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Predicting Socio-economic Impacts of Market and Policy Change on Forest-Dependent Communities: the Case of Petitcodiac, NB.

(A Modified Computable General Equilibrium Modeling Approach)

By*: Yigezu Y. Atnafe and
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March, 2002

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With regard to Part II of this report, our thanks goes to the village council and business community members in Petitcodiac who took a full day out of their schedules to participate in our meeting and help determine reasonable estimates for the modeling parameters.

Executive Summary:

- The forest industry is an important sector in all provinces in Canada, representing an average of 10% of total value added produced. Given the important role that this industry plays in the country, in-depth studies of the characteristic features of forest-based industries, their linkages with the rest of the economy, and the impacts of changes in policies on the society as a whole is believe to be instrumental in the process of ensuring sustainable development.

- In an effort to address these issues, this report investigates the socio-economic impacts of market and policy changes on a forest dependent community in the region. A computable general equilibrium model is used to facilitate this analysis.

- Calibration of the CGE model requires estimation of a number of industry-level elasticity measures. Hence, Part I of this report characterizes the production structure of forest based industries in the New Brunswick region. By using the Saw and Planning Mill industry data collected by Statistics Canada for the province (as a typical forest industry sector in the case study region) the price and factor substitution elasticities of production have been estimated.

- Looking at the particular elasticity relationships, findings indicate that: (i) labour can more easily be substituted by capital than capital can be substituted by labour; (ii) it is easier to substitute material by capital and labour than capital and labour by material; (iii) the substitution elasticity of capital by material is greater than that of labour by material; and (iv) energy can substitute material, but material cannot substitute energy (rather it complements it). Overall, it is found that increasing returns exist in the Saw and Planning Mill industry.

- The above-mentioned results of the provincial Saw and Planning Mill production structures are used in Part II of this report to customize and calibrate a CGE model to the community of Petitcodiac, located in the Fundy Model Forest in

Southern New Brunswick. This community has been chosen because it is thought to represent a mid-range level of forest dependence in the region. By building and calibrating a two-sector computable general equilibrium (CGE) model for Petitcodiac, we can predict future economic impacts of changes in forest product prices and the annual allowable cut (AAC).

- Simulations have been conducted for a 1% reduction in the world price of forest sector products and a reduction in the Annual Allowable Cut (AAC). In general, we observe that both of these changes will have negative impacts on the economy. Particularly, the two changes tend to reduce the total GDP of Petitcodiac ($2.05 million and $0.8 million respectively), reduce households' income (by 0.3% and 0.2% respectively), and negatively affect the factors of production; significantly decreasing the employment of labor (by 0.6% and 0.2% respectively) and land (by 0.7% and 0.3% respectively).

- Interestingly, the reduction in the AAC causes other sectors in the economy to expand (by 0.0007% in aggregate). This occurs mainly from the positive effect it has on capital demand. More specifically, the demand for capital in the composite sector increases (by 0.02%) and hence more capital flows from outside of the community into the Petitcodiac economy. Although labour and land employment tend to decrease (by 0.1% and 0.3% respectively), the capital intensive nature of the 'other' sectors of the economy result in the overall expansion of this sector. These findings are similar to other such studies conducted in various regions of North America.

- Overall, it is believed that this modeling framework provides the basis to effectively predict socio-economic impacts of changes in forest prices and policies in any forest-dependant community. Such information will be useful to industry, government, and other groups concerned about how to effectively prepare for expected future developments in the forest product industry.

INTRODUCTION

Forest resources in Canada provide many benefits to Canadians. It constitutes about 10% of the value added in the economy and it is one of the most important economic contributors in terms of jobs and income for many communities (Kant and Nautiyal, 1997). For instance, in New Brunswick, the forest sector employs 5.83% of total labor force in the province. In some communities the forest dependency ratio is above 20% (MacFarlane et al., 1998). Moreover, 6.44% of total personal employment income in the region is derived from this sector.

In the Maritimes, the forest industry produces over $2.5 billion in exports annually, and is the largest single industrial sector. Although the Maritimes account for only 2.5% of Canada's forested land, it produces about 7% of the country's total value of forest exports. It is also believed that there is a relatively intense utilization of the forest resource with in the region which is due mostly to the demand for raw material by the 13 pulp and paper mills and approximately 500 sawmills and other wood manufacturing facilities in the region (MacFarlane et al, 1998).

Uncertainty with respect to the fate of the forest sector, and in particular to forest-dependent communities, has grown in recent years for a variety of reasons. The major causes of uncertainty are: (i) the expected decrease in world price due to increase in global supply of the forest sector products from Latin America and South East Asia. These suppliers may have a comparative advantage over producers in the Maritime regions such as the Fundy Model Forest (FMF) especially in terms of the production of pulp. The competitive advantage is created from such factors as technological advances in pulping technology and regional differences in timber growth rates, rotation age, labor costs and environmental regulations; (ii) continual technological advancement in the communications technology such as business advertising through the internet, TV and radio and electronic communications. These developments are projected to have negative impact on the global demand for paper (and thus timber demand); and (iii) increasing concern for environmental quality. This may call for government intervention to reduce the Annual Allowable Cut (AAC) thereby negatively impacting forest dependent communities (Alavalapati 1999).

Given the important role that the forest sector plays in the Maritime provinces, in-depth studies of the characteristic features of forest-based industries, their linkages with the rest of the economy, and the impacts of changes in policies on the society as a whole is believe to be instrumental in the process of ensuring sustainable development. Particularly, the study of the effect of changes in prices of forest sector products and factors of production (such as the AAC) would help to make predictions about the future development path of the sector and the likely impact on the overall economy. In an effort to address these issues, this report will investigate the socio-economic impacts of market and policy changes on a forest dependent community in the region.

The case study chosen in this report is the community of Petitcodiac, located in the Fundy Model Forest in Southern New Brunswick. This community was chosen because it is thought to represent a mid-range level of forest dependence in the region. By building and calibrating a two-sector computable general equilibrium (CGE) model for Petitcodiac, we will be in the position to predict future economic impacts of changes in such factors as forest product prices and the annual allowable cut (AAC).

The calibration of our CGE model requires estimation of a number of industry-level elasticity measures. In a recent study of the production structure in the Canadian forest industry, Lantz (1995) has shown that the elasticities of factor substitution, for example, vary substantially across regions in Canada. Hence, the first task in this report will be to characterize the production structure of forest based industries in the New Brunswick region. By using the Saw and Planning Mill industry data collected by Statistics Canada for the province (as a typical forest industry sector in the case study region) the price and factor substitution elasticities of production is estimated. Within these initial calculations, a new and more precise approach for the calculation of cost and price of capital over a given production year is introduced. The elasticity results provided in this report are expected to have high significance in terms of providing important industrial structure information to both Saw and Planning Mill managers and forest policy decision-makers in the region.

The second task of this report is to use the elasticity estimates, along with other information gathered from statistical agencies and community council/business members, to customize and calibrate a CGE model to the community of Petitcodiac. Since the community relies on purchasing and selling goods and services outside of the immediate region, it is necessary to augment the basic CGE model (which initially assumes a closed system) to account for this fact. This augmentation along with other modifications, such as allowing for unemployment (the basic model assumes full employment), is thought to better address the real-world economic conditions of the community. Simulations are then conducted that predict the income, employment, and output impacts to the community from negative shocks to the price of timber and to the AAC. This information will be useful to industry, government, and other groups concerned about changes in the forest industry.

The overall organization of this report is as follows. In Part I, the econometric work aimed at characterizing the production structure of the forest sector (estimating the price and substitution elasticities required for the CGE modeling work) will be presented. Then, in Part II, the CGE modeling work for assessing the socio-economic impacts of market and policy changes on the community of Petitcodiac will be presented. Each part will have separate sections for literature review, data sources, empirical evidence, and policy implications. The last section reviews the overall findings and concludes the study.

Part I: Characterization of Production Structures

I.I Review of the Literature

The application of econometric models designed to provide empirical measures of industrial structure parameters has become more pronounced in recent years. This trend was inspired by the popularization of generalized flexible functional forms and by recognition of the suitability of duality theory for applied production analysis. More specifically, it has become well known that an industry's production structure can be studied empirically using either a production function or a cost function (the latter being the dual).[1]

The choice between using one of the two techniques mentioned above should be made on statistical and case-specific grounds. Direct estimation of the production function is more convincing in the case of endogenously determined input prices and output levels, however, in the case of exogenous input prices and output levels, the cost function estimation is preferred (Christensen and Greene, 1976).[2] This latter methodology is explored more fully below.

For given inputs of capital (*K*), labour (*L*), energy (*E*), materials (*M*) and output levels (*Y*) all the empirically relevant information contained in a well behaved production possibility set, X, can be summarized by a long-run cost function as follows:

$$(1) \qquad C(r, w, e, m, Y, z) = MIN_{KLEM}\ (rK+wL+eE+mM)$$

where $(K, L, E, M, Y, z) \in X$, and $r, w, e,$ and m are the prices of capital, labour, energy and materials respectively(Martinello, 1985).

[1] It has been noted in the economic literature that when the objective of the firm is to minimize costs, a duality exists between the cost function and the production function (Singh and Nautiyal, 1985). Varian (1978) has shown that the cost function contains all the economic information of the production function and vice versa.

