Effect of Land Use Restrictions on the Economy of Alberta: A Computable General Equilibrium Analysis*

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In the recent past, public concern over environmental degradation has prompted public agencies to impose restrictions on the use of the natural resource base. For example, in the Pacific North West (PNW), vast areas of forests are closed for logging in order to protect the habitat for the spotted owl. In British Columbia, the Protected Areas Strategy policy has made a commitment to increase British Columbia's protected areas from the existing 6% to 12% of the total land base. Alberta's Special Places 2000 also seeks to identify and designate land which is integral to the preservation of the province's natural heritage. Such restrictions on the use of land may have implications for resource dependent regional economies. In the long run, these restrictions on land use may improve environmental quality and thus promote growth in tourism and service sectors. An increase in tourism and service sectors may offset the negative impacts associated with land use restrictions. However, in the short-run, a reduction in the use of land resource may impact all sectors in the economy and natural resource sectors in particular. The overall impacts of land use restrictions may be pervasive in regions where resource sectors are the mainstay of the economy. We believe that information regarding the impacts of changes in land use restrictions may help corporate managers and policy makers in making land use decisions.

The economy of the province of Alberta is heavily reliant upon its resource base. Primary resource industries account for approximately 23% of the provincial economy and 13% of the total employed labour force (Alberta Input-Output Table 1990). This suggests that any change or shock in resource based sectors may have a significant impact on the provincial economy. In this paper we examine the socio-economic impacts of three hypothetical changes in resource based sectors using a Computable General Equilibrium (CGE) approach. Specifically, the paper investigates changes in regional income, employment, prices of outputs and inputs, demands for inputs, and supply of and demand for output in response to a reduction in the use of land in resource sectors of Alberta. Each change is simulated with a 1% reduction in the use of land in agricultural, forestry, and energy sectors.(1) We estimate the impacts of land use restrictions under two scenarios. First, we assume that wages are rigid in the economy and labour market adjusts through changes in unemployment levels. Second, we assume that

wages are flexible and the labour force is re-allocated across sectors such that full-employment is assured.

The paper is organized as follows. A graphical model explaining possible effects of land use restrictions in a resource sector on the economy and welfare of the province is presented in the next section. A brief literature review about the CGE approach is provided in the third section. Model specification details are discussed in the fourth section. The details of data and model calibration are discussed in the fifth section. Simulation results are discussed in the sixth section. The final section concludes with a summary and some notes on the limitations of the study.

Theoretical Framework

Figure 1 presents a model which may be used to study the impact of land use reductions on the provincial economy. For simplicity, it is assumed that only two goods (resource and composite) are produced in the economy and land is used only in the production of the resource good. With an initial production possibility frontier (PPF1) and price line, the levels of resource and composite output, resp ectively, are R1 and C1. The provincial welfare level is shown to be at indifference curve (IC1). The position of IC1 off of PPF1 suggests that resource good will be exported while the composite good is being imported. A reduction in the availability of land for production causes a PPF1 shift inward along the resource axis. With new production possibility frontier (PPF2) and no change in the price level, the new levels of resource and composite output, respectively, are R2 and C2 and provincial welfare level is IC2. In the figure it is shown that a reduction in the use of land causes a decline in the resource output and an increase in composite output and an overall decrease in the provincial welfare.[(2)]

A contraction in the resource sector implies that labour and capital which are displaced from the resource sector may be available for use in the composite sector.[(3)] The increased availability of labour and capital may cause a reduction in the price of labour and capital. This reduction in the price of inputs may stimulate an expansion in the composite sector. Incorporation of this chain of events is critical in socio-economic policy analysis.

