Economic impacts of changes in the forestry sector:
A case study of the Foothills region in Alberta

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Abstract

Economic impacts of a reduction in the annual allowable cut and in the price of forest products on the Foothills Model Forest regional economy are examined. A two sector computable general equilibrium model is developed for the region to do this task. The results indicate that these changes cause significant negative impacts on the forestry sector and on the local economy. Results show that other sectors of the economy will expand in response to the above changes in the forest sector. However, the expansion cannot offset the reduction in the forest sector and thus local communities sustain reduction in their income. The results are sensitive to the assumptions about markets for factors.
Acknowledgments

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Introduction

The forest industry is an important contributor to the economy of Alberta. In 1993, this sector accounted for almost $792 million gross domestic product and employed over 26024 people (Natural Resources Canada 1995). However, the shares of this sector in provincial gross domestic product (GDP) and employment are only 1.2% and 2%, respectively. However, the corresponding shares in resource dependent regions may be much higher. For example, in 1995 the forest sector in the Foothills Model Forest (FMF) region\(^2\) accounts for approximately 25% in the regional GDP and employment. This suggests that activities related to the forest sector are important to the FMF regional economy and communities in this region are largely dependent on this sector for their livelihood. Therefore, any changes which affect the forest sector may have significant impact on the wider regional economy.

Historically, Alberta’s forest strategy has been characterized by the public ownership and private management of forests. The provincial government gives rights to harvest and manage timber on public forest lands to local and/or multi-national companies. These companies are expected to undertake value-added activities (pulp and wood products) thereby providing employment and stability in the local communities.\(^3\) In 1954, the government of Alberta signed

\(^2\)See Appendix 1 for the map of the Foothills region.

\(^3\)The term “community stability” was first introduced by Gifford Pinchot of the U.S. Forest Service in the early part of this century (Hardy Stevenson and Associates Ltd. 1996). Besides economic efficiency, community stability is another objective which public agencies would like to pursue in public forest management.
the first forest management agreement (FMA) giving North Western Pulp and Power Ltd. (Now Weldwood of Canada Ltd.) the rights to harvest and manage timber on 780,000 hectares in the Foothills region. In return the company established a pulpmill in 1957 and later on a sawmill in 1972. Since then many changes have taken place in FMA and company operations. For example, the land base for timber management has been increased from 780,000 to 1,012,000 hectares; pulp mill capacity has been doubled; and a new sawmill has been established. In 1995, the forestry sector in the Foothills region produced over $504 million output and employed 1151 people.

The stability of the forest products industry is critical for sustainable income and employment in the FMF region. In the future, two factors may influence the forest products industry in the FMF region. First, the increasing demand for recreation and the growing concerns for the environment may prompt public agencies to impose a variety of new regulations on the industrial users public forests. Consequently, there may be attempts to increase the preservation of timber lands and/or a decrease in the annual allowable cut (AAC). Reductions in the AAC will decrease the supply of timber to the forest products industry. This decrease in production will affect the use of factors of production including labor. Second, future changes in markets for forest products may pose a threat to the stability of the forest sector. Cyclical changes endemic to forest products markets may have little impact on the stability of an established industry and thus the sustainability of local communities. However, long-term changes in forest products markets may affect the industry's viability. Specifically, two factors are thought to have a significant impact on the pulp industry in the Foothills region. First, the global supply of pulp is expected to increase because of entry of new suppliers from Latin America and South East Asia. These new
suppliers may have a comparative advantage over producers in the Foothills region in producing pulp because of the regional differences in timber growth rates and rotation age, labor costs, and environmental regulations. Second, advancements in communication technology may have a negative impacts on the global demand for paper. For example, e-mail communication and business advertisement through the Internet will decrease the demand for paper.

Figure 1 shows how changes in the AAC and price of pulp would influence the forest sector and local communities in the Foothills region. For example, a reduction in the AAC will reduce the availability of stumpage for the forest products sector thereby reducing its annual

**Figure 1. Interrelationships between changes in the forest sector and the regional economy**

output. The reduction in the output may cause a decrease in the demand for inputs used in the production process. Consequently there may be fewer workers required and/or a reduction in the wage rate. Some capital may move out of the industry or out of the region. Changes in the employment of factor inputs and factor prices may influence the stability of local communities.
A decrease in the forest product prices will have a negative impact on industry's profit and output. As explained earlier, the decrease in the industry’s output will have consequences for factor markets and local communities.

