. However, in the Canadian context, a range of federal policies seemed directed specifically to offset the automatic market adjustment mechanisms that help correct regional trade imbalances. Moreover, in the modelling framework, the fact that ownership by the rest of Canada of British Columbia assets is high, as is ownership by British Columbia residents of rest-of-Canada assets, makes it very difficult to quantify capital flows -- whether short-term or long-term. Thus our approach is to assume that regional balance of payments is a "long, long-run" constraint that we do not impose. The most important mechanism of adjustment at the regional level to economic shocks is through factor markets -- investment and migration -- in response to

shifts in relative output prices influencing the derived demand for factors.

3. DATA

The data requirements of the modelling exercise are quite modest. The parameters and sources of data are described in detail in an appendix available from the authors. The assumption of Cobb-Douglas technologies in production means that input-output tables can be used to derive estimates of distributive shares used in the unit cost functions of the simulation exercises. Similarly, input-output tables provide estimates of the distribution of output among export, intermediate and final demands. The assumption of Cobb-Douglas utility functions yields very tractable final demand systems whose parameters can be based on estimates of consumer expenditures. Moreover, sensitivity analysis by the authors suggests that the model results are quite insensitive to the specification of individual distributive shares, distribution of output, or technical elasticity of substitution parameters.

The key parameters of any such model are the elasticities of export demand and of regional factor supply. For our simulation purposes the most important set of elasticities are those relating to the American excess demand for wood products. Table 1 provides a range of estimates of these elasticities in the short run and long run. The simulation exercises of Section 3 provide sensitivity analysis for excess demand elasticities of -0.75 (low) and -4.00 (high).

In the case of factor market adjustments, our dichotomy of short run and long run provides a sensitivity analysis of the importance of factor supply responsiveness in determining the impact of the softwood lumber dispute. The short-run scenarios assume that the supply of labour to the region is fixed.

TABLE 1

U.S. DEMAND, SUPPLY, AND EXCESS DEMAND ELASTICITIES

FOR CANADIAN LUMBER

Source	U.S. DEMAND		U.S. SUPPLY		U.S. EXCESS DEMAND		
	Short Run	Long Run	Short Run	Long Run	Short Run	Long Run	
ADAMS AND HAYNES (1980a)	-0.35		0.39	1.27	-1.92(a) -2.44(b)	-3.78(a) -4.92(b)	
KALT (1987)	-0.15			.42		-1.36(a)	
GELLNER (1989)	-0.08 -0.08	-0.38 -0.38		2.3 0.39(c)		-5.13 -1.08	-6.06 -3.88
SHARMA (1986)		-0.30(d)		0.81		-2.65	

NOTES: Excess demand elasticities e_{ED} were calculated from US demand (e_D) and supply (e_S) elasticities according to the expression $e_{ED} = (D/I)e_D - (S/I)e_S$, where (D/I) is the ratio of total US demand to imports and (S/I) is the ratio of total US supply to imports. These ratios were calculated from 1985 data in (a), 1980 data in (b), and 1978-82 data in (d). Supply elasticities in (c) are from Adams and Haynes (1980a).

Hence any one sector in the region faces an excess supply of labour which is derived from shifts in the demand for labour in the other sectors. In the long-run scenarios, the region as a whole faces a supply of labour which has a responsiveness of 5.0 to movements in real wages in the region relative to those in the rest of Canada. Capital is assumed to be perfectly inelastic at the sectoral level in the short run. However, in the long run, the elasticity of capital supply with respect to relative nominal returns is assumed equal to 20.0.

The issue of natural resource supply elasticities is difficult in any modelling exercise. For example, in the case of non-renewable resources, the distinction between stock-flow considerations is very important at the theoretical level, but far more difficult to address at the level of the aggregate sector. Our approach is to treat natural resource (land) inputs as fixed in the short run but unit elastic with respect to nominal rental rates in the long run. Our view is that shifts in the extensive margin of natural resource use brought about by shifts in relative output prices do lead to variations in the quantity of resources available. Unfortunately, the literature does not offer much guidance as to exactly how responsive the extensive margin is to shifts in derived demands in the long run.