FIGURE 1 Effect of Land Use Reduction on Output and Welfare

Literature Review

Many researchers have argued that CGE models provide an ideal framework for appraising the socio-economic effects of policy changes (See Dervis et al. 1982; Shoven and Whalley 1992; Conrad and Schroder 1993). The essence of CGE models is as follows. The model assumes

that consumers maximize their utility while producers maximize profits (Shoven and Whalley 1992). Equilibrium in the model is achieved through a set of prices and levels of production in each industry such that the total supply of commodities equals the total demand for commodities. Similar to conventional input-output models, CGE models incorporate intersectoral linkages and limit the problem of either overstating or understating the effects of a policy variable on sectors. However, unlike I-O models, CGE models permit prices and quantities of inputs employed to vary with respect to changes in output prices. Thus, the CGE approach is a convenient way of incorporating the price responsiveness of producers and consumers in regional economic policy analysis. On the other hand, by ignoring changes in prices, I-O models do not provide flexibility for industries to adjust input structures in response to changes in relative prices.(4)

Model Specification

The model divides the Alberta economy into five sectors: agricultural, forestry, energy, manufacturing, and services. The first three sectors rely primarily on the natural resource base. The domestic demand for the outputs of these sectors is quite small when compared to their exports. Therefore, these sectors are treated as net exporters. Sector four consists of all manufacturing industries. Since the domestic demand for manufactured goods exceeds the domestic supply, this sector is treated as a net importer. The service sector includes all services and is treated as a non-traded sector. This implies that all goods and services produced from this sector are consumed within the province.

In each sector, producers are assumed to produce goods and services by combining intermediate and primary inputs. The primary factors of production are labour, capital, and land. Labour is assumed to be employed in all sectors and its supply is fixed. Under this assumption, interprovincial and international migration of labour is not considered. The labour market is modelled in two scenarios. First, we assume that the economy's wage rate is rigid. This Keynesian assumption may be appropriate in the short-run and under conditions where labour is heavily unionized.(5) When wages are rigid, adjustments to the labour market are achieved largely through changes in employment levels. Second, we assume full employment in the economy. Under this assumption, wages adjust such that there will be no unemployment in the economy.

The second primary input, capital, is assumed to be sector specific and not mobile across the sectors. This implies that the availability of capital for each sector is fixed and rental rates of capital which are endogenous to the model will rise or fall to reflect changes in the sectoral value of exogenous level of capital. It is assumed that the third factor of production, land, is

used only in agricultural, forestry, and energy sectors. Similar to capital markets, land is also assumed to be sector specific. Land rents are responsive to changes in the demand for land in each sector. For example, an exogenous reduction in the use of land in the forest sector will result in an increase in stumpage prices in that sector.[(6)]

The input technology is specified at two levels. At the first level it is assumed that intermediate inputs and primary factor inputs are demanded in fixed proportions to produce each unit of output. At the second level, substitution is allowed only among primary factors using Constant Elasticity Substitution (CES) production technology. Since intermediate inputs are assumed to be used in fixed proportions they are expressed as the functions of output only. The demands for primary factor inputs are derived through the cost minimization approach. Therefore, they are expressed as the functions of output and the prices of inputs.

By maximizing utility subject to a budget constraint, the demand for services is derived as a function of own price and regional income. A structural model describing production and factor demands, consumer demand for products, factor and product markets equilibrium, zero pure profits and regional income is presented below. Following a small country assumption, we assume that Alberta is not large enough to influence world prices through the alteration of its export or import volumes.

Structural Model

Production and Input Demands

It is assumed that industry *j* chooses its inputs to minimize the cost of production

$$C = \sum_{\cdot\Theta} R\,F + \sum_{\cdot\Theta}^{E} X\,P \qquad (1)$$

$$if\ j = 1,2,3\ \ i = 1,2,3;\ \ if\ j = 4,5\ \ i = 1,2$$

subject to

$$X = (A[\Sigma\delta\,F^{-\rho}]^{-\Theta\Phi}),\ X_{\Theta},\ldots,X) \qquad (2)$$

$$if\ j = 1,2,3\ \ i = 1,2,3;\ \ if\ j = 4,5\ \ i = 1,2,$$

where F_i is a primary factor input (labour, capital, and land), R_i is returns for a primary factor input (wages, rental rates of capital, land rents), C_j is costs of production, X_j is output, P_n is price of an intermediate input, $X_{n\ j}$ is intermediate inputs in sector *j*, *A* and $_j$ are positive parameters, is a parameter whose value is greater than -1, but not equal to zero. It is assumed that $_i$ = 1. It should be noted that in equation (2) we assume that primary inputs and

intermediate inputs are used in fixed proportions and the production technology is constant to returns to scale.