The impacts of changes in the factor markets in response to changes in the AAC or price of forest products may affect the forest sector and other sectors of the economy. For example, the wage rate in the forest sector may drop in response to a decline in the demand for labor thereby reducing the unit cost of production; timber lands which are withdrawn from timber production may promote recreational activities in the region thereby promoting the service industry; some capital once invested in the forest sector may flow into other sectors of the economy. The changes in the rest of the economy in response to changes in the factor market in turn may influence local factor markets. These indirect changes in the factor markets may have impacts on forest products industry and local communities. For example, the expansion in other sectors of the economy may place an upward pressure on factor demands and factor prices. This upward pressure will have positive impacts on local communities but negative impacts on forest product companies. Therefore, the output in the forest sector may drop further and thereby causing a decrease in the demand for timber and other factors of production. In short, changes in the AAC and prices for forest products will have both direct and indirect impacts on the regional economy. Failure to incorporate indirect impacts into policy analysis may generate biased estimates and natural resource management decisions based on biased estimates may be erroneous.

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4 It should be noted that individual producers have no market power to influence the market price.
According to “Special Places 2000: Alberta’s Natural Heritage” policy\textsuperscript{5}, it was suggested that approximately 6\% of the current FMA be set aside for preservation. This would cause a 6\% reduction in the AAC of the FMF region. Therefore, we chose to analyze the effect of 6\% decrease in the AAC. In the case of markets for forest products, as noted earlier, we expect that in the long-run the entry of new suppliers in the international pulp market and advances in communication technology are expected to have a negative impact on the price of pulp. In the absence of information about the long-run price of pulp, we chose to simulate the impact of a 10\% decrease in the price of pulp on the FMF regional economy. We use computable general equilibrium (CGE) approach to estimate both direct and indirect impacts of these changes in the forest sector.\textsuperscript{6} Furthermore, we estimate the impacts under two different scenarios. First, we assume that the economy’s wage rate is rigid. This Keynesian assumption may be appropriate under conditions where labor is heavily unionized.\textsuperscript{7} When wages are rigid, adjustments to the labor market are achieved largely through changes in employment of the forest sector. Second, we assume that the reduction in the demand for labor in the forest sector will put downward pressure on the wage rate. In this scenario, the adjustment in the labor market are achieved through changes in both employment and the wage rate.

The paper is organized as follows. A brief description of model specification is given in


\textsuperscript{6}Several studies have applied CGE models to examine changes in the forestry sector. See Daniel et al. 1991; Binkley et al. 1994; and Alavalapati et al. 1997 for examples.

\textsuperscript{7}Daniels et al. (1991) noted that skilled forest workers are less market responsive than workers in other sectors.
the next section. Simulation results are presented and discussed in the third section. A brief summary and conclusions is provided in the final section.

Model specification

For the purpose of this analysis, we divide the economy of the Foothills region into two sectors: forest products sector and the composite sector representing all other sectors in the economy. The forest sector uses labor, capital, and timber in its production process while the composite sector employs labor, capital, and land in its production process. It is assumed that the local economy is a price taker with respect to both sectors. This implies that prices of forest products and the composite sector are fixed in the outside markets and thus exogenous to the local economy. The computable general equilibrium model developed in this study is somewhat similar to that of Daniels et al. (1991). The technical description of the model is given in appendix 2.

Simulation results and discussion

The CGE model described in appendix 2 is used to simulate the impacts of changes in the AAC and price of pulp. Table 1 reports the results of a 6% decrease in the AAC in the FMF region. Estimates presented in the second column are derived under the assumption that the wage rate in the forest sector is responsive to changes in the demand for labor. On the other hand, results reported in the third column are derived under the assumption that the wage rate is rigid in the forest sector.