4. SIMULATION RESULTS

In reviewing the simulation results it should be borne in mind that all other shocks to the economy are held constant. Consequently, only the impact of the shock in question is assessed. Table 2 provides the simulation results for the short-run impact of either a 15 percent countervail or export tariff being imposed on softwood lumber exports from British Columbia for

high (-4) and low (-.75) estimates of the U.S excess demand elasticity for softwood lumber. The export tariff revenue is assumed redistributed to the residents as a lump-sum transfer. In comparing the countervail to the export tariff outcome, three points are immediately apparent. First, regardless of tax scenario, the more elastic the U.S. excess demand, the greater is the incidence borne by British Columbia producers, especially in the Interior. Second, from the perspective of the wood products industry, there is little difference in outcomes between the countervail and export tariff scenarios for a given value of the U.S. excess demand elasticity. In fact, profits are lower in the export tariff scenario because the industry is adversely affected by rising prices in other sectors brought about by the lump-sum redistribution of export tariff revenue to the residents of the province. Third, real gross domestic product in the province increases for the low value of the U.S. excess demand elasticity in the export tariff scenario. However, the evidence of Table 1 suggests that the value of -0.75 is probably unrealistically low for the U.S. excess demand elasticity. For values in excess of -1.5, simulation results not reported show that real gross domestic product in the province falls.

The impact on industrial structure of various dispute outcomes is also interesting. Had the countervail duty been imposed, one result is that British Columbia would have become more diversified in structure. The contraction of the wood products and logging sectors would have released labour for use in the import competing goods (domestic manufacturing) sector. Output in this industry expands and imports fall. The shift towards manufacturing is greater, the larger the U.S. excess demand for softwood lumber. The expansion of the domestic manufacturing sector also leads to a fall in

TABLE 2
SHORT-RUN IMPACT OF TRADE RESTRICTIONS ON SOFTWOOD LUMBER
EXPORTS TO THE UNITED STATES ON THE ECONOMY OF BRITISH COLUMBIA

CHANGE IN	COUNTERVAILING DUTY IMPOSED		EXPORT TAX IMPOSED	
	HIGH	LOW	HIGH	LOW
price Coast logs	-7.43	-3.97	-7.28	-3.19
price Interior logs	-10.41	-4.78	-10.11	-3.73
price Coast wood products	-6.05	-3.23	-5.92	-2.58
price Interior wood products	-8.65	-3.96	-8.49	-3.27
price paper & allied products	-2.45	-1.20	-2.14	-0.50
exports mineral products	4.23	2.05	3.09	-0.22
imports mfrg products	-13.50	-6.55	-10.07	0.33
price of services	-3.93	-1.91	-2.90	0.14
"price" of govt. services	-4.23	-2.05	-3.10	0.19
Coastal logging output	-2.05	-1.12	-2.14	-1.13
Interior logging output	-5.35	-2.41	-5.52	-2.47
Coastal wood output	-2.79	-1.52	-2.92	-1.57
Interior wood output	-6.08	-2.74	-6.28	-2.83
paper & allied output	0.30	0.15	0.32	0.16
mineral sector output	0.64	0.31	0.48	-0.01
domestic mfrg. output	1.35	0.65	1.01	-0.02
services output	-3.43	-1.67	-2.52	0.15
government services	-3.92	-1.91	-2.83	0.26
nominal wage rate	-0.99	-0.48	-0.76	-0.02
profits Coastal logging	-11.81	-6.41	-12.05	-6.00
profits Interior logging	-27.47	-12.43	-28.07	-12.25
profits Coastal wood	-13.18	-7.15	-13.56	-6.89
profits Interior wood	-23.86	-10.80	-24.40	-10.68
profits paper & allied products	0.51	0.26	0.82	0.78
profits mineral products	2.30	1.12	1.71	-0.06
profits domestic mfrg.	5.34	2.59	3.98	-0.13
profits services	-15.60	-7.57	-11.50	0.61
"profits" government	-12.91	-6.27	-9.37	0.77
Coastal stumpage	-11.81	-6.41	-12.05	-6.00
Interior stumpage	-27.47	-12.43	-28.07	-12.25
mineral rents	2.30	1.12	1.71	-0.06
urban land rents	-15.60	-7.57	-11.50	0.61
employed labour force	-4.93	-2.40	-3.80	-0.09
unemployment	36.18	17.57	27.85	0.69
real gross domestic product	-4.54	-2.20	-3.08	0.66
real per capita gross domestic product	-4.54	-2.20	-3.08	0.66
real wages	1.76	0.86	1.27	-0.12

mineral sector (other primary) exports as more of this sector's output is processed domestically than before. The paper and allied products industry expands not only because of downward pressure on nominal wages, but also because timber prices fall significantly, thus further reducing input costs.