Primary input demand functions derived from the cost minimizing problem will have the form

$$F = X \frac{1}{A} [\Sigma\delta (\frac{R\ \delta}{R\ \delta})^{\text{illegible}}] \quad \text{if } j = 1,2,3 \;\; i,k = 1,2,3; \;\; \text{if } j = 4,5 \;\; i,k = 1,2 \tag{3}$$

On the other hand intermediate demand functions will have the form

$$X = z\ X \quad i, j = 1,2,3,4,5 \tag{4}$$

Consumers Demand for Products

Consumers are assumed to choose their consumption levels of goods to maximize the Cobb-Douglas utility function

$$U = \prod X^{\alpha} \quad j = 1,2,3,4,5 \tag{5}$$

subject to their budget constraint

$$Y = \sum_{\cdot\Theta}^{\Xi} X\ P \tag{6}$$

where U is the utility, Y is the household income, X_{jc} is the households demand for commodity j, and $_j$ is a set of positive parameters summing up to one. The household demand functions derived from the utility maximizing problem will have the form

$$X = \alpha\ Y/P \quad j = 1,2,3,4,5 \tag{7}$$

Product and Factor Markets Equilibrium

Product market equilibrium requires that total demand for each good equals the supply of that good. The factor market equilibrium implies that total employment of factor inputs equal to their supply.

$$\Sigma X + X + X = X \quad i = 1,2,3; \quad j = 1,2,3,4,5 \tag{8}$$

$$\Sigma X + X - X = X \quad i = 4; \quad j = 1,2,3,4,5 \tag{9}$$

$$\Sigma X + X = X \quad i = 5; \quad j = 1,2,3,4,5 \tag{10}$$

$$\begin{aligned} \Sigma F &= \bar{F} \quad i = 1; \ j = 1..,5 \\ \Sigma F + UF &= \bar{F} \quad i = 1; \ j = 1..,5 \end{aligned} \tag{11}$$

Where X_{ic} is consumer demand for product *i*, X_{iE} is exports of product *i*, X_{iM} is imports of product *i*, $\bar{F}$ is the total labour supply, and *UF* is unemployed labour. In the case of full employment assumption, the second part of equation (11) is not necessary as the labour market clears through changes in the wage rate. On the other hand, when the wage rate is assumed to be fixed, the labour market clears through changes in employment levels. Therefore, the first part of equation (11) can be dropped. Since capital and land are assumed to be sector specific, there is no need to specify market equilibrium conditions for these inputs.

Export demands for product *i* and import demand for manufactured goods are specified as the ratio of domestic and world prices

$$X = (P / WP \ ER)^{-\Phi} \quad i = 1,2,3 \tag{12}$$

$$X = (P / WP \ ER)^{\omega} \quad i = 4 \tag{13}$$

Where WP_i is the world price for product *i*, *ER* is the exchange rate, is the export demand elasticity, and is the import demand elasticity.

Zero Pure Profits

It is assumed that in each industry the value of outputs equals the total payments made to factors of production.

$$\begin{aligned} P X &= \sum_{\Theta}^{E} X \ P + \sum_{\Theta}^{I} F \ R \quad i = 1,2,3,4,5 \\ if \quad j &= 1,2,3 \quad k = 1,2,3; \quad j = 4,5 \quad k = 1,2 \end{aligned} \tag{14}$$

Nominal Household Income

Regional income is defined as the total payments made to primary factors of production.

$$Y = \sum_{\Theta}^{E} F_{\Theta} R_{\Theta} + \sum_{\Theta}^{E} F_{\Theta} R_{\Theta} + \sum_{\Theta}^{I} F_{T} R_{T} \tag{15}$$

Real Household Income

Real income for households can be obtained by deflating nominal income with a price deflator.

$$Y = Y / \sum_{\cdot\Theta}^{\Xi} \mu P \qquad (16)$$

where Y_R is household real income and μ_i is the consumption weights.