Results show that a 6% reduction in the AAC causes significant negative impacts on the

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8 We strongly encourage readers to refer Caves and Jones (1985) for details of model development. See Dervis et al. 1982 and Dixon et al. 1992 for extensive details on CGE models.
forest sector. The reduction in the AAC and associated decrease in the supply of timber is shown to cause a 2.606% increase in stumpage cost. The reduction in the supply of timber also causes a 3.026% ($15.27 million) reduction in the forestry output. As a result we notice 1.197% (14 jobs) and 2.471% ($6.94 million) decrease in the demand for labor and capital, respectively, in the forest sector. The decrease in the demand for labor and capital put downward pressure on their prices. As such we notice 2.395% and 0.189% reduction in the prices of labor and capital, respectively.

<table>
<thead>
<tr>
<th>Variables with base values</th>
<th>Wage flexible</th>
<th>Wage rigid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forestry sector output (F) = $504.7 M</td>
<td>-3.026</td>
<td>-4.274</td>
</tr>
<tr>
<td>Composite good output (C) = $2018.8 M</td>
<td>0.546</td>
<td>0.786</td>
</tr>
<tr>
<td>Forestry sector employment (L_F) = 1151</td>
<td>-1.197</td>
<td>-4.251</td>
</tr>
<tr>
<td>Composite sector employment (L_C) = 4604</td>
<td>0.210</td>
<td>0.302</td>
</tr>
<tr>
<td>Capital in forestry sector (K_F) = $281.22 M</td>
<td>-2.471</td>
<td>-3.561</td>
</tr>
<tr>
<td>Capital in composite sector (K_C) = $656 M</td>
<td>0.924</td>
<td>1.331</td>
</tr>
<tr>
<td>Total capital in the region (K) = $937 M</td>
<td>-0.094</td>
<td>-0.136</td>
</tr>
<tr>
<td>Wage in forestry sector (W_F) = $105.83 M</td>
<td>-2.395</td>
<td>no change</td>
</tr>
<tr>
<td>Wage in composite sector (W_C) = $317.49 M</td>
<td>0.280</td>
<td>0.403</td>
</tr>
<tr>
<td>Rent on capital (R)</td>
<td>-0.189</td>
<td>-0.272</td>
</tr>
<tr>
<td>Stumpage cost (S) = $117.64 M</td>
<td>2.606</td>
<td>0.651</td>
</tr>
<tr>
<td>Rent on land (V)</td>
<td>-0.175</td>
<td>-0.252</td>
</tr>
<tr>
<td>Household wage income (Y) = $423.3</td>
<td>-0.530</td>
<td>-0.533</td>
</tr>
</tbody>
</table>
The results reported in column 2 of Table 1 also show that a decrease in the AAC causes an expansion in other sectors of the economy. The output in the composite sector increases by 0.546% ($11.02 million). The decrease in the demand for capital in the forestry sector and associated drop in the rental rate of capital stimulate other sectors to use more capital. Depending upon the degree of substitutability among inputs, there will be changes in the demand for labor and land in other sectors. Results show that in other sectors the demand for labor and capital increases, respectively, by 0.21% (9 jobs) and 0.924 ($6.06 million). The increase in the demand for capital may have an upward pressure on the rental rate of capital. However, the results show that the increase in the demand for capital in other sectors are not shown to offset the decrease in the demand in the forestry sector. Therefore, we notice an overall decline in the demand which suggests that capital flows out of the region. Finally, results show that a 6% decrease in the AAC causes 0.530% ($2.24 million) decrease in households’ wage income. This implies that the increase in the demand for labor and wage in other sectors of the economy cannot offset the decrease in the demand and wage in the forest sector.

Column 3 of Table 1 presents economic impacts in response to 6% reduction in the AAC under wage rigid (WR) scenario. In this scenario, the negative impacts associated with reduction in the timber supply are much larger than those of WF scenario. For example, the decrease in the forestry output is 4.27% ($21.57 million). Correspondingly, the expansionary effects are also larger than those of WF scenario. As such there is not much difference in households’ wage income. With rigid wages, the decrease in the demand for labor associated with the decrease in the AAC will have no effect on the wage rate. In other words, labor market clears only through adjustments in the employment. Therefore, forest companies may have to layoff more people. In
WR scenario, 35 more people will be laid off in the forestry sector than will be in WF scenario.