Table 3 models the long-run impact of the alternate outcomes to the softwood lumber dispute. As in the case of the short-run results, we find that the incidence of the countervail or export tariff on the wood products industry and logging is greater, the more elastic the U.S. excess demand for softwood lumber. Moreover, we find that from the perspective of the wood products industry, the export tariff actually worsens their economic position in terms of returns to capital. The lump-sum redistribution causes factor prices to be higher than they would be in the countervail alternative.

In the scenario based on the low value of the excess demand elasticity, real gross domestic product in the province increases. However, the long run U.S. excess demand elasticity is certainly greater than -0.75 , so the 'high' export tariff simulation results are probably more realistic. An interesting feature of the long-run results is that real gross domestic product per capita rises in each of the export tariff scenarios. What is driving these results, particularly for the high excess demand elasticity scenario, is the fact that economic rents per capita are increasing. The employed labour force decreases by 0.66 percent -- representing outmigration in the context of the long-run labour market adjustment specification. Thus the consumer surplus extracted from American consumers is spread over proportionately fewer residents, as are the other resource and land rents in the economy. The contraction of the wood products and logging industries brought about by the export tariff put sufficient downward pressure on nominal and real wages to

TABLE 3

LONG-RUN IMPACT OF TRADE RESTRICTIONS ON SOFTWOOD LUMBER
EXPORTS TO THE UNITED STATES ON THE ECONOMY OF BRITISH COLUMBIA

CHANGE IN	COUNTERVAILING DUTY IMPOSED		EXPORT TAX IMPOSED	
	HIGH	LOW	HIGH	LOW
price Coast logs	-2.42	-0.53	-2.42	-0.54
price Interior logs	-2.17	-0.44	-2.16	-0.42
price Coast wood products	-1.37	-0.30	-1.36	-0.29
price Interior wood products	-0.99	-0.20	-0.97	-0.18
price paper & allied products	-0.44	-0.09	-0.43	-0.08
exports mineral products	-11.55	-2.40	-8.72	0.67
imports mfrg products	-13.82	-2.87	-9.88	1.38
price of services	-0.12	-0.02	-0.08	0.02
"price" of govt. services	-0.14	-0.03	-0.10	0.02
Coastal logging output	-7.64	-1.69	-7.74	-1.78
Interior logging output	-16.43	-3.30	-16.61	-3.46
Coastal wood output	-10.42	-2.30	-10.51	-2.38
Interior wood output	-18.73	-3.76	-18.91	-3.93
paper & allied output	0.84	0.18	0.67	0.00
mineral sector output	0.73	0.15	0.53	-0.06
domestic mfrg. output	7.97	1.66	5.82	-0.67
services output	-0.65	-0.14	-0.25	0.30
government services	-0.94	-0.20	-0.20	0.60
nominal wage rate	-0.24	-0.05	-0.19	0.01
profits Coastal logging	-0.49	-0.11	-0.49	-0.11
profits Interior logging	-0.90	-0.18	-0.91	-0.19
profits Coastal wood	-0.52	-0.11	-0.52	-0.12
profits Interior wood	-0.93	-0.19	-0.94	-0.19
profits paper & allied	0.04	0.01	0.03	0.00
profits mineral products	0.04	0.01	0.03	0.00
profits domestic mfrg.	0.39	0.08	0.29	-0.03
profits services	-0.04	-0.01	-0.02	0.02
"profits" government	-0.05	-0.01	-0.01	0.03
Coastal stumpage	-5.80	-1.28	-5.87	-1.34
Interior stumpage	-12.26	-2.46	-12.39	-2.57
mineral rents	0.46	0.10	0.34	-0.04
urban land rents	-0.53	-0.11	-0.22	0.22
employed labour force	-0.79	-0.16	-0.66	-0.02
real gross domestic product	-0.83	-0.17	-0.08	0.63
real per capita				
gross domestic product	-0.04	-0.01	0.56	0.65
real wages	-0.15	-0.03	-0.13	0.00

induce outmigration.