In most of the forest industry studies that employ the cost function to evaluate production structures, it seems that there is no uniformity of results in terms of factor substitution estimates. For instance, Lantz (1995) found that in some provinces (e.g. the Prairie and British Columbia), the own price elasticities of labour and capital are negative in most forest industries (as is their theoretical expectations) while they are positive in the Atlantic and Quebec provinces. As for cross partial elasticities, capital and labour (and capital and energy) were found to be complementary for more regions in the Pulp and Paper industry relative to the Wood industry. While labour and energy are substitutable in all regions of the Wood industry, they are complementary for the British Columbia and the Atlantic regions' Pulp and Paper industries. Meil and Nautiyal (1988), on the other hand, found that all intra-regional industrial sectors demonstrate own-price substitution elasticities with the expected negative sign, with energy and material being the most and least sensitive to their respective own prices. Energy has been found to exhibit a higher degree of complementarity with material in Ontario than in Quebec.[3]

I.II. Methodology

Due to the fact that at least the Crown owns 50% of the forestland in New Brunswick, the output levels of the forest industries in the province can be assumed to be quasi-fixed (and determined largely by government regulations). Hence the cost function approach described above can be used as a credible technique to obtain the long-run equilibrium path of forest industry sectors in New Brunswick.[4] Below, we present the basic structure of the cost function estimation procedure, and the resulting elasticity measures.

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[2] When output levels and input prices can plausibly be assumed to be exogenous (the latter is more likely the case), it is preferable to employ the cost function in which the input prices are the regressors rather than a production function in which input quantities are the right-hand variables (Berndt and Wood, 1974).

[3] In all such studies, increasing returns to scale has been found (to differing degrees) for each Canadian forest industry region and sector. This indicates that all forest industry sectors in Canada tend to be producing a sub-optimally low output levels, and that by increasing their scale of production, their revenues would grow at a faster rate than their production costs. Capacity and other such constraints, however, may be limiting expansion opportunities.

[4] It is acknowledged here that New Brunswick has a larger proportion of privately-owned land than the Canadian average. As a result, some may argue that a profit-function approach should be considered. However, data requirements seriously limit this line of inquiry.

I.II.i The Transcendental Logarithmic (Translog) Cost Function

Among all homogenous, non-decreasing and concave functions of factor prices, which qualify as legitimate cost functions, many studies investigating the industrial production structures (Banskota et al., 1985; Lantz, 1995; Kant and Nautiyal, 1997; Singh and Nautiyal, 1985; Martinello, 1985; Meil and Nautiyal, 1988) have chosen the Transcendental Logarithmic (Translog) cost function. The main advantage in choosing the Translog cost function is that it can serve as a second-order approximation to an arbitrary twice differentiable, well behaved cost function (Varian, 1978). Moreover, the production function parameters can be uniquely recovered from estimation of the demand equations derived from the dual cost function (Berndt 1991). One can then effectively draw inferences about all principal economic effects without imposing any restrictive assumptions on the underlying production structure (Viton, 1981, cited in Singh and Nautiyal, 1985). The general form of the translog cost function for the four inputs (capital, K, labour, L, energy, E, and materials, M) and output levels, Y, can be expressed as follows:

$$(2) \qquad Ln\, C^* = ln\alpha_0 + \varepsilon_y\, lnY + ½\, \varepsilon_{yy}\, [lnY]^2 + \varepsilon_{yk}\, lnY\, lnP_k + \varepsilon_{yl}\, lnY\, lnP_l$$
$$+ \varepsilon_{ye}\, lnY\, lnP_e + \varepsilon_{ym}\, lnY\, lnP_m + \alpha_k\, lnP_k + \alpha_l\, lnP_l + \alpha_e\, lnP_e + \alpha_m\, lnP_m$$
$$+ ½\, \beta_{kk}\, [lnP_k]^2 + \beta_{kl}\, lnP_k\, lnP_l + \beta_{ke}\, lnP_k\, lnP_e + \beta_{km}\, lnP_k\, lnP_m + ½\, \beta_{ll}\, [lnP_l]^2$$
$$+ \beta_{le}\, lnP_l\, lnP_e + \beta_{lm}\, lnP_l\, lnP_m + ½\beta_{ee}[lnP_e]^2 + \beta_{em}\, lnP_e lnP_m + ½\, \beta_{mm}[lnP_m]^2$$
$$+ \theta_t\, lnT + \theta_{tt}\, [lnT]^2 + \theta_{tk}\, lnT\, lnP_k + \theta_{tl}\, lnT\, lnP_l + \theta_{te} lnT\, lnP_e + \theta_{tm} lnT\, lnPm$$

where C^* is the long-run, least cost of producing output level *Y, T* is an indictor of technological progress, the P_i*'s* are the respective prices of input i's and the α*s,* β*s,* ε*s,* and θs are the coefficients to be estimated.

Some of the parameters of the cost function have no clear and direct interpretation as they are estimates of the gradient and Hessian for the logarithms of the true underlying cost functions (DeBorger and Buongorno, 1985).

Although the general structural framework is identical, previous studies tend to differ in the details of the variables they include in the cost functions. For example Lantz (1995) and Singh and Nautiyal (1985) do not include in their models the cross product of the technology coefficient and the respective prices. Kant and Nautiyal (1997) and Martinello (1985), on the other hand, do include these specifications. In the current report, we have chosen to include the cross products of the technology coefficient and the respective input prices because, as Lantz (1995) has shown, the coefficient of technical change (T) was significant at the 99% level and its inclusion in to the model has increased the goodness of fit. However, the small R^2 values in Lantz (1995)'s cost share equations are likely due to the omission of the input mix (relative quantities of inputs) that are captured by the technology coefficient in the Cost function (for technology obviously determines not only the cost but also the cost share of each one of the inputs). Hence, the additional elements in our cost function are systematically designed (as in Kant and Nautiyal, 1997) in order for the technology coefficient to appear on the cost share functions as well. The cost share functions, S_i, which are also the cost-minimizing demands for the respective inputs, can be derived as follows:

$$(3) \qquad S_i = \partial LnC/\partial P_i = (\partial C/\partial P_i)\,(P_i/C) = P_iX_i/C$$

The respective share equations will therefore be as follows:

$$(4) \qquad S_k = \alpha_k + \varepsilon_{yk}\, lnY + \beta_{kk}\, lnP_k + \beta_{kl}\, lnP_l + \beta_{ke}\, lnP_e + \beta_{km}\, lnP_m + \theta_{tk}\, lnT$$

$$(5) \qquad S_l = \alpha_l + \varepsilon_{yl}\, lnY + \beta_{kl}\, lnP_k + \beta_{ll}\, lnP_l + \beta_{le}\, lnP_e + \beta_{lm}\, lnP_m + \theta_{tl}\, lnT$$

$$(6) \qquad S_e = \alpha_e + \varepsilon_{ye}\, lnY + \beta_{ke}\, lnP_k + \beta_{le}\, lnP_l + \beta_{ee}\, lnP_e + \beta_{em}\, lnP_m + \theta_{te}\, lnT$$

$$(7) \qquad S_m = \alpha_m + \varepsilon_{ym}\, lnY + \beta_{km}\, lnP_k + \beta_{lm}\, lnP_l + \beta_{em}\, lnP_e + \beta_{mm}\, lnP_m + \theta_{tm}\, lnT$$

To correspond with a well-behaved production function, a cost function must be homogeneous of degree one in the input prices. This requires the establishment of the following identities:

$$(8) \qquad \alpha_k + \alpha_l + \alpha_e + \alpha_m = 1$$

$$(9) \quad \beta_{kk} + \beta_{kl} + \beta_{ke} + \beta_{km} = 0$$

$$(10) \quad \beta_{kl} + \beta_{ll} + \beta_{le} + \beta_{lm} = 0$$

$$(11) \quad \beta_{ek} + \beta_{el} + \beta_{ee} + \beta_{em} = 0$$

$$(12) \quad \beta_{mk} + \beta_{ml} + \beta_{me} + \beta_{mm} = 0$$

$$(13) \quad \varepsilon_{yk} + \varepsilon_{yl} + \varepsilon_{ye} + \varepsilon_{ym} = 0$$

$$(14) \quad \theta_{tk} + \theta_{tl} + \theta_{te} + \theta_{tm} = 0$$

From defining the cost shares as $S_i = P_iX_i/C$, it follows that the sum of inputs must add-up to unity, i.e., $S_k + S_l + S_e + S_m = 1$. This adding-up condition of the share equations has important implications for econometric estimation. As only three out of the four cost share equations are linearly independent, the above equations cannot be estimated jointly, and hence, one of them has to be dropped before estimation in order to avoid singularity of the variance-covariance matrix (Berndt, 1991). To do this, the prices in all four remaining equations will have to be divided by the price of the input being dropped, which will eliminate all the entries of the input price from the remaining equations. All of the eliminated parameters can later be recovered from these identities.

Stochastic estimation requires that disturbance terms be appended to the cost function and the remaining three cost share equations. The disturbances capture the errors associated with the failure of maintaining cost-minimizing levels of inputs. Input price changes cause both the total cost and cost shares to change, hence the disturbance in each equation is affected. The disturbance terms in the equations are assumed to be normally distributed with a zero mean and differing finite variance, and are contemporaneously correlated across equations (Meil and Nautiyal, 1988).