Table 2 reports long-run economic impacts associated with a 10% decline from the base price of pulp. The output in the forestry sector drops by 11.224% ($56.64 million). The decrease in the output causes a decline in the demand for factors of production and a corresponding downward pressure on their prices. Therefore, we notice 8.359% (96 jobs) and 16.999% ($47.77 million) reduction in the demand for labor and capital in the forest sector and 16.719%, 1.3002% and 24.751% decline in wages, rental rate of capital, and stumpage cost, respectively, in the forest sector.

| Table 2. Economic impacts of 10% reduction in the price of pulp  
<p>| (Values are expressed in percentage changes) |</p>
<table>
<thead>
<tr>
<th>Variables with base values</th>
<th>Wage flexible</th>
<th>Wage rigid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forestry sector output ($F = $504.7 M)</td>
<td>-11.224</td>
<td>-19.931</td>
</tr>
<tr>
<td>Composite good output ($C = $2018.8 M)</td>
<td>3.756</td>
<td>5.436</td>
</tr>
<tr>
<td>Forestry sector employment ($L_F = 1151$)</td>
<td>-8.359</td>
<td>-29.674</td>
</tr>
<tr>
<td>Composite sector employment ($L_C = 4604$)</td>
<td>1.444</td>
<td>2.091</td>
</tr>
<tr>
<td>Capital in forestry sector ($K_F = $281.22 M)</td>
<td>-16.999</td>
<td>-24.603</td>
</tr>
<tr>
<td>Capital in composite sector ($K_C = $656 M)</td>
<td>6.356</td>
<td>9.200</td>
</tr>
<tr>
<td>Total capital in the region ($K = $937 M)</td>
<td>-0.650</td>
<td>-0.940</td>
</tr>
<tr>
<td>Wage in forestry sector ($W_F = $105.83 M)</td>
<td>-16.719</td>
<td>no change</td>
</tr>
<tr>
<td>Wage in composite sector ($W_C = $317.49 M)</td>
<td>1.926</td>
<td>2.787</td>
</tr>
<tr>
<td>Rent on capital ($R$)</td>
<td>-1.300</td>
<td>-1.881</td>
</tr>
<tr>
<td>Stumpage cost ($S = $117.64 M)</td>
<td>-24.751</td>
<td>-38.401</td>
</tr>
<tr>
<td>Rent on land ($V$)</td>
<td>-1.203</td>
<td>-1.742</td>
</tr>
<tr>
<td>Household wage income ($Y = $423.3)</td>
<td>-3.741</td>
<td>-3.759</td>
</tr>
</tbody>
</table>
Again we notice that an expansion in the rest economy with an increase in the output of other sectors by 3.756% ($75.82 million). The results show that the demand for labor and capital increases, respectively, by 1.444% and 6.356% in the rest of the economy. The increase in the demand for capital is not shown to offset the decrease in the demand in the forestry sector. Therefore, the overall rental rate of capital falls and some capital will flow out of the region. The net impact of the decline in the price of pulp on regional household wage income is negative 3.3741% which equals to $15.83 million. Column 3 of table 2 reports economic impacts when wages are rigid in the forestry sector. For reasons explained earlier, the negative impacts of price of decline are larger in WR scenario than those of WF scenario.