Linearized Model

Following Johansen (1960), the model described above is transformed into a system of linear equations and expressed in the form of proportional rates of change by taking logarithmic differentiation.[7] This format is employed as it requires relatively little data, produces results easily interpreted in terms of elasticity relationships, and suits the economic analysis of a wide range of policy shocks. One of the limitations of the Johansen approach is that it introduces linear approximation errors. However, we have addressed this problem by solving the model in 4 steps (See Dixon et al. 1992:109-123 for details on multi-step computation).

Input Demand Equations

$$f_\Theta = x - \sigma [r_\Theta - (S_\Theta r_\Theta + S_\beta r_\beta + S_\tau r_\tau)] \quad j=1,2,3;\ \sigma = \frac{1}{(1+\rho)} \qquad (17)$$

$$f_\Theta = x - \sigma [r_\Theta - (S_\Theta r_\Theta + S_\beta r_\beta)] \quad j=4,5 \qquad (18)$$

$$f_\beta = x - \sigma [r_\beta - (S_\Theta r_\Theta + S_\beta r_\beta + S_\tau r_\tau)] \quad j=1,2,3 \qquad (19)$$

$$f_\beta = x - \sigma [r_\beta - (S_\Theta r_\Theta + S_\beta r_\beta)] \quad j=4,5 \qquad (20)$$

$$f_\tau = x - \sigma [r_\tau - (S_\Theta r_\Theta + S_\beta r_\beta + S_\tau r_\tau)] \quad j=1,2,3 \qquad (21)$$

$$x = x \quad i,j = 1,2,3,4,5 \qquad (22)$$

Where S_i is value added cost share of a primary factor input. The lower case letters are percentage changes in the variables denoted by the corresponding upper-case letters. Equations (17) to (21) are linear transformations of structural equations of primary input demands (3) while equation (22) is the linear form of intermediate demands equation (4). Since land is assumed to be used only in resource sectors, equations (18) and (20) do not have rental rates of land.

Consumers Demands for Products

$$x = y - p \qquad j=1,2,3,4,5 \tag{23}$$

The above equation is the linear transformation of structural equation (7).

Product Market and Factor Market Equilibrium

$$x = \alpha \sum_{\Theta}^{E} x + \mu x + \zeta_{\Theta} x \qquad i = 1,2,3 \quad j=1,2,3,4,5 \tag{24}$$

$$x = \alpha \sum_{\Theta}^{E} x + \mu x - \zeta_{\Theta} x \qquad i = 1 \quad j=1,2,3,4,5 \tag{25}$$

$$x = \alpha x + \mu x \qquad i=5 \quad j = 1,2,3,4,5 \tag{26}$$

where $_i$, μ_i, $_{iE}$, $_{iM}$ are respectively, shares of total intermediate demand, consumer demand, export demand, and import demand for product *i*.

$$\sum_{\Theta}^{E} \lambda f_{\Theta} = \bar{f} \qquad j=1,2,3,4,5 \tag{27}$$

$$\beta_e \sum_{j=1}^{S} \lambda_j f_{1j} + \beta_u u f_{1u} = \bar{f} \qquad j=1,2,3,4,5 \tag{28}$$

Where $_j$ is a sectoral employment share, $_e$ and $_u$ are, respectively, shares of employment and unemployment in total labour force. As noted earlier, if wages are assumed to be flexible then equation (27) will clear the labour market and equation (28) should be dropped from the model. If wages are assumed to be rigid, equation (28) will clear the labour market and the equation (27) should be dropped from the model.[(8)]