As long as the Maximum Likelihood estimation procedures are employed on the remaining (k-1) share equations, all parameter estimates and estimated standard errors will be invariant to the choice of which share equation is dropped (Berndt, 1991). Hence, we have arbitrarily dropped the energy cost share and divided the prices in all the remaining equations with the price of energy (P_e). The final system of equations to be estimated will then be as follows:

$$\begin{aligned}(15)\quad \text{Ln C} = {} & ln\alpha_0 + \varepsilon_y\, lnY + \tfrac{1}{2}\,\varepsilon_{yy}\,[lnY]^2 + \varepsilon_{yk}\, lnY\, ln(P_k/P_e) + \varepsilon_{yl}\, lnY\, ln(P_l/P_e) \\ & + \varepsilon_{ym}\, lnY\, ln(P_m/P_e) + \alpha_k\, ln(P_k/P_e) + \alpha_l\, ln(P_l/P_e) + \alpha_m\, ln(P_m/P_e) + \tfrac{1}{2}\,\beta_{kk}\,[ln(P_k/P_e)]^2 \\ & + \beta_{kl}\, ln(P_k/P_e)\, ln(P_l/P_e) + \beta_{km}\, ln(P_k/P_e)\, ln(P_m/P_e) + \tfrac{1}{2}\,\beta_{ll}\,[ln(P_l/P_e)]^2 \\ & + \beta_{lm}\, ln(P_l/P_e)\, ln(P_m/P_e) + \tfrac{1}{2}\,\beta_{mm}\,[ln(P_m/P_e)]^2 + \theta_t\, lnT + \theta_{tt}\,[lnT]^2 \\ & + \theta_{tk}\, lnT\, ln(P_k/P_e) + \theta_{tl}\, lnT\, ln(P_l/P_e) + \theta_{tm}\, lnT\, ln(P_m/P_e)\end{aligned}$$

$$(16)\quad S_k = \alpha_k + \varepsilon_{yk}\, lnY + \beta_{kk}\, ln(P_k/P_e) + \beta_{kl}\, ln(P_l/P_e) + \beta_{km}\, ln(P_m/P_e) + \theta_{tk}\, lnT + \mu_k$$

$$(17)\quad S_l = \alpha_l + \varepsilon_{yl}\, lnY + \beta_{kl}\, ln(P_k/P_e) + \beta_{ll}\, ln(P_l/P_e) + \beta_{lm}\, ln(P_m/P_e) + \theta_{tl}\, lnT + \mu_l$$

$$(18)\quad S_m = \alpha_m + \varepsilon_{ym}\, lnY + \beta_{km}\, ln(P_k/P_e) + \beta_{lm}\, ln(P_l/P_e) + \beta_{mm} ln(P_m/P_e) + \theta_{tm} lnT + \mu_m$$

It is possible to estimate the parameters of the cost function using ordinary least squares (OLS), but this would neglect the information shared between the cost equation and the share equations. An alternative estimation procedure is to estimate the cost shares as a multivariate regression system. However, several parameters, which are found in the cost function, only would not be estimated. Hence, the optimal procedure is to jointly estimate the cost and cost share equations as a multivariate regression system using the iterative Zellner estimation procedure until convergence of the estimated coefficients and residual covariance matrix is attained (Berndt and Wood, 1974). Such a procedure not only effectively reduces possible multicollinearity among regressors of the cost function and the cost share equations (by giving additional information contained in the share equations), but also has the effect of adding many additional degrees of freedom without adding any unrestricted regression coefficients (Singh and Nautiyal, 1985). Therefore, in this report, the iterative Zellner method will be used to estimate the above system of four equations.[5]

[5] For a certain cost function to be well behaved, it has to be concave in the input prices, and its input demand functions should strictly be positive. The positivity condition is satisfied if the fitted cost shares of all the inputs are positive (Berndt and Wood, 1975).

I.II.ii Structure of Production

The translog cost function does not constrain the structure of production to be homothetic, nor does it impose restrictions on the elasticities of substitution. However, these restrictions can be tested statistically. A cost function corresponds to homothetic production structure if and only if the cost function can be written as a separable function in output and factor prices (Christensen and Greene 1976). A homothetic production structure is further restricted to be homogenous if and only if the elasticity of cost with respect to output is constant. The elasticities of substitution can all be restricted to unity by eliminating the second-order terms in the prices from the translog cost function. Thus, for the translog cost function, the homotheticity, homogeneity and unitary elasticity restrictions are: $\varepsilon_{yi} = 0$, $(\varepsilon_{yi} = 0$ & $\varepsilon_{yy} = 0)$ and $\varepsilon_{ij} =0$ respectively, where $i,j = K, L, E, M$.

The hypotheses of homothticity, homogeneity, and unitary elasticity, can be tested using the likelihood ratio, which is equal to double the difference between the logarithmic values of the likelihood function of the unrestricted and the restricted models (Kant and Nautiyal, 1997). This ratio has a χ^2 (Chi-square) distribution with degrees of freedom equal to the number of independent restrictions imposed.

I.II.iii Elasticities of Factor Substitution

It is expected that the elasticities of factor substitution and their associated price elasticities will vary with the relative size of share of each input in total cost. Many studies (Christensen and Greene, 1976, Banskota et al, 1985, Lantz, 1995, Kant and Nautiyal, 1997, Singh and Nautiyal, 1985, Martinello, 1985, Meil and Nautiyal, 1988) have used the Allen elasticities of Substitution to estimate how effectively one factor could be substituted for the other. Uzwa (1962), cited in Berndt (1991), has shown that the Allen Partial Elasticities of Substitution (AES) and price elasticities of demand between inputs *i* and *j* can respectively be expressed as:

$$(19) \qquad e_{ij}= (\beta_{ij} + (S_i *S_j))/(S_i * S_j), \text{ for } i \neq j \text{ and}$$

(20) $e_{ii}= (\beta_{ii} + (S_i^2-S_i))/S_i^2$ and

(21) $\in_{ij}= (\beta_{ij} + (S_i *S_j))/S_i$ for $i \neq j$ and

(22) $\in_{ij} = (\beta_{ii} + (S_i^2-S_i))/S_i$

It is possible that some of the estimates of the coefficients in the cost function could turn out to be insignificant, thus limiting the confidence in the elasticity estimates. Fortunately however, Anderson & Thursby (1986) have shown that we can compute confidence intervals for the Allen Elasticities of Substitution, AES, (with which we can attach some degree of confidence to our estimates) as follows:

(23) $\sigma_{ij} \pm A/B$

where $\sigma_{ij} = 1+ (\beta_{ij}/\bar{I}_i\bar{I}_j)$, $A= Z_\alpha (V^2\sigma^2_{ij} - 2VS_\beta r_1\sigma_{ij} + S^2{}_\beta)^{1/2}$, $B= \bar{I}_i\bar{I}_j+r_{ij}S_iS_j/N$, $\bar{I}_i$, $\bar{I}_j$, S_i, S_j, are the mean and standard deviation of the sample cost shares i and j, Z_α is the critical value from the standard normal distribution $V^2 = (\bar{I}^2{}_i\, S^2{}_j + \bar{I}^2{}_j\, S^2{}_i + 2\, \bar{I}_i\, \bar{I}_j\, S_i\, S_j\, r_{ij} + (1+ r_{ij})\, S^2{}_i\, S^2{}_j\,)/N$, where N is the sample size, r_{ij} is the sample correlation between share i and share j, S_β is the estimated standard error of β_{ij}, r_1 is the sample correlation between β_{ij} and $\bar{I}_i\bar{I}_j$. Anderson and Thursby (1986) suggest that r_1 should be set to zero and hence the confidence interval reduces to $\sigma_{ij} \pm (Z_\alpha (V^2\sigma^2{}_{ij} + S^2{}_\beta)^{1/2})/(\bar{I}_i\bar{I}_j + (r_{ij}\, S_i\, S_j)/N)$.

Kant and Nautiyal (1997) have used an alternative measure of elasticity of substitution between factors called Morishma Elasticity of Substitution (MES). The MES measures the ease of substitution, and it is a sufficient statistic for assessing the effects of changes in price or quantity ratios on relative factor shares. The basic difference between the Allen (AES) and Morishma (MES) elasticities is that the AES is always symmetric (i.e, the elasticity of substitution of input *i* by input *j* is the same as the elasticity of substitution of input *j* by input *i*), while this is not the case with MES (Blackorby and Russell 1989). Blackorby and Russell (1989) have shown that the Morishma elasticity of substitution can be calculated as:

$$(24) \quad M_{ij} = \epsilon_{ji} - \epsilon_{ii}$$

$$(25) \quad M_{ji} = \epsilon_{ij} - \epsilon_{jj}$$

Given the complex nature of many production structures (with more than two inputs), a strong case can be made for using the MES estimate (over the AES estimate) as the most appropriate measure. As such, although this report will present both estimates, more emphasis will be given to the interpretation of the MES estimates.