The gains from the export tariff ultimately accrue to returns to specific factors in the long run, such as land or natural resources. This result is to be expected in the case of a small regional economy. In the short run, differential returns relative to other regions for mobile factors, such as labour and capital, are in the nature of quasi-rents or losses. In the long run, after these quasi-rents (or losses) have induced entry or exit of labour and capital, the sole component of per capita income changes has to arise from returns to specific or fixed factors receiving economic rents.³

5. CONCLUSIONS

In this paper we have tried to assess the impact of the softwood lumber dispute on the economy of British Columbia, the province most affected in Canada by the dispute and its resolution. Our results show that British Columbia is always better off under the export tariff scenario than the countervail alternative. However, it does not follow that economic welfare in British Columbia is necessarily higher from the exercise of monopoly power, as some of the literature suggests. The fact that the forest industry is a significant component of the economic base of the province means that gains to the aggregate economy from the capture of American consumer surplus are offset by the contraction of the wood products and ancillary sectors brought about by the fall in softwood lumber producer prices. The nature of the tradeoff is very dependent on the value of the U.S. excess demand for softwood lumber and the time frame for which the impact of the trade shock is assessed. In the short run, real income in the province may have risen as a result of the export tariff, but this conclusion is very sensitive to the value of the

U.S. excess demand elasticity chosen. In the long run, real income per capita in the province does rise, but the gain accrues to specific or fixed factors rather than interregionally or internationally mobile factors such as labour or capital.

Appendix A

Rate of Change Format

The rate of change equations corresponding to the relevant levels equations of the model are presented below. The dot above variables represents rates of change (i.e., $\dot{x} = dx/x$). A superscript bar "-" denotes an exogenous variable.

The long-run factor supply equations are:

$$\dot{L} = \dot{L}_\phi + \beta(\dot{W} - \dot{P} - \dot{W}) \quad (4')$$

$$\dot{K}_i = \dot{K}_{\phi i} + \beta_{Ki}(\bar{r}_i - \dot{r}) \quad i = 1, \dots, 9 \quad (6')$$

$$\dot{R}_i = \dot{R}_{\phi i} + \beta_{Ri}(v_i - \dot{v}) \quad i = 1, 2 \quad (7')$$

$$\dot{R}_j = \dot{R}_{\phi j} + \beta_{Rj}(\dot{v}_j) \quad i = 6, \dots, 8 \quad (8')$$

The expression for the unit cost equal producer price equations are as follows:

$$\theta_{w_i}^i \dot{w} + \theta_{r_i}^i \dot{r} + \theta_{v_i}^i \dot{v} + \sum_j \theta_{p_j}^i \dot{p}_j = \dot{p}_i \quad i = 1, \dots, p \quad (9')$$

The share of each input in the gross value of output of that sector is represented by θ , where $\theta_{w_i}^i = \left(\frac{w_i C_i^i}{P_i w_i}\right)$, for example. The economic interpretation of equation (7') is that in competitive equilibrium the change in producer output price of a given sector equals the weighted sum of input price changes.

The solutions to the full employment equations (10) to (12) are more complex in form.

$$\theta_{w_i}^i \sigma_{w_i} \dot{w} + \theta_{v_i}^i \sigma_{v_i} \dot{v}_i - (\theta_{w_i}^i \sigma_{w_i} + \theta_{v_i}^i \sigma_{v_i}) \dot{r}_i + \dot{X}_i = \dot{K}_i \quad (10')$$

$$i = 1, \dots, 9$$

$$- \sum_{i=1}^9 \lambda_{iL} (\theta_{r_i}^i \sigma_{w_i} + \theta_{v_i}^i \sigma_{w_i}) \dot{w} + \sum_{i=1}^9 (\lambda_{iL} \theta_{r_i}^i \sigma_{w_i}) \dot{r}_i$$

$$+ \sum_{i=1}^9 (\lambda_{iL} \theta_{v_i}^i \sigma_{w_i}) \dot{v}_i + \sum_{i=1}^9 \lambda_{iL} \dot{X}_i = \dot{L} \quad (11a')$$