The linearized form of export and import demand equations are

$$x = -\phi(p - wp + er) \qquad i = 1,2,3 \tag{29}$$

$$x = \omega(p - wp + er) \qquad i = 4 \tag{30}$$

Zero Pure Profit conditions

$$p = (\theta_{\Theta} r_{\Theta} + \theta_{\Pi} r_{\Pi} + \theta_{T} r_{T}) + \sum_{\Theta}^{E} \psi p \qquad j=1,2,3 \tag{31}$$

$$p = (\theta_{\Theta} r_{\Theta} + \theta_{\Theta} r_{\Theta} + \sum_{\Theta}^{\Theta} \psi \quad p \qquad j=4,5 \tag{32}$$

Where $_i$ is the total cost share of primary factor *i* in sector *j*, and $_i$ is the total cost share of intermediate input *i* in sector *j*.

Nominal Household Income

$$y = \sum_{\Theta}^{\Theta} f_{\Theta} r_{\Theta} + \sum_{\Theta}^{\Theta} f_{\Theta} r_{\Theta} + \sum_{\Theta}^{\Theta} f_{\Theta} r_{\Theta} \tag{33}$$

Real Household Income

$$y = y - \sum_{\Theta}^{\Theta} \mu p \tag{34}$$

The linearized model has 60 equations. In the case of wage flexible scenario, there is no unemployment in the model and the total number of variables are 74. When the wage rate is rigid, it is necessary to consider unemployment in the model increasing the number of variables to 75. The split showing endogenous and exogenous variables is given in Appendix A. An aggregated version of Alberta Input-Output Table 1990 used to derive parameters is presented in Appendix B. The simulations are conducted using GEMPACK v.5.1 software.

Simulation Results and Discussion

An exogenous land use reduction in resource sectors is one of the options public agencies have to address public concerns for the environment. We simulate the effect of a land use restriction in agriculture, forestry, and energy sectors. Since the model is linear in proportionate changes of variables, the values can be interpreted as elasticities of the endogenous variables with respect to land use reduction. Furthermore, the combined impact of a 1 % reduction in the use of land in all three sectors can be calculated as the sum of the responses of the individual shocks.

Table 1 reports the structural responsiveness of the Alberta economy to a 1 % reduction in the use of land under rigid wage rate assumption. The results show that such a reduction in each of the resource sectors decreases nominal and real household income. For example, a 1% reduction in the use of land in each of the three resource sectors causes, respectively, 25.1, 0.8, and 73.3 million dollars decrease in household nominal income. The results show that the decrease in the household income is the greatest when the reduction of land use is in the energy sector. The decrease in the household income causes a drop in the household demand

for products and a corresponding decline in the supply of manufacturing and services output.[9] The reduction in the output of these sectors puts downward pressure on the demand for primary inputs. The reduction in the demand for primary inputs decreases the price of inputs and thereby causes a reduction in the output prices. The results illustrate that the decrease in the overall price level cannot offset the drop in the household income. Therefore, we notice a decrease in real income for households in response to the above shocks.

The results also indicate that a reduction policy in a particular sector causes a reduction in the supply of output and an increase in the rental rate of land only in that sector. Since the wage rate is assumed to be fixed, a reduction in the supply of output in the economy will cause a general decline in the demand for labour and thereby an increase in unemployment. Again, we notice a significant difference in the magnitude of these unemployment levels. When the shock is in the energy sector, the unemployment increases by 1.18%. On the other hand the shocks in agriculture and forestry sectors cause unemployment to increase by 0.43% and 0.01% respectively.