I.II.iv Economies of Scale

A final statistic presented in this report on the production structure of the New Brunswick forest industry is that of economies of scale. Economies of scale are usually defined in terms of the relative increase in output resulting from a proportional increase in all inputs. Hanoch (1975), cited in Christensen and Greene (1976), has pointed out that it is more appropriate to represent scale economies by the relationship between total cost and output along the expansion path – where input prices are constant and costs are minimized at every level of output. Hence, a natural way to express the extent of scale economies is as the proportional change in cost resulting from a small proportional change in the level of output, or the elasticity of total cost with respect to out put. This can be computed (Christensen and Greene, 1976) as:

$$\begin{aligned}(26) \quad SCE &= 1 - (\partial LnC/\partial LnY) \\ &= 1 - (\varepsilon_{y} + \varepsilon_{yy} LnY + \varepsilon_{yk} LnPk + \varepsilon_{yl} LnPl + \varepsilon_{ym} LnPm + \varepsilon_{ye} LnPe)\end{aligned}$$

I.III Data Sources and Organization

As mentioned in the introduction, the case study chosen in this report is the community of Petitcodiac. Within this community, the major forestry sector (representing over 80% of the forest production value) is the lumber industry (Personal Communication, 2002). As such, the data collected in this section to estimate production structure elasticities will relate only to the New Brunswick Saw and Planning Mill sector.

The main data sources used in the analysis of the New Brunswick Saw and Planning Mill production structure include annual data from the Canadian Forestry Statistics publications by Statistics Canada (Stats. Can. 1965-1995) and their ESTAT database (ESTAT, 2002). Annual data for volume of production of timber in the Saw and Planning Mills in New Brunswick (in m^3) were obtained from ESTAT databases Table No. 303-0009. The number of employees and costs of wages and salaries, energy and material were obtained from Stats. Can. (1965-1995), Cat. No. 25-202. The cost of fuel and electricity represent cost of energy while aggregate data on cost of materials and supplies that include not only the cost of wood but also of other supplies is incorporated. The wage index has been computed from the annual average wage, which is the ratio of wages and salaries and number of employees.

Price of wood as an input in the saw and planning mills are taken from ESTAT (2002), Table No. 330-0001 (1,2). However, the data was not available for the period prior to 1981. As such, we have fitted the time trend for the price index of timber/lumber (which were taken from the national Timber/lumber price indices in ESTAT (2002), Table 329-0001) and that of wood as raw material for the period 1981-1995. Both exhibit similar trends over the years (see graphs below). Therefore, the trend in the price index of timber/lumber for the period prior to 1981 can be used to estimate wood prices. The formula used is: *Price of wood (t-1) = (Price of timber (t-1) x Price of wood (t)) / Price of timber (t)*.

Electric power is the major source of energy in the Saw and Planning mills, while other possible sources of energy, like oil, are insignificant. Hence, we have taken the price index of electricity for non-residential use in New Brunswick to represent the overall price index of energy. The price indices of electricity (for the period 1973-1995) have been taken from Stats Can. (2001), Cat. No. 62-011 (and converted into the same base year). As there was no data for the years before 1973, we fitted the time trend of this variable for the period 1973-1995 and findings indicated a more or less linear trend. This is especially true for the period 1973-1976. Hence, we have used the average annual percentage growth in the price index of electricity for the adjacent three years (1973-1976, which is about 15.74%) to estimate the price index for the years prior to 1973.

Researchers have used a variety of techniques to calculate the cost and price of capital in a given production year. However, we believe that all these attempts tend to fall short of capturing the true values. As such, we have decided to develop a more precise way of calculating an industry-specific cost and price of capital. We have summarized the two most common approaches used by others and the new technique forwarded by us in Table 1.

Using our approach to develop capital prices over time, it is found that net reported profit for some years is negative (as others have also found using their specifications). As such, the computed prices of capital in those years turn out to be negative. Following Singh & Nautiyal (1995)'s procedures, the price of capital variable can be smoothened by fitting a least-squares trend. A graphical presentation of the smoothing is presented in Figures 1 and 2.

From Figures 1 and 2, it is evident that the price of capital, using the new approach, has shown a decreasing trend. Under the old approach, on the other hand, the capital price exhibits an increasing trend. This indicates that the estimates of the cost and cost share functions will be entirely different when calculated using the two methods. We will only present estimation results using our new approach (for the reasons explained in Table 1).

Table 1. Capital Cost and Price Calculation Alternatives

Reference	Approach Used to calculate		
	Expenditure on Capital	Price of Capital	Remarks
Singh & Nautiyal (1986), Meil & Nautiyal (1988), Kant & Nautiyal (1997) and others	Capital and repair expenditures during the year under consideration	Approximated by returns to Capital, i.e., the ratio of Net Profit and Net Fixed Assets	In the computation of cost of capital, capital and repair expenditure doesn't tell that part of capital that has been fully consumed in the specific year's production. Moreover, returns to capital doesn't explicitly single out that portion of profit that is attributable to capital. Considering a onetime investment, the denominator will always show a decreasing trend, which is likely to result in an increasing trend in the price of capital, while that may not actually be the case.
Banskota et al. (1985)	Capital and repair expenditures during the year under consideration (?)	(Depreciation + Maintenance+ Repair)/Capital Stock	This approach also uses Capital stock as the denominator, which is inappropriate for not all the capital stock is being fully consumed in a given production year.
Our new approach	TCC = D+ R &M+NIF, Where: TCC= Total Capital Cost, D= Cost of Depreciation, R&M* is repair and maintenance, (NIF)= Nominal Income Forgone is the product of nominal interest rate and the value of Net Fixed Assets = r x NFA The rationale behind using the Nominal Income Forgone is to account for the cost of holding that part of Fixed Assets, which actually is not consumed in the current year of production, while it actually has to be included as part of the current year's expenditure for the production process necessitates it to be held. Hence, we have used the opportunity cost approach to arrive at an approximate value.	Price of Capital is then given by the ratio of the contribution (share) of capital in Net Industrial Profit (NIP) and Total Capital Expenditure, i.e., S^c_π / TCC = $(\pi /(\text{TIE} + \text{NIF}))$	Where, S^c_π is the contribution (share) of capital in Net Industrial Profit (NIP), given by: (TCC/TIE+NIF) x π, where, TIE is Total Industrial Expenditure and π is Net Industrial Profit.

*/ Repair and maintenance refers to the cost incurred to replace fast moving items, which are not accounted for by depreciation cost.

Fig. 1   Actual and Smoothened Prices of Capital (computed using the new method)

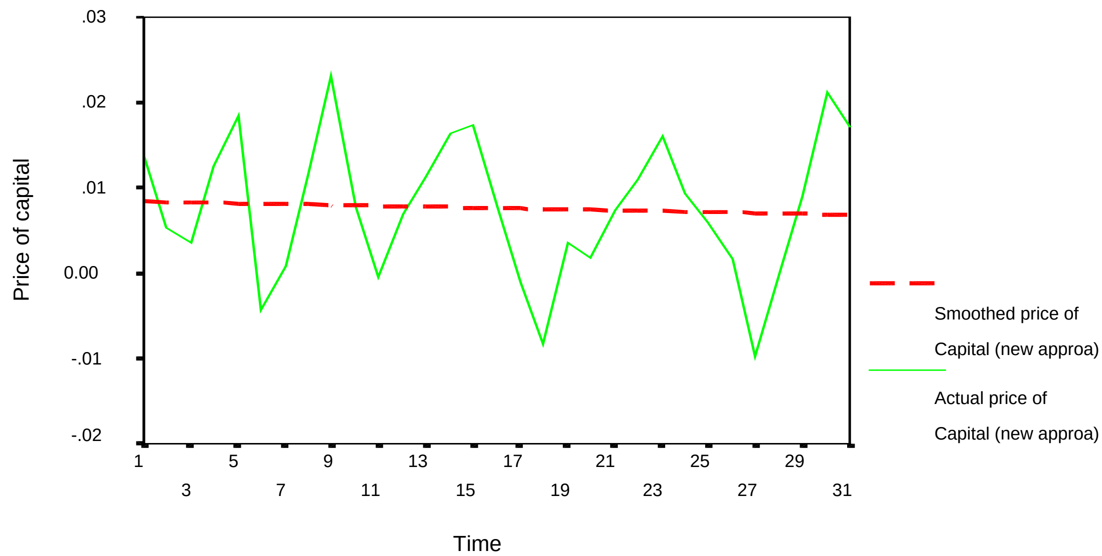
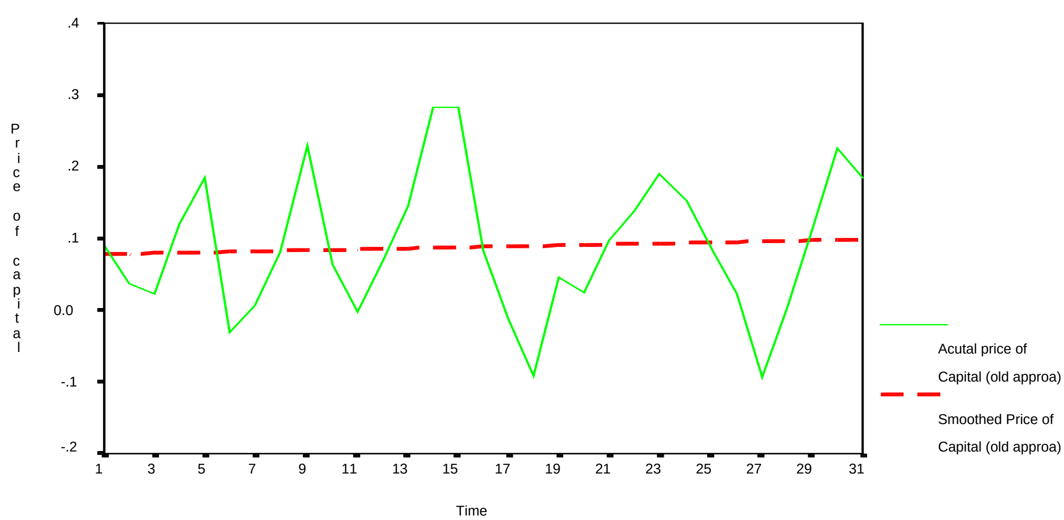


Fig. 2   Actual and Smoothened Prices of Capital (computed using the old method)



I.IV Empirical Results and Policy Implications

I.IV.i Structure of Production

In order to determine the production structure of the Saw and Planning mills in New Brunswick, we have estimated six models (denoted as models A to F). Model A is the unrestricted model and models B, C, D, E and F are respectively the models on which the homotheticity, homogeneity, unitary elasticity of substitution, joint homotheticity and unitary elasticity of substitution, and joint homogeneity and unitary elasticity of substitution restrictions have been imposed. Table 2 reports the results.