$$\theta_{w_i}^i \sigma_{v_i, w} \dot{W} + \theta_{r_i}^i \sigma_{v_i, r_i} \dot{r}_i - (\theta_{w_i}^i \sigma_{v_i, w} + \theta_{r_i}^i \sigma_{v_i, r_i}) \dot{v}_i + \dot{X}_i = \dot{R}_i \quad (12')$$

$$i = 1, 2, 6, 8$$

The parameter $\theta_{j_i}^i$ is the distributive share of the i^{th} factor in the j^{th} sector, λ_{L_i} is the share of labour employed in the i^{th} sector, σ_{jk}^i is the technical elasticity of substitution between factors represented by factor prices j and k in sector i . In the case of labour and capital, for example,

$$\sigma_{wr_i}^i = C^i(\cdot) C_{wr_i}^i(\cdot) / C_w^i(\cdot) C_{r_i}^i(\cdot)$$

(Diewert, 1974; and Epstein, 1974). Basically, the expressions for the full employment equations consist of two terms. One represents the change in demand for the factor due to variations in relative factor prices and the other represents the output effect (\dot{X}_i). For convenience it is assumed that there are no substitution possibilities among purchased inputs or between these and primary factors.

The Keynesian (short-run) specification of (10') is identical to the neoclassical version except that the right-hand side of the equation is equal to the change in the employed labour force. The supply of employed labour is treated as a function of the nominal wage. The link between employed and unemployed and the regional labour force is given by:

$$\lambda_L \dot{E} + \lambda_u \dot{U} = \dot{L} \quad \lambda_L + \lambda_u = 1 \quad (3')$$

The parameters λ_L and λ_u are the shares of employed and unemployed in the labour force.

The general solution for the demand system is given by:

$$\dot{X}_i = S_{iq} \dot{Q} + \sum_{j=1}^9 S_{ij} \dot{X}_j + S_{iE} \dot{E} \quad i = 1, \dots, 9 \quad (13')$$

where the general term S_{in} is the proportion of the output of sector i going to use n , so that

$$\sum_n S_{in} = 1.$$

The final form of the equation is obtained by substituting \dot{Q}_i and \dot{E}_i .

For sectors 3, 4 and 5, equation (13') takes the form:

$$\dot{X}_i = S_{iQ} \dot{Y}_d - [S_{iQ} - S_{iE} \pi_{pi} \phi_i] P_i + \sum_{j=1}^5 S_{ij} \dot{X}_j - S_{iE} \pi_{Ti} \phi_i \dot{T}_i \quad (13'1)$$

$i = 3, 4, 5$

where $\pi_{pi} = P_i / (P_i + T_i)$, and $\pi_{Ti} = T_i / (P_i + T_i)$

\dot{Y}_d in equation (13.1') is the rate of change of income available for consumption and is given by:

$$\dot{Y}_d = \theta_{yd} \dot{Y} - \theta_{ys} \dot{S}$$

where θ_{yd} and θ_{ys} are the ratios of gross domestic product and savings to disposable income.

In the case of sector 6 the domestic price is given by

$$\pi_{P6} \dot{P}_6 + \pi_{T6} \dot{T}_6 = \dot{P}_6 \quad (15a')$$

The demand for output of the non-traded sectors 8 and 9 is given by:

$$\dot{X}_i = S_{iQ} \dot{Y}_d - S_{iQ} \dot{P}_i + \sum_{j=1}^9 S_{ij} \dot{X}_j \quad i = 8, 9$$

$j = 1, \dots, 9$

The change in provincial GDP is defined as the weighted sum of factor incomes:

$$\dot{Y} = \theta_w (\dot{L} + \dot{w}) + \sum_{i=1}^9 \theta_{r_i} (\dot{r}_i + \dot{K}_i) + \sum_{i=1, 2, 6, 8} \theta_{v_i} (\dot{v}_i + \dot{R}_i) \quad (16')$$

The changes in consumer and aggregate price levels are given by equations (17') and (18'), respectively. The parameter α_i of equation (17') is the share in the consumer's budget (or expenditure) of the i^{th} sector, while the parameter θ_i of equation (18') is the share in aggregate value added of the i^{th} sector.