Summary and conclusions

The forest sector in the Foothills region is a significant contributor to the regional economy. Local communities are largely dependent on the forest sector for their livelihood. Therefore, any changes in the forest caused by institutional and/or market forces may have implications for the stability of local communities. In the future, two factors are thought to influence the forest sector in the Foothills region. First, the growing concerns for the environment and increasing demand for recreational activities may prompt public agencies to reduce the AAC in the region. Second, new suppliers from Latin America and South East Asia may cause an increase in global supply of pulp and advancements in communication technology may put downward pressure on the demand for pulp and consequently, on the price of pulp in the international market. In this study we examine the effect of a 6% decrease in the AAC and a 10% decline in the price of pulp on the economy of the Foothills region.
Not surprisingly, we found that both the reduction in AAC and price of pulp would have negative impacts on the Foothills economy. The output, employment, and wages in the forest sector will decline in response to the above shocks. The results indicate that there will be some expansion in the rest of the economy because some capital once employed in the forest sector will be available for other sectors at lower rental rates. However, the expansion in the rest of the economy is not shown to offset the reduction in the forest sector. Thus we notice a significant decline in the regional household income. We also examine the effect of the shocks mentioned above under two different assumptions about the labor market in the forestry sector. The shocks are shown to have greater negative impacts on the forest sector under WR scenario than those of WF scenario. In either scenario, the shocks are shown to cause significant negative impacts on the local economy. If community stability is a major objective to be pursued, public agencies should be aware of the consequences of the changes in the forest sector of the Foothills region.

We point out that the results estimated in this study should be read with a caution. For example, our model does not incorporate additional environmental benefits (if there are any) associated with the decrease in AAC. We assumed that capital rents, stumpage revenues, and land rents do not enter the household income equation. If stumpage revenues and capital rents are reinvested in the region, the impacts of these changes would be different. We also assume that the land withdrawn from timber production is not used in other sectors of the economy. It might well be the case that the increase in preserved areas may promote recreation and tourism activities in the region. Furthermore, we have developed the model based on our understanding of factor markets in the Foothills region. For example, we did not consider labor mobility between sectors. On the contrary, we assumed that workers who are laid off in the forestry sector
may move out of the region searching employment in the forestry sector elsewhere. Economic impacts may be less severe if labor is mobile between sectors within the region. Finally, we did not have accurate data on the rest of the economy. Based on our understanding of the region and discussions with knowledgeable in the community, we assigned values to some variables used in the model. Also, lack of information about other sectors in the Foothills region have prompted us to aggregate them and model as a composite sector. More disaggregation and the use of more accurate information will improve the quality of results. Work is currently underway to include more sectors in the model.
References


Appendix 1: Location of the Foothills Model Forest
Appendix 2: Technical details of the model

A. Commodity supply

We assume that both the forest and composite sectors are competitive and exhibit constant returns to scale. These assumptions facilitate finding changes in product supply relative to changes in factor shares. For example, equation (1) describes proportional changes in the supply of forest products as a function of share-weighted changes in the inputs employed.

\[ \hat{F} = \theta_{LF} \hat{L}_F + \theta_{KF} \hat{K}_F + \theta_{TF} \hat{T} \]  

(1)

\[ \hat{C} = \theta_{LC} \hat{L}_C + \theta_{KC} \hat{K}_C + \theta_{DC} \hat{D} \]  

(2)

Where F = forest products sector; C = composite sector; L = labor; K = capital; T = timber; D = land; and \( \theta_{ij} \) is the share of input i in the total cost of producing a unit output. The hats represent the proportional change in a variable. For example, \( \hat{F} = \frac{dF}{F} \).\(^9\)

B. Factor demands

The conditions of competition and constant returns to scale also allow us to write factor input demands as a function of changes in factor prices and output.

\[ \hat{L}_F = \theta_{LF} \sigma^F_L \hat{w}_{F} + \theta_{KF} \sigma^F_{LK} \hat{K} + \theta_{TF} \sigma^F_{LT} \hat{T} \]  

(3)

\[ \hat{K}_F = \theta_{LF} \sigma^F_{KL} \hat{w}_{F} + \theta_{KF} \sigma^F_{KK} \hat{K} + \theta_{TF} \sigma^F_{KT} \hat{T} \]  

(4)

\[ \hat{L}_C = \theta_{LC} \sigma^C_L \hat{w}_{C} + \theta_{KC} \sigma^C_{LK} \hat{K} + \theta_{DC} \sigma^C_{LD} \hat{D} \]  

(5)

\(^9\)The model in proportional change format will introduce errors associated with linearization. This type of model is correct only for infinitesimal changes in exogenous variables. See Hertel (1992) for details on linearized errors in CGE models.
\[ \dot{K}_C = \theta_{LC} \sigma_{KL} \dot{W}_C + \theta_{KC} \sigma_{KC} \dot{R} + \theta_{DC} \sigma_{KD} \dot{\hat{V}} + \ddot{C} \] (6)