Table 2 Homotheticity, Homogeneity and Unitary Elasticity of Substitution Tests

	Model A	Model B	Model C	Model D	Model E	Model F
No. of restrictions	0	3	4	6	9	10
Log of likelihood function	311.109	276.95	275.79	264.37	243.75	279.68
Calculated χ^2	NA	68.32*	70.63*	93.49*	134.72*	62.87*
Critical χ^2 (1%)	NA	11.34	13.28	16.81	21.96	23.21

*/ Significant at 1% level of significance

The likelihood ratio test results for the six models presented in Table 2 show that all of the restrictions are rejected at 1% level of significance. Hence, we can conclude that the non-homothetic, non-homogenous and non-unitary elasticity of substitution production function associated with the unrestricted model (Model A) depicts, or closely approximates, the structure of production in the Saw and Planning Mills in New Brunswick. This implies that in this sector, any change in the output level will result in a change in the relative mix and hence demand of inputs, which once again would mean that the output elasticity of cost is not constant but varies with output levels (implying increasing or decreasing returns to scale).

I.IV.ii Regression Results

Table 3 presents the results of the unrestricted model (Model A) using SHAZAM (1997). The predicted values of the input shares for this model have been computed and are found to be strictly positive at every point of observation, implying that Model A is a well behaved cost function. From the Durbin Watson test for autocorrelation, we don't have any evidence of autocorrelation. From the correlation matrix, despite the systematic use of logarithmic functions, there is still high degree of multicollinearity between the linear and quadratic terms of price of capital and the linear and quadratic terms of output. However, we have decided to adopt the model as it is for the following reasons: (i) The linear term of price of capital is significant; (ii) The Wald chi-square statistic on the linear and quadratic entries of output and the quadratic term of price (i.e. *LnY, (LnY)*^{2} and *HP1SQ*) have turned out to be significant and hence the hypothesis H_0: $\varepsilon_y = \varepsilon_{yy} = \beta_{kk} = 0$ has been rejected at 1% level of significance; and (iii) Omission of any term from the cost function or change in their form may result in a major structural change in the associated production function.

Even though it is not the primary focus of this study, a brief discussion on few interesting results from the estimation of the cost function is worthwhile. For instance, the individual estimates of the output parameters are not significant, which is against the theoretical expectation. This could, however, be an indication of inefficiency in the Saw and Planning Mill industry in New Brunswick where it may be possible to increase output for a fixed level of cost simply by changing the relative input mix.

The estimates of the coefficients of price of all factors of production and technology have been found to be significant which are consistent with the theoretical expectations. One interesting point in here is that the linear term of technology has a negative coefficient, which is consistent with the theoretical expectation while the quadratic technology term has a positive coefficient. This may indicate that sophisticated technologies in the Saw and Planning Mill industry in New Brunswick contribute towards the increase in costs of production rather than to the reduction. This might imply that Saw and Planning Mills in New Brunswick do not have incentive to invest in new technology.

Table 3 Parameter Estimates of the Cost and Cost Share Equations

Coefficient	Estimate	Standard error	P-values	Coefficient	Estimate	Standard error	P-values
Cost Equation				**Capital Cost Share Equation**			
α_0	-1.6871	4.6080	0.7140	α_k	-0.4757	0.1316	0.0000***
ε_y	1.8387	2.0660	0.3740	ε_{yk}	0.1100	0.0223	0.0000***
ε_{yy}	-0.2769	0.4655	0.5520	β_{kk}	-0.0214	0.0232	0.3560
ε_{yk}	0.1100	0.0223	0.0000***	β_{kl}	0.0212	0.0145	0.1440
ε_{yl}	-0.0452	0.0193	0.0190**	β_{km}	0.0423	0.0156	0.0070***
ε_{ye}	-0.1408	0.0252	0.000***	θ_{tk}	0.0245	0.0211	0.2450
ε_{ym}	0.0760	0.0181	0.0000***	R^2	0.9029		
α_k	-0.4757	0.1316	0.0000***	**Labour Cost Share Equation**			
α_l	0.4495	0.0870	0.0000***	α_l	0.4495	0.0870	0.0000***
α_m	0.2262	0.0911	0.0130**	ε_{yl}	-0.0452	0.0193	0.0190**
β_{kk}	-0.0214	0.0232	0.3560	β_{kl}	0.0212	0.0145	0.1440
β_{kl}	0.0212	0.0145	0.1440	β_{ll}	0.0489	0.0271	0.0710*
β_{km}	0.0423	0.0156	0.0070***	β_{lm}	-0.0385	0.0138	0.0050***
β_{ll}	0.0489	0.0271	0.0710*	θ_{tl}	0.0019	0.0126	0.8800
β_{lm}	-0.0385	0.0138	0.0050***	R^2	0.8161		
β_{mm}	-0.0020	0.0165	0.9050	**Material Cost Share Equation**			
θ_t	-0.6571	0.2931	0.0250**	α_m	0.2262	0.0911	0.0130**
θ_{tt}	0.2046	0.0457	0.0000***	ε_{ym}	0.0760	0.0181	0.0000***
θ_{tk}	0.0245	0.0211	0.2450	β_{km}	0.0423	0.0156	0.0070***
θ_{tl}	0.0019	0.0126	0.8800	β_{lm}	-0.0385	0.0138	0.0050***
θ_{tm}	0.0296	0.0143	0.0380**	β_{mm}	-0.0020	0.0165	0.9050
R^2	0.9629			θ_{tm}	0.0296	0.0143	0.0380**
				R^2	0.7286		
				Energy Cost Share Equation (calculated)			
				α_e	0.8000	0.0954	-***
				β_{ke}	-0.0421	0.0140	-***
				β_{le}	-0.0317	0.0151	-**
				β_{ee}	0.0756	0.0169	-***
				β_{em}	-0.0018	0.0151	-
				θ_{te}	-0.0157	0.0128	-

NB: *, ** and *** indicate that the estimates of the corresponding parameters are significant at 10%, 5% and 1% levels respectively

Focusing on the cost share equations, it is evident that the technology coefficient has been found to be significant only in the fourth equation where it has a positive sign. As this is a *ceteris peribus* analysis where prices are held constant, it would mean that technological advancement results in increased quantity demand for material inputs.

I.IV.iii Elasticities of Substitution

The empirical results for price elasticities, presented in Table 4, show that all factors (except that for energy) have negative elasticities with respect to their own price. This is consistent with the theoretical expectation. However, only the demand for capital with respect to its own price and with respect to the price of material is elastic while the rest are either price inelastic or are close to unitary elastic. One of the possible explanations for capital to be elastic with respect to its own price is that it may (as shown by the Morishma elasticity) be easily substituted by energy. A similar rationale could be made for the latter finding (the relationship between capital demand and the price of material). Material is found to be the least inelastic input showing that it has the ‘basic good’ feature in the Saw and Planning Mill industry. This is consistent with the findings of Meil and Nautiyal (1988) and Banskota et. al (1985).

Table 4 Own and Cross Price Elasticities of demand for Inputs

Inputs	Capital	Labour	Material	Energy
Capital	-1.2460	0.5411	1.2859	-0.5809
Labour	0.1607	-0.5574	0.4976	-0.1008
Material	0.1317	0.1716	-0.3377	0.0433
Energy	-1.0667	-0.6234	0.7757	0.9144

Table 5 presents the estimated Allen (AES) and Morishma (MES) elasticities of substitution along with the 95% confidence interval for the AES estimates. As can be seen, all, estimated Allen elasticities of substitution (except the Energy – Capital relationship), fall with in the 95% confidence interval. Provided that our specification of the model is correct, this indicates that we could reasonably rely on our estimates. However, when it comes to interpretation of results, the AES estimates suggest that capital and labour, capital and material, material and labour and material and energy are pair wise substitutes, while capital and energy and labour and energy are pair wise complements. Although theory suggests that in the long run, all inputs are substitutes in a partial static spatial model, the finding of complementary relationships is not uncommon (Meil and Nautiyal, 1988). Intuitively, the complementarity between capital and energy makes more sense than between energy and labour. For example, the more machines are used in the industry, the higher will be the demand for energy to run them. On the other hand, in a situation where labour and capital are substitutes, there is no apparent argument regarding the complementarity between energy and labour, which is also confirmed by the estimates of Morishma elasticities of substitution. This finding leads to further support of the superiority of the MES estimates over the AES estimates.