The results reported in Table 2 are obtained for the shocks when the wage rate is flexible to changes in the demand for labour in the economy. We notice a decrease in the wage rate in response to a decrease in the land use in each resource sector. The drop or increase in sectoral employment is higher in this scenario when compared to the wage rigid scenario. Because of this adjustment, there is no unemployment in the economy. Unlike in the wage rigid scenario, adjustments in labour market in response to changes in the wage rate may cause higher expansion in other traded sectors. For example, a 0.1405 percent contraction in the energy sector and a 0.0865 percent fall in the price of labour cause agriculture, forestry, and manufacturing sectors to expand, respectively, by 0.037, 0.073, and 0,074 percent. This result supports the argument of Constantino and Percy (1988), that the contraction of a sector may induce expansion of other traded sectors. Therefore, the reduction in household income is smaller in this scenario when compared to that of a wage rigid scenario. The reduction in household income is shown to be 60.0 million dollars when wages are flexible while the reduction is 99.0 million dollars if wages are rigid in the economy. It should be noted that the expansion of the non-traded sector, service, depends not only on the price of inputs but also on the domestic demand for services. A significant reduction in regional income associated with a contraction in any of the resource sectors may decrease the demand for services by more than the increase in the demand for services due to expansion in other sectors. The net result may be a drop in the demand for service and a corresponding decrease in the output of the service sector. Results support this argument by showing a drop in the output of service sector when each of the resource sector contracts in response to a decrease in the use of land.

Finally, the results suggest that the negative impacts of land use reduction policies under the wage flexible scenario are much smaller than those of the wage rigid scenario.

TABLE 1. Impacts of a 1% Reduction in Land Use on Selected Variables under Wage Rigid Scenario (Values Are Expressed in Percentage Changes)

TABLE 2. Impacts of a 1% Reduction in Land Use on Selected Variables under Wage Flexible Scenario (Values Are Expressed in Percentage Changes)

Conclusions

Growing concern for the environment may encourage public agencies to undertake polices which have the potential to promote environmental quality. A reduction in the use of land in the production process is one of the instruments public agencies have to address the public concerns for environment. In this study we investigate the impact of a set of hypothetical policies which would cause a 1 % decrease in the use of land by agriculture, forestry, and energy sectors in the province of Alberta. A five sector CGE model was developed to simulate land use reduction shocks. Shocks are simulated assuming that: First, the wage rate is rigid in the economy and, second, the wage rate is flexible to changes in the demand for labour.

Under wage rigid assumption, simulation results indicate that, regional income declines and unemployment rises in response to land use reduction policies. However, when the wage rate is flexible the negative impacts associated with the same shocks are relatively small. Under the wage rigid scenario, with capital and land being sector specific, a reduction in the use of land cause greater changes in the demand for labour and thus greater changes in the sectoral output. Therefore, negative impacts are larger under wage rigid scenario than under the wage flexible scenario. Since energy is one of the key sectors in the provincial economy, a shock in this sector under both scenarios is shown to have a greater impact on the economy than when a shock either in agricultural or forestry sector.

Some of the limitations of the study should be noted. First, the model does not incorporate the environmental benefits associated with land use reduction policies. In the long-run, recreation and tourism activities may expand and outweigh the negative impacts of the land use reduction. Second, because the model is short-run in nature we did not consider factor mobility beyond the regional borders. For example, in the long-run, capital can be mobile across the sectors in the economy. The impacts of land use reduction may vary when intersectoral mobility of capital and land is considered. Third, an exogenous zero balance of trade assumption may limit the responsiveness of the economy with respect to shocks introduced. Finally, the model is aggregated at the provincial level and therefore can not

accommodate differences among regions within the province. The socio-economic impacts of the shocks may be different among various communities within the province. For example, a reduction in the use of land in the forestry sector may affect forest dependent communities more than a reduction in the energy sector.[(10)]

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Appendix A: Table 3 and Table 4