Where \( W_F \) = wages in the forest sector; \( R = \) rental of capital; \( S = \) stumpage cost; \( V = \) rental of cost of land; \( \sigma_{ij} \)'s are Allen partial elasticities of substitution between factor inputs. Alternatively, one could substitute equations 1 and 2 for outputs and obtain expression for the proportional change in factor intensities as a function of changes in factor prices. The terms on the right-hand side of factor demand equations 3-6 reflect own-price and cross-price effects in addition to output effect. Restrictions on the share-weighted Allen partials permit one of the demand equations to be dropped (Hertel 1988) in each sector. In this case, the redundant demand equations for timber and land have been dropped.\(^{10}\) It should be noted from factor demand equations that two kinds of wage rates exist in the economy. Our discussions with knowledgeable individuals in the region indicated that wages in the forest sector may be much higher than in the rest of the economy.

**C. Zero pure profits**

The assumptions of perfect competition and constant returns to scale result in zero pure profit conditions. Zero pure profit conditions imply that factor payments exhaust the total revenue in each industry (Euler's theorem).

\[ \dot{P}_F = \theta_{LF} \dot{W}_F + \theta_{KF} \dot{R} + \theta_{TF} \dot{\hat{S}} \] (7)

\[ \dot{P}_C = \theta_{LC} \dot{W}_C + \theta_{KC} \dot{R} + \theta_{DC} \dot{\hat{V}} \] (8)

Where \( P_F \) and \( P_C \) are market prices of forest products and composite good.

**D. Regional income**

In resource dependent communities, where natural resource sector firms are not locally owned, it is not unrealistic to assume that households' income depends largely on regional employment and wage rate. Capital rents, stumpage revenues, and land rents may flow out of the

\(^{10}\)Daniel et al. (1992) show that in three factor case, equations of changes in factor inputs are linearly related and only two are required to solve the system.
Therefore, we specify regional household income as follows

$$\hat{Y} = \delta_F (\hat{L}_F + \hat{W}_F) + \delta_C (\hat{L}_C + \hat{W}_C)$$

(9)

**E. Factor supplies**

Unlike national economies, in small regional economies the supply of labor and capital may not be fixed. At the same time we do not agree with input-output modelers who assume that there will be unlimited supply of factors of productions. Based on our understanding of the local situations, we have specified that the supply of timber and land are fixed in supply while the supply of labor and capital are responsive to changes in their prices. Furthermore, we assume that some capital is mobile across sectors.

$$\hat{L}_F = \beta_F \hat{W}_F$$

(10)

$$\hat{L}_C = \beta_C \hat{W}_C$$

(11)

$$\hat{K} = \alpha_F \hat{K}_F + \alpha_C \hat{K}_C$$

(12)

$$\hat{K} = \gamma \hat{K}$$

(13)

Where $\beta_F$ and $\beta_C$ are supply elasticities of labor in the forest sector and the composite sector, respectively; $\alpha_F$ and $\alpha_C$ are share of each sector in total capital; and $\gamma$ is the supply elasticity of capital stock.

The model has 13 equations with 17 unknown variables. This requires to specify 4 variables as exogenous. The assumption we made earlier that both sectors are price takers suggests that market prices of output are exogenous. Tenure regulations in Alberta largely dictate annual supplies of timber in the forest sector. Therefore, we consider timber supply as an exogenous variable in our analysis. Since the supply of land in the composite sector is fixed, land can be considered as an exogenous variable. Finally, it should be noted that if wages are rigid in the forest sector, we may have to drop equation 10. The details of data for the variables specified in the model are given in Appendix 3.
Appendix 3: Variables and Their Data Sources

The data on the forestry sector are obtained from forest companies of the FMF region. Census statistics are the main data sources used in this study. Other sources include our knowledge of the Foothills region and discussions with knowledgeable individuals in the FMF region. Elasticity of substitution values used in the forestry sector are taken from Nautiyal and Singh (1986). For the composite sector, unitary elasticity values are employed.