Table 5 Estimated Allen and Morishma Elasticities of Substitution and the 95% Confidence Intervals for the Allen Elasticities of Substitution

		95% Confidence Interval for the AES*		
Inputs	**Estimated AES**	**Lower**	**Upper**	**Estimated MES**
K, L	2.3580	0.3844	4.3315	1.4067
L, K	2.3580	0.3844	4.3315	1.0985
K, M	1.9328	0.9704	2.8951	1.3777
M, K	1.9328	0.9704	2.8951	1.6235
K, E	-15.6539	-28.0113	-3.2965	0.1793
E, K	-15.6539	-28.0113	-3.2965	-1.4953
L, M	0.7479	0.5695	0.9264	0.7291
M, L	0.7479	0.5695	0.9264	0.8353
L, E	-2.7170	-3.9146	-1.5193	-1.5378
E, L	-2.7170	-3.9146	-1.5193	-1.0152
M, E	0.9256	3.3543	5.8249	1.1134
E, M	0.9256	3.3543	5.8249	-0.8711

*/ The author of this paper has not come across any literature, which show the methodology for constructing the confidence intervals for the Morishma elasticities.

One of the striking observations from the MES estimation results is that none of the pairs of factors are equally substitutable among each other (in vice-versa terms). This further justifies the appropriateness of the MES as measure of factor substitution as it allows for more flexibility in parameter estimates. Moreover, the magnitudes of the individual elasticities are generally lower and more ‘reasonable’ in the MES than the AES (since large substitution estimates are more difficult to defend).

Looking at the particular relationships, the MES of labour by capital turns out to be smaller (at 1.0985) than the MES of capital by labour (at 1.4067). This result suggests that in the existing technology in the Saw and Planning Mill industry in New Brunswick, labour can more easily be substituted by capital than capital can be substituted by labour. This could possibly be due to the fact that the industry is characterized by a labour intensive technology - which is in line with the conclusion we can arrive at by analyzing the relative cost shares of the two inputs.

The results also show that it is easier to substitute material by capital and labour than capital and labour by material. This indicates that the existing production technology is material saving. Another interesting result is that the MES of capital by material is greater than that of labour by material, showing that, in the existing technology in the Saw and Planning Mills in New Brunswick, capital is more material saving than labour.

A final result worth mentioning is that energy can substitute material, but material cannot substitute energy (rather it complements it). The possible justification for their substitutability is that capital has been found to be a complement for energy, while it is a substitute for material. Therefore, the net effect turns out to be that increased inputs of energy and hence capital would reduce the demand for material thereby substituting it. On the other hand, material cannot substitute energy because energy is a complement to capital and hence material could not play the complementary role of energy to capital.

I.IV.iv Economies of Scale

Economies of scale, measured at the mean values of LnY, LnPk, LnPl, LnPm, and LnPe, for the Saw and Planning Mill industry in New Brunswick has been calculated to be 0.339. This implies that, in order to increase output by 100%, it will require an increase all inputs by only 33.9%. This implies that the industry is exhibiting increasing returns to scale (i.e., saving costs as a result of growing larger). These results are consistent with other studies in Canada, as mentioned in this report.

Overall, the above analysis indicates that the structure of production of the Saw and Planning Mill industry in New Brunswick has a non-homothetic, non-homogeneous and non-unitary elasticity characteristic. The scale economies result shows that the industry is exhibiting increasing economies of scale. Hence, from the information we have utilized, we can infer that the average sized Saw and Planning Mill in New Brunswick is not maximizing profits for they are producing in the downward slopping portion (and not at the minimum level) of their average cost curve. The policy implication for managers of average-sized operations is therefore to increase the level of production (up to the point where industrial average costs are at their minimum, and hence marginal costs would be equated to average costs). This would result in increased returns on inputs.

With regard to the Allen elasticities of substitution estimates, we have determined that most fall in their respective 95% confidence intervals. This finding incorporates a new method of calculating the cost and price of capital. Provided that our specification of the model is correct, the confidence interval results reveal that our method is reasonably dependable from a statistical point of view.

From the Morishma Elasticity of Substitution results, we have seen that, under the existing technology in the Saw and Planning Mill industry in New Brunswick, labour can more easily be substituted by capital than capital by labour. Moreover, labour has been found to be more material consuming (complementary) than capital. These results indicate that labour in the Saw and Planning Mill industry is unlikely to have a favorable outlook in the future. Other factors reinforce this conclusion: (i) The existing technology is labour intensive, indicating that the industry is operating somewhere at the extreme tail of its isoquant curve. Production theory, however, asserts that averages are preferred to extremes in terms of input mix; (ii) We have found that labour is relatively cheaper and hence can easily be substituted by capital for which, in view of their interest, firms will sooner or later start to replace labour by capital; and (iii) Labor has also been found to be more material (wood) consuming than capital. However, in view of environmental considerations and past trends, it is likely that there will be more and more forest-use regulations in the future thereby making fiber even more expensive. This would once again compel firms to be in favor of material saving inputs while reducing the material consuming ones for which labour will gradually be replaced by capital. The policy implication is then that, the provincial government may be well advised to devise means with which to absorb the labour force that may ultimately be laid off in the Saw and Planning Mill industry in the future.

Energy has been found to be a cheaper substitute for material. Hence, firms will benefit from cost saving if they increase their expenditure on energy and reduce their expenditure on material. Assuming that increased use of energy (in this case, electricity) has less adverse effect on the environment than timber production, the above allocation of resources may also enable the Saw and Planning Mill industry to positively contribute towards environmental sustainability. Increased expenditure on energy is therefore one of the key aspects that require further study in the future for it could probably be one among the very few decision variables. This may help in reconciling the conflicting interests of firms as profit maximizers, government as custodian for the environment, and society as bearers of the consequences of environmental degradation.

Part II Socio-Economic Impact Study (CGE Modeling Work)

II.I Socio-economic Description of the Community of Petitcodiac

Petitcodiac is a village found in the in the Fundy Model Forest (FMF) region, particularly in the southeastern part of New Brunswick Province in Canada. The village covers a total area of about 17 KM^2 and according to the Statistics Canada figures the total population of the village in 2001 was 1,444. For the purpose of this study, we have expanded the area covered by Petitcodiac in order to include the community that surrounds the village and would, to some degree, associate themselves with the village. This community is bounded by River Glade in the east, Anagance in the west, Elgin in the south, and New Canaan in the north. As such, the Petitcodiac community is defined as covering a total area of about 1036 KM^2 out of which about 70% is said to be forestland. The estimated total population in this community is about 8,000 (Personal Comm., 2002). Thus, when referring to Petitcodiac throughout this study, we will be referring to this larger community/territory.

According to the estimates by a committee comprising of some of the village council members and key informants from the community, the 2002 unemployment rate in Petitcodiac is 10% and the share of the forest sector in total employment in this territory is estimated to be about 12.67% (Personal Comm. 2002). The average annual wages or salaries in all industries in Petitcodiac has been estimated at $22,000, while that of the composite and forest related industries is $21,000 and $24000 respectively.

To give an insight about the study area, according to the Statistics Canada figures, labour force participation rate (both employed and unemployed) in the region is 53.1%. The service sector is the principal employer (73%) followed by manufacturing (14%) and agriculture and other resource based industries (13%) (Stats. Can. 2002). There are a total of 515 businesses out of which 35 are forest-related (10 logging and 25 wood industries). Out of the population 25 years of age and over, 52.4 % have high school certificate or higher (MacFarlane et al. 1998).

II.II Review of the Literature

II.II.i Methodological Review of CGE Models

It has now been over two decades since multi-sector, economy-wide mathematical models like the input-output (I-O), linear programming (LP) and the computable general equilibrium (CGE) models have first been used for development planning and policy analysis. All these inter-industry analyses emphasize the idea that the economy should be viewed as a complete system of interdependent industrial sectors. Individual industries supply produced inputs to each other, they compete for the economy's supplies of primary factors of production, they compete for sales in domestic markets, and they interact with each other via international trade. The implications of industrial interdependence are often crucial to the understanding of the effects of changes in economic circumstances both on particular industries and on the economy as a whole. Consequently, the ability of economic models to capture inter-industry effects is of great importance for policy analysis (Parmenter, 1982).

Input-output models, in their basic form, consist of a system of linear equations, each one of which describes the distribution of an industry's product throughout the economy (Miller and Blair, 1985). Given their theoretical structure, input-output and even linear programming models seem best suited to a situation in which a central authority fully in control of the various quantity variables in the system (but subject to various technological and physical constraints) has to make consistent or optimal decisions. They are constructs that best reflect a pure command economy and, indeed, input-output analysis has often been used to "solve" the problems of material balancing in the productive sphere of a centrally planned economy (Dervis et al 1982).

The standard formulation of I-O models does not appear well suited to situations where many agents independently maximize their own welfare functions and jointly but inadvertently determine an outcome that can be affected only indirectly by planner or policy maker. Linear programming and input-output models do not contain variables that can be considered to be instruments controlled by policy makers in such market economies. Although policy makers can benefit from the consistent economy-wide picture provided by the models, they cannot easily relate the computed variables to any actual policy decisions. In order to achieve greater policy relevance, it is clear that the fiction of a central command economy must be abandoned in the very specification of the model and be replaced by a framework in which endogenous price and quantity variables are allowed to interact so as to simulate the workings of at least partly decentralized markets and autonomous decision makers (Dervis et al 1982).