FIGURE 1 Effect of Land Use Reduction on Output and Welfare

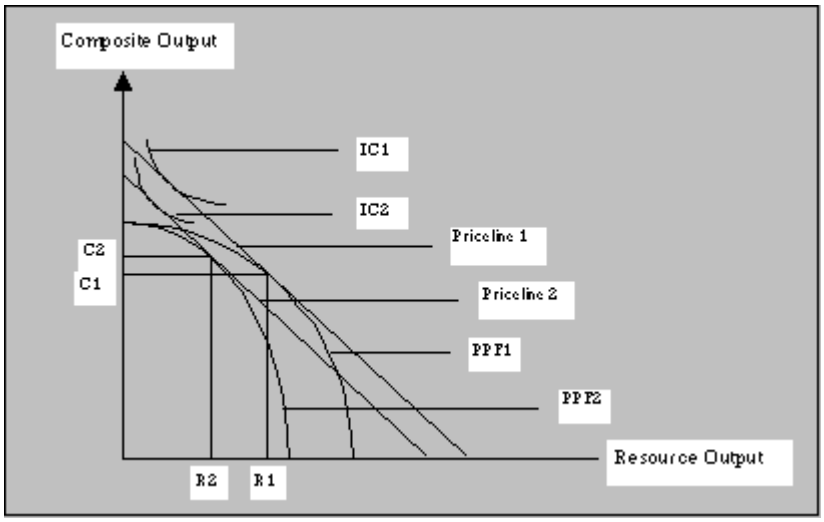

TABLE 1. Impacts of a 1% Reduction in Land Use on Selected Variables under Wage Rigid Scenario (Values Are Expressed in Percentage Changes)

Changes In:	1% Reduction in the Use of Land in			
	Agriculture	Forestry	Energy	**All Resource Sectors**
Nominal income	-0.0428	-0.0015	-0.1249	-0.1691
Real income	-0.0261	-0.0011	-0.0728	-0.1000
Price of output in: Agriculture Forestry Energy Manufacturing Services	0.1016 -0.0226 -0.0024 -0.0046 -0.0218	-0.0006 0.1129 -0.0001 0.0003 -0.0007	-0.0111 -0.0386 0.0227 -0.0201 -0.0645	0.0897 0.0517 0.0202 -0.0244 -0.0871
Supply of output in: Agriculture Forestry Energy Manufacturing Services	-0.3415 -0.0407 0.0037 -0.0427 -0.0254	-0.0004 -0.0391 0.0001 -0.0036 -0.0009	0.0070 -0.0243 -0.1723 -0.0280 -0.0745	-0.3349 -0.1043 -0.1684 -0.0742 -0.1008

Demand for Labour in: Agriculture Forestry Energy Manufacturing Services	-0.1300 -0.0645 0.0129 -0.0762 -0.0526	-0.0016 0.1727 0.0003 -0.0064 -0.0019	0.0319 -0.0385 -0.1021 -0.0499 -0.1543	-0.1000 0.0694 -0.0889 -0.1323 -0.2086
Unemployment	0.4347	0.0146	1.184	1.6329
Price or labour	0	0	0	0
Price of Capital in: Agriculture Forestry Energy Manufacturing Services	-0.1572 -0.0737 0.0161 -0.0807 -0.0526	-0.0020 0.1974 0.0004 -0.0067 -0.0019	0.0386 -0.0440 -0.1266 -0.0529 -0.1543	-0.1209 0.0793 -0.1102 -0.1402 -0.2086
Price of land in: Agriculture Forestry Energy	1.0635 -0.0737 0.0161	-0.0020 1.3549 0.0004	0.0386 -0.0440 1.1265	1.1003 1.2355 1.1431

TABLE 2. Impacts of a 1% Reduction in Land Use on Selected Variables under Wage Flexible Scenario (Values Are Expressed in Percentage Changes)