$$\dot{P} = \sum_{i=6}^9 \alpha_i \dot{P}_i \quad \sum_{i=6}^9 \alpha_i = 1 \quad (17')$$

$$\dot{P}I = \sum_{i=1}^9 \theta_i \dot{P}_i$$

$$\sum_{i=1}^9 \theta_i = 1$$

(18')

Appendix B

Parameter Values of the General Equilibrium Model

Capital Stock

The capital stock estimates were based on the distribution of the net capital stock in 1981. (Source: *Fixed Capital Flows and Stocks, British Columbia, 1955-82*, Statistics Canada.)

$$\begin{array}{ll} \lambda_{K1} = .0186 & \lambda_{K6} = .1135 \\ \lambda_{K2} = .0096 & \lambda_{K7} = .0633 \\ \lambda_{K3} = .0156 & \lambda_{K8} = .4563 \\ \lambda_{K4} = .0217 & \lambda_{K9} = .2204 \\ \lambda_{K5} = .0807 & \end{array}$$

The capital stock was allocated between Coast and Interior logging in proportion to labour force. The same procedure was adopted for coastal and interior sawmilling.

Distribution of Labour Force

Several sources were used to allocate labour across sectors for 1981 in a manner consistent with the industry aggregation employed in the model. (Source: Statistics Canada, Cat. 31-203 and 25-202; Province of British Columbia, Ministry of Economic Development, *British Columbia Economic Activity*, 1983; and Economic Council of Canada, *Western Transition*.)

$$\begin{array}{ll} \lambda_{L1} = .0182 & \lambda_{L6} = .0453 \\ \lambda_{L2} = .0094 & \lambda_{L7} = .0853 \\ \lambda_{L3} = .0181 & \lambda_{L8} = .7077 \\ \lambda_{L4} = .0252 & \lambda_{L9} = .0716 \\ \lambda_{L5} = .0192 & \end{array}$$

Distribution of Output

$S_{13} = .751$	$S_{24} = .869$	$S_{35} = .126$	$S_{45} = .084$
$S_{14} = .225$	$S_{25} = .108$	$S_{37} = .042$	$S_{47} = .084$
$S_{18} = .008$	$S_{28} = .008$	$S_{38} = .091$	$S_{48} = .091$
$S_{1Q} = .002$	$S_{2Q} = .002$	$S_{3Q} = .007$	$S_{4Q} = .007$
$S_{1E} = .014$	$S_{2E} = .013$	$S_{3E} = .734$	$S_{4E} = .734$
$S_{57} = .101$	$S_{66} = .013$	$S_{71} = .022$	$S_{81} = .012$
$S_{58} = .060$	$S_{67} = .516$	$S_{72} = .020$	$S_{82} = .011$
$S_{1Q} = .038$	$S_{68} = .063$	$S_{73} = .005$	$S_{83} = .002$
$S_{5E} = .801$	$S_{69} = .015$	$S_{74} = .008$	$S_{84} = .003$
	$S_{6Q} = .118$	$S_{75} = .011$	$S_{85} = .004$
	$S_{6E} = .275$	$S_{76} = .022$	$S_{86} = .019$
		$S_{77} = .129$	$S_{87} = .051$
		$S_{78} = .414$	$S_{88} = .418$
		$S_{79} = .037$	$S_{89} = .178$
$S_{9Q} = 1.0$		$S_{7Q} = .332$	$S_{8Q} = .302$

The allocation of output among intermediate, final, and export demands was based on the "Use and Final Demand Matrices of British Columbia Input-Output Table," 1974, Aggregation S, and Statistics Canada industry publications, Cat. 25-201, 35-204 and 36-201.

1. The input-output table indicated substantial use by forestry inputs. These flows were assumed to be some form of manufacturing activity and allocated as manufacturing (wood products). The distribution of Coast and Interior logging output between wood products and pulp and paper used weights derived from Pearse (1976, Vol. 2, Table B-5). The weights of exports, final demand, and intermediate demands other than wood products and pulp and paper were assumed identical for both industries and taken from the input-output table.