A few researchers have used the I-O model to examine economic-wide impacts of changes in the forest sector in Canada (see Alavalapati et al 1998). The information derived from such I-O analysis can play a key role in forest policy making thereby influencing the management of Canadian forests. A closer look at the underlying assumptions of I-O models, however, raise serious concerns about the validity of the information derived from these models. The following lists some limitations if I-O models: (i) Prices of inputs and outputs are fixed in the economy. This does not allow I-O modelers to capture the behavior of economic agents with respect to changes in prices; (ii) Production is based on a technology in which fixed amounts of inputs are required in order to produce a unit of output. This rules out the possibility of factor substitution; (iii) There are no constraints on the supply of factor inputs. This eliminates the possibility of interdependence among firms that are not directly linked by inter-industry flows of commodities (which could possibly be related in terms of their competition for factors of production); and (iv) Final demand for the output of each industry is exogenous. This disregards the effect of changes in relative prices on consumption decision and hence may generate estimates that are biased.

All of the above assumptions may result in an overstatement or understatement of the economy-wide impacts of any changes in the forest sector. Forest policy decisions based on estimates obtained by employing I-O models may therefore be erroneous (Alavalapati et al 1998).

These concerns have prompted economic modelers to propose an alternative inter-industry analytical tool, called the computable general equilibrium (CGE) model. The CGE model is thought to provide a greater flexibility and generate less biased estimates when compared to I-O and linear programming models (Dervis et al 1982).

Like I-O models, CGE models are also built on the assumption that the different sectors in the economy are inter-dependent in terms of the supply of intermediate goods. However, CGE models improve on I-O models in certain aspects. These include, amongst others, the incorporation of the behavioral responses of economic agents to changes that occur in the economy. For instance, CGE models permit prices of inputs to vary in response to changes in output prices and vice versa, thus capturing the individual households' decision on the supply of factors of production and the demand for outputs. They also allow for the specification of a variety of flexible functional forms for the production functions thereby allowing the producers to substitute one factor for the other in response to changes in relative factor prices.

Generally, CGE models employ four basic assumptions (Perman et al 1996): (i) Market clearing – all markets are in equilibrium; (ii) Walras Law – all markets are connected; (iii) Utility maximization by households; and (iv) Profit maximization by firms.

One of the basic features of CGE models, which make them more applicable to real world problems is that they are built on the recognition of the fundamental economic problem of resource constraints. Hence, they capture an important form of the inter-sectoral linkages in terms of their competition for the limited available resources. Moreover, unlike the I-O models, which treat final demand variables as exogenous, CGE models can endogenously determine final demand variables within the model.

The other merit of CGE models is that, depending upon the nature of the economy and production functions under investigation, each of these assumptions can be modified to reflect the desired scenario. For instance, the relationship between inputs can be assumed as either one of no substitution or perfect substitution while the supply of primary inputs as highly inelastic, elastic or highly elastic. Each modification will therefore provide the policy analyst a certain degree of flexibility to specify models that fit the economy under investigation. (Dervis et al. 1982).

However, CGE models are not with out their problems. Shoven and Whalley (1992), cited in Alavalapati et al (1998), have noted that elasticities and other key parameter values play a pivotal role in the model specification, but no consensus exists regarding such values; large amounts of data are required to specify CGE models (in addition to I-O data), and the results may be quite sensitive to the key assumptions underlying the model (such as full employment, capital mobility, and perfect competition). For instance, given the full employment assumption and the fact that factors are limited in supply, the expansion in some sectors will necessarily require drawing factors of production from other sectors thereby causing a contraction in the latter. This however is not always the case for in reality, we observe unemployment for which the possibility of mutual or simultaneous growth of the different sectors is not to be absolutely ruled out.

In general, many researchers have argued that CGE models provide an improved framework for appraising the socio-economic effects of policy changes (See Dervis et al. 1982; Shoven and Whalley 1992; and Alavalapati et al 1998).

II.II.ii Review of Previous CGE Findings

There have been two studies that have employed the CGE modeling technique in the North American forest industry. Daniels et al. (1991), for example, applied the CGE modeling technique to study the distributive effects of United States Forest Service attempts to maintain community stability in Western Montana. In this study, they found that the economy is increasingly responsive to higher stumpage supply elasticities. That is, all variable factors and products diverge further from their initial values in response to the given change in lumber prices and more elastic stumpage supplies. They argue that in any market sensitive case, decreasing lumber prices reduces both demand for the final output of the wood products sector and demand for its factors of production and therefore stumpage demand decreases and stumpage prices also decrease. As a result, some capital facilities in the wood products sector become underemployed, and the return on the capital facilities in the wood products sector become underemployed, and the return on the capital facilities in this sector drops sharply. Some labour also shift to the composite sector and that sector expands absolutely absorbing some new capital from outside western Montana.

In another study, Alavalapati et al (1999) specify and calibrate a CGE model to the foothills region in Alberta and simulate (under a flexible wage rage scenario), a 6% reduction in the annual allowable cut (AAC). The reduction in the AAC and associated decrease in the supply of timber is shown to cause a 2.61% increase in stumpage cost. The reduction in the supply of timber also causes a 3.03% ($15.27 million) reduction in the forest output. As a result, we notice 1.2% (14 jobs) and 2.47% ($6.94 million) decrease in the demand for labour and capital respectively in the forest sector. The decrease in the demand for labour and capital also put downward pressure on their prices. As such, we notice 2.4% and 0.19% reduction in the prices of labour and capital, respectively.

On the other hand, Alavalapati et al. (1999) revealed that the AAC decrease causes an expansion in the other sectors of the economy. The output in the composite sector increases by 0.55% ($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 which would normally be sourced from outside the region. Depending upon the degree of substitutability among inputs, there will be changes in the demand for labour and land in other sectors. The simulation results show that in the other sectors, the demand for labour and capital increases respectively, by 0.21% (9 jobs) and 0.92% (6.06 million). The increases in the demand for capital may have an upward pressure on the rental rate of capital. However, the results show that the increases in the demand for capital in the other sectors do not offset the decrease in the demand in the forestry sector. Therefore, we notice an overall decline in the demand for capital. The effect on wage income of the 6% reduction in the AAC is a 0.53% (2.24 million) decrease in the households' wage income. This implies that the increase in the demand for labour and wage in other sectors of the economy cannot offset the decrease in the demand and wage in the forest sector.

II.III Methodology

II.III.i Introducing The Basic Structure of a CGE Model

The model described below is derived from Dinwiddy and Teal (1988). It uses Cobb-Douglas functions for both production and preferences (utilities) in a simple 2-good, 2-factor closed economy with universal perfect competition and constant returns to scale. Total households income is Y, consumption quantities are identified by C_1, C_2, total factor inputs are L_1, L_2 and unit factor inputs are k_1, l_1, k_2, l_2.

The assumptions that there are constant returns to scale and perfect competition have two important implications. First, long-run profits are necessarily zero (Euler's Theorem). Second, we cannot define a supply function for either producing sector. Suppose for example that the production function for industry 1 is:

(27) $$X_1 = K_1^{\alpha} L_1^{1-\alpha}$$

Re-arranging, we get the following:

(28) $$K_1 = \left(\frac{X_1}{L_1^{1-\alpha}}\right)^{\frac{1}{\alpha}}$$

Substituting equation (28) into the total cost function ($TC_1 = rK_1 + wL_1$) gives the following:

(29) $$TC_1 = r\left(\frac{X_1}{L_1^{1-\alpha}}\right)^{\frac{1}{\alpha}} + wL_1$$

To derive the conditional (cost minimizing) demand for labour, we take the derivative of equation (29) with respect to L_1 and set this equal to zero to get the following:

(30) $$L_1 = \left(\frac{1-\alpha}{\alpha}\frac{r}{w}\right)^{\alpha} X_1$$

In terms of labour requirement per unit of output, the following holds:

(31) $$l_1 = \frac{L_1}{X_1} = \left(\frac{1-\alpha}{\alpha}\frac{r}{w}\right)^{\alpha}$$

Similarly, the conditional demand for capital and the capital requirement per unit of output is as follows:

(32) $$K_1 = \left(\frac{\alpha}{1-\alpha}\frac{w}{r}\right)^{1-\alpha} X_1$$

(33) $$k_1 = \frac{K_1}{X_1} = \left(\frac{\alpha}{1-\alpha}\frac{w}{r}\right)^{1-\alpha}$$

Given industry profits, $\pi_1 = p_1 X_1 - rK_1 - wL_1$, we can substitute in for the conditional demands for capital and labour to give the following:

(34) $$\pi_1 = p_1 X_1 - r\left(\frac{\alpha}{1-\alpha}\frac{w}{r}\right)^{1-\alpha} X_1 - w\left(\frac{1-\alpha}{\alpha}\frac{r}{w}\right)^{\alpha} X_1$$

Note that equation (34) is a linear function of output, X_1. If we set the derivative of profit with respect to output to zero then we have an expression that does not contain X_1, and so we cannot define the supply function. What we obtain is the 'unit price' or 'unit cost' equation:

(35) $$p_1 = r\left(\frac{\alpha}{1-\alpha}\frac{w}{r}\right)^{1-\alpha} + w\left(\frac{1-\alpha}{\alpha}\frac{r}{w}\right)^{\alpha} = rk_1 + wl_1$$

Equation (35) necessarily implies zero (long-run) profits (price = unit cost). This is consistent with the hypothesis that, in a perfectly competitive market, factor payments exhaust the price of the product.