Changes In:	**1% Reduction in the Use of Land in**			
	Agriculture	Forestry	Energy	**All Resource Sectors**
Nominal income	-0.0254	-0.0009	-0.0775	-0.1038
Real income	-0.0038	-0.0003	-0.0123	-0.0164
Price of output in: Agriculture Forestry Energy Manufacturing Services	0.1059 -0.0292 -0.0027 -0.0057 -0.0281	-0.0005 0.1127 -0.0001 0.0002 -0.0009	0.0007 -0.0566 0.0218 -0.0232 -0.0815	0.1062 0.0268 0.0189 -0.0288 -0.1105
Supply of output in: Agriculture Forestry Energy Manufacturing Services	-0.3305 -0.0049 0.0154 -0.0053 -0.0030	0.0000 -0.0379 0.0005 -0.0023 -0.0001	0.0370 0.0735 -0.1405 0.0741 -0.0135	-0.2936 0.0306 -0.1246 0.0666 -0.0166
Demand for Labour in: Agriculture Forestry	-0.0801 -0.0077 0.0534	0.0000 0.1746 0.0016 -	0.1678 0.1164 0.0080	0.0877 0.2833 0.0630

Energy	-0.0094	0.0041	0.1322	0.1187
Manufacturing	-0.0062	-0.0003	-0.0280	-0.0344
Services				
Unemployment	0	0	0	0
Price or labour	-0.0318	-0.0011	-0.0865	-0.1193
Price of Capital in:	-0.1286	-0.0010	0.1163	-0.0133
Agriculture	-0.0405	0.1986	0.0464	0.2042
Forestry	0.0344	0.0010	-0.0766	-0.0412
Energy	-0.0417	-0.0054	0.0535	0.0063
Manufacturing	-0.0379	-0.0014	-0.1144	-0.1537
Services				
Price of land in:	1.0925	-0.0010	0.1163	1.2092
Agriculture	-0.0405	1.3561	0.0464	1.3618
Forestry	0.0344	0.0010	1.1772	1.2130
Energy				

TABLE 3 Endogenous and Exogenous Variables Used In The Model

Endogenous Variables		
Variable	**Description**	
x_j	output of sector j	j = 1, 2, 3 , 4, 5
f_{ij}	labour demand in sector j	i = 1; j = 1, 2, 3, 4, 5
uf	unemployed labour force	
p_j	prices of output	j = 1, 2, 3, 4, 5
r_1	wage rate	
r_{2j}	rental rate of capital	j = 1, 2, 3, 4, 5
r_{3j}	rental rate of land	j = 1, 2, 3
x_{ij}	intermediate inputs	i, j = 1, 2, 3, 4, 5
x_{jc}	household demand for commodity j	j = 1, 2, 3, 4, 5
x_{iE}	exports of sector i	i = 1, 2, 3
x_{iM}	imports of sector 4	i = 4
y	household nominal income	
y_R	household real income	
Exogenous Variables		
	total labour force available in the economy	
wp_j	world prices of output j	j =1, 2, 3, 4
er	exchange rate	

f_{2j}	sector specific capital input	j = 1, 2, 3, 4, 5
f_{3i}	sector specific land input	j = 1, 2, 3

Note: Under wage rigid assumption, wage rate becomes exogenous and unemployment variable will be included in the model. In the case of flexible wage rate, wage rate becomes endogenous and there will be no unemployment in the model.

TABLE 4 An Aggregated version of Alberta Input-Output Table 1990 ($'000,000)

	Agri.	**Fore.**	**Ener.**	**Manu.**	**Serv.**	**D. demand**	**Trade**	**Total**
Agri	1287.77	1.38	6.64	2227.79	105.90	235.26	1119.30	4984.03
Fore	6.08	44.04	0.42	225.74	6.74	24.31	6.19	313.53
Ener	70.98	1.63	1184.58	3477.97	2355.69	553.27	14056.94	21701.05
Manu	948.97	15.47	915.75	5387.56	8847.73	13284.91	-8857.40	20542.98
Serv	1094.78	124.94	8074.08	3287.70	20079.85	38309.74	0000.00	70971.09
Labo	347.39	79.63	3331.63	3328.63	19108.82	00000.00	0000.00	26196.10
Capi	736.84	27.86	6550.36	2607.58	20466.37	00000.00	0000.00	30389.02
Land	491.23	18.58	1637.59	0000.00	00000.00	00000.00	0000.00	2147.40
Total	4984.03	313.502	21701.05	20542.98	70971.09	52407.49	6325.03	n..a.

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