2. The distribution of output of Coast and Interior logging was derived from the input-output table in conjunction with Pearse (1976, Vol. 2, Table B-5). The distribution of output of Coast sawmilling between pulp and paper and manufacturing (excluding wood products and pulp and paper) is in the ratio of 3 to 1. In the case of Interior manufacturing the ratio is 11 to 1.
3. For pulp and paper and other primary products industries the allocation provided by the input-output table was retained.
4. The distribution of manufacturing output among the various sectors was allocated as follows. The share allocated to forestry in the input-output table was distributed between Coast and Interior logging in proportion to the value of intermediate input usage for 1973 as given in Statistics Canada, Cat. 25-202. The allocation among Coast and Interior sawmilling, pulp and paper was in proportion to intermediate input usage by each of these sectors for 1973 given in Statistics Canada, Cat. 25-202 and 35-204.
5. The allocation of services to forestry between Coast and Interior logging was on the basis of intermediate usage in the two industries. Similarly the allocation of services was distributed among Coastal and Interior wood products, pulp and paper, and manufacturing (other than wood product and pulp and paper) in proportion to each sector's intermediate input usage in 1973.
6. Government output was treated as final demand.

Distributive Shares, θ_{ij}

$\theta_{1W} = .1896$	$\theta_{2W} = .2020$	$\theta_{3W} = .2285$	$\theta_{4W} = .2656$
$\theta_{17} = .0141$	$\theta_{27} = .0277$	$\theta_{31} = .5112$	$\theta_{42} = .3402$
$\theta_{18} = .2378$	$\theta_{28} = .4435$	$\theta_{37} = .0440$	$\theta_{47} = .0717$
$\theta_{1V} = .4017$	$\theta_{2V} = .1588$	$\theta_{38} = .0508$	$\theta_{48} = .0909$
$\theta_{1R} = .1483$	$\theta_{2R} = .1532$	$\theta_{3R} = .1392$	$\theta_{R4} = .1888$
$\theta_{1M} = .0084$	$\theta_{2M} = .0149$	$\theta_{3M} = .0262$	$\theta_{4M} = .0428$

$\theta_{5W} = .2030$	$\theta_{6W} = .1960$	$\theta_{7W} = .2132$	
$\theta_{51} = .0627$	$\theta_{66} = .0123$	$\theta_{77} = .2332$	
$\theta_{52} = .0323$	$\theta_{67} = .0826$	$\theta_{78} = .2160$	
$\theta_{53} = .0642$	$\theta_{68} = .2110$	$\theta_{7R} = .1983$	
$\theta_{54} = .0850$	$\theta_{6V} = .1335$	$\theta_{7M} = .1393$	
$\theta_{58} = .1264$	$\theta_{6M} = .0493$		
$\theta_{5R} = .3200$			
$\theta_{5M} = .0396$			
$\theta_{8W} = .2350$	$\theta_{9W} = .3291$		
$\theta_{86} = .0050$	$\theta_{96} = .0058$		
$\theta_{87} = .1346$	$\theta_{97} = .0429$		
$\theta_{88} = .3720$	$\theta_{98} = .4231$		
$\theta_{8V} = .0521$	$\theta_{9R} = .1735$		
$\theta_{8R} = .1210$	$\theta_{9M} = .0256$		
$\theta_{8M} = .0801$			

1. For Coast and Interior logging, Coast and Interior wood products, pulp and paper, and manufacturing (excluding wood products and pulp and paper), Statistics Canada industry publications, Cat. 25-202 and 31-203, were used to derive the distributive shares for labour, intermediate input usage, and capital. The share of capital was calculated as a residual in gross value of production after accounting for labour and intermediate input usage.

The distributive share of intermediate inputs (other than wood costs) in Coast and Interior logging was allocated in the following manner. The share allocated to manufacturing and services was in proportion to the shares in the input-output table for forestry with the share of energy added to services. The share of manufacturing was then disaggregated between domestic and imported manufacturing in the proportion of .6262

and .3738, respectively. The latter represents domestic consumption of manufacturing goods met by imports.

A similar procedure for Interior and Coast wood products was adopted as above for the two logging sectors. All wood inputs to Interior wood products were assumed to come from Interior logging, with the same assumption for Coast wood products and Coast logging.

2. The distributive shares of wood inputs in the pulp and paper industry were allocated among Coastal and Interior logging, Coastal and Interior wood products on the basis of Pearse (1976, Vol. 2, Table B-5). The distribution of non-wood intermediate inputs between services and manufacturing was in proportion to the shares derived from the input-output table. The share of manufacturing was distributed between imported and domestic manufacturing using the weights of .3738 and .6262, respectively.
3. In the case of other primary products, the distributive shares were calculated using the data of the 1973 input-output table, aggregation S. The share of manufacturing was distributed between domestic and imported manufacturing goods using the .6262 and .3738 weights. The distributive share of capital derived from the input-output table was distributed between capital and land using the shares of .1 and .3, respectively.
4. The distributive shares of inputs in the manufacturing sector were derived from Statistics Canada, Cat. 25-505, for data exclusive of the wood products and pulp and paper industries. The distributive share of manufacturing used as an intermediate input in manufacturing was distributed between domestic and imported sources using the weights of .6262 and .3738, respectively.
5. The distributive shares of inputs of the service industry were derived from the input-output table. The manufacturing share was disaggregated between domestic and imported sources using the weights of .6262 and .3738, respectively, and share of capital was distributed between capital and land using the weights of .7 and .3, respectively.
6. The distributed shares of the government sector were derived from the input-output

table. The share of capital was assumed equal to the share of capital and land in services. The remaining intermediate inputs were then prorated over the residual after the share of capital was set. The manufacturing share was disaggregated between domestic and imported sources.

Shares of Primary Factors in National Income

$\theta_w = .544$	$\theta_{r7} = .047$
$\theta_{r1} = .005$	$\theta_{r8} = .190$
$\theta_{r2} = .003$	$\theta_{r9} = .019$
$\theta_{r3} = .009$	$\theta_{v1} = .013$
$\theta_{r4} = .015$	$\theta_{v2} = .003$
$\theta_{r5} = .025$	$\theta_{v6} = .014$
$\theta_{r6} = .033$	$\theta_{v8} = .083$

These weights were derived as the product of the share of each factor in industry value-added times the share of the industry in GDP. The estimates of each factor in value-added were derived from their shares in gross value of production (see previous section). The estimates of industry shares in GDP were taken from *British Columbia Economic Accounts*, 1961-80, Province of British Columbia, Ministry of Industry and Small Business Development, Table 11.

Weights in CPI

The share of expenditures of publicly provided private output was calculated as .209. This figure represents the share of transfers to the government from personal income, *British Columbia Economic Accounts*, 1961-80, Table 3. The shares of X_6 , X_7 and X_8 were derived from the 1973 input-output table of British Columbia, aggregation S. The shares for X_6 , X_7 and X_8 were prorated over the share of expenditures remaining after purchases of X_9 .

$$\alpha_6 = .017$$

$$\alpha_8 = .476$$

$$\alpha_7 = .298$$

$$\alpha_9 = .209$$

Weights of National Income Deflator

These weights are the shares of each sector in gross domestic product. The shares are from *British Columbia Economic Accounts, 1961-1980, Table 11*. The estimates for regional sectors are prorated according to value-added.

$$\theta_1 = .024$$

$$\theta_6 = .067$$

$$\theta_2 = .009$$

$$\theta_7 = .097$$

$$\theta_3 = .023$$

$$\theta_8 = .638$$

$$\theta_4 = .036$$

$$\theta_9 = .065$$

$$\theta_5 = .041$$

The shares of transportation costs and producer prices in landed prices are:

$$\pi_{3T} = .40$$

$$\pi_{5T} = .40$$

$$\pi_{3P} = .60$$

$$\pi_{5P} = .60$$

$$\pi_{4T} = .40$$

$$\pi_{6T} = .20$$

$$\pi_{4P} = .60$$

$$\pi_{6P} = .80$$

Footnotes

1. Respectively, Professor, Department of Economics, and Associate Professor, Department of Rural Economy, University of Alberta
2. The focus of this paper is not the impact of these replacement measures on the provincial economy. Rather, our aim is to assess the perception that the export tariff increased overall welfare in the British Columbia economy. A preliminary analysis of the impact of the replacement measures on the provincial economy is found in Constantino and Percy (1989).
3. The role of rents as the sole contribution of a resources boom to per capita income was highlighted by Chambers and Gordon (1967).

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