A computable version of the simple 2-good and 2-factor closed economy could therefore be summarized as follows:

Assume that the economy has two producers each producing a good (X_1 or X_2). The producers use labour and capital as inputs to the production process. Assume there also exists a representative individual in the economy who consumes the two products produced in the economy. This individual has a utility function that is dependant on the amount of each product consumed, C_1 and C_2. The total income of the individual is given by Y, and the following Cobb-Douglas utility and production functions are assumed:

(36) $U = C_1^{\alpha} C_2^{(1-\alpha)}$

(37) $X_1=K_1^{\beta} L_1^{(1-\beta)}$

(38) $X_2=K_2^{\gamma} L_2^{(1-\gamma)}$

(a) Commodity Demand:

Considering the whole society as an individual consumer, the consumer's problem is to maximize utility which can be describe as:

Max $\{U = C_1^{\alpha} C_2^{(1-\alpha)}\}$ subject to the income constraint: $Y = P_1C_1 + P_2C_2$ from which we get the following demand functions:

(39) $$C_1 = \frac{\alpha Y}{P_1}$$

(40) $$C_2 = \frac{(1-\alpha)Y}{P_2}$$

(b) Factor Demand:

Each of the producers will strive to maximize their respective profits:

- Max $\{\pi_1 = P_1X_1 - wL_1 - rK_1\}$ subject to the constraint $X_1=K_1^{\beta} L_1^{(1-\beta)}$
- Max $\{\pi_2 = P_2X_2 - wL_2 - rK_2\}$ subject to the constraint $X_2=K_2^{\gamma} L_2^{(1-\gamma)}$

From the first order conditions, we get the following equations:

(41) $$K_1 = \left[\frac{\beta w}{(1-\beta)r}\right]^{(1-\beta)} X_1$$ (42) $$K_2 = \left[\frac{\gamma w}{(1-\gamma)r}\right]^{(1-\gamma)} X_2$$

(43) $$L_1 = \left[\frac{(1-\beta)r}{\beta w}\right]^{\beta} X_1$$ (44) $$L_2 = \left[\frac{(1-\gamma)r}{\gamma W}\right]^{\gamma} X_2$$

(c) Commodity Supply (Zero Profit condition):

In equilibrium, we know (i) $\pi_1 = P_1X_1 - wL_1^* - rK_1^*$, and (ii) $\pi_2 = P_2X_2 - wL_2^* - rK_2^*$. Substituting equations (41) to (44) into the profit functions we get:

(45) $\pi_1 = P_1X_1 - wl_1X_1 - rk_1X_1$

(46) $\pi_2 = P_2X_2 - wl_2X_2 - rk_2X_2$

where $k_1 = \left[\frac{\beta w}{(1-\beta)r}\right]^{(1-\beta)}$, $k_2 = \left[\frac{\gamma w}{(1-\gamma)r}\right]^{(1-\gamma)}$, $l_1 = \left[\frac{(1-\beta)r}{\beta w}\right]^{\beta}$, and $l_2 = \left[\frac{(1-\gamma)r}{\gamma W}\right]^{\gamma}$

The maximum profit conditions (setting $\frac{\partial \Pr ofit}{\partial X_1}$ = 0) are therefore as follows:

(47) $P_1 = wl_1 + rk_1$

(48) $P_2 = wl_2 + rk_2$

(d) Factor Supply:

Assuming inelastic overall factor supply functions (where $\overline{K}$ and $\overline{L}$ represent a fixed supply of capital and labour respectively) we have the following equations:

(49) $\overline{K} = K_1 + K_2$

(50) $\overline{L} = L_1 + L_2$

(e) Income Equation:

Assuming the revenues from the supply of the two factors of production are the only sources of income in the economy, we have the following relationship:

$$(51) \qquad Y = r\overline{K} + w\overline{L}$$

(f) Market Clearing:

Assuming that what ever is produced in the economy is either consumed by the consumers (final demand) or used by the other sector as an intermediate input, we have the following product market clearing equations:

$$(52) \qquad X_1 = a_{12} X_2 + C_1$$

$$(53) \qquad X_2 = a_{21} X_1 + C_2$$

Hence, we have thirteen unknown variables in the model (*Y, C1, C2, P1, P2, K1, K2, X1, X2, L1, L2, K, L*) in thirteen equations, and hence each of the variables can uniquely be determined.

II.III.ii A Modified CGE Model Built For The Petitcodiac Economy

For the purpose of this study, the economy of Petitcodiac is divided in to two sectors – the forest sector and the composite sector. This latter sector is defined as the sum total of the rest of the other sectors in the economy. The approach followed in this paper is similar to that of Caves et al (1993), Daniels et al (1991), and Alavalapati et al (1999), where, based on the Harberger convention, the elements of the single community's general equilibrium system characterized by its equations of change is used.

The Harberger convention addresses the problem associated with the fact that we rarely know actual quantities of outputs and factor inputs (and in any event, with aggregated sectors, ‘quantities’ are not really definable). Hence, we are more likely to have data on incomes, revenues and expenditures. However, quantities are, even for a homogeneous good, measured in arbitrary units, and in CGE modeling we are usually concerned with proportionate changes in quantities (and prices) rather than with absolute values. The ‘Harberger Convention’ is employed where there are no distortions (such as taxes) that introduce a wedge between prices for the same good/factor. In this case, we can assume that all prices are equal to 1, so that ‘quantities’ are then defined to be equal to the income, revenue or expenditure concerned (Miller and Blair 1985).

Accordingly, the proportionate changes in the demand for the products of the two sectors are expressed in terms of the share weighted proportionate changes in the different sectors’ final consumption or intermediate demand for the products. To provide more information about the relationship between the quantity demand by each sector with respect to the commodity prices and also with respect to the changes in other economic agents’ quantity demand, equations containing own price and cross quantity elasticities are formulated that can consistently be derived from the respective demand functions. The cost minimizing demand equations for factors of production are derived from the cost share functions determined in Part I of this report (the econometric work). For the factor demand equations, the proportionate change in the demand for inputs of production are expressed in terms of the proportionate changes in their own and all other factor prices, the respective share of each factor in the total cost of producing one unit of output, and the Allen partial or Morishma elasticities of factor substitution.

On the supply side, proportionate changes in product supply are expressed as a function of the proportionate change in the input-use (which are equal to the respective cost minimizing factor demands explained above) and the relative share of each factor in total cost of producing one unit of output. The proportionate change in the factor supplies, on the other hand, are expressed in terms of the proportionate changes in their respective prices and price elasticities of supplies.

To make our analysis as realistic as possible, we have portrayed the economy of Petitcodiac as an open economy, which has interactions with 'the rest of the world' (that being outside of the region specified previously). The community is a net exporter of forest sector products and a net importer of the composite sector products (Personal Comm., 2002). From our discussions with the key informants in the village, Petitcodiac is a small economy in the face of the world market where it is only a price taker and hence, any changes in the world prices of both the forest sector and composite sector products are fully reflected in the domestic prices of Petitcodiac (i.e., one percent change in world price is matched with a one percent change in the domestic price).

Unlike the standard CGE models, our model does not assume full-employment. Rather, our model is built in such a way that it recognizes the existence of unemployment. This model therefore treats the factor market as a balancing market on which the net effect of all the changes occurring in the economy is reflected. While we assume product markets always clear (as firms work out their inventories or, with the help of imports, increase their supply to meet any excess demand), factor markets do not (we almost always observe some of the labor, capital, material or energy being unemployed mainly because of the imperfect factor mobility across borders). Also in this model, as is the case in reality, provisions are made for non-zero profits, non-zero household savings, and mobility of factors of production across the different sectors with in the economy.

We assume that the forest sector uses only four factors of production, namely (i) labor, (ii) capital, (iii) timber and (iv) electricity, while in the composite sector, land replaces timber (with all other inputs remaining the same). Even though we have found out in Part I that the Saw and Planning Mill industry (representative of the forest sector in this region) exhibits an increasing returns to scale, for computational convenience's sake, both industries are assumed to be competitive and also are assumed to exhibit constant returns to scale. These assumptions permit writing the product supply equations as in section A below.[6]

[6] Without the constant returns to scale assumption, this technique could not be implemented. As such, we must proceed while acknowledging this (somewhat minor) inconsistency.

A. Commodity Supply

Assuming a Cobb-Douglas production function in both sectors, output from the two sectors can be expressed as follows:

(54) $X_F' = \theta_{LF}L'_F + \theta_{KF}K'_F + \theta_{MF}M' + \theta_{EF}E'_F$

(55) $X_C' = \theta_{LC}L'_C + \theta_{KC}K'_C + \theta_{DC}D' + \theta_{EC}E'_C$

where X_F and X_C are quantity of product supplies from the forest and composite sectors, L = Labour; K = Capital; M = Timber; D = Land, E = Electricity; and θ_{ij} is the share of input i in the total cost of producing a unit of out put in sector j. The apostrophes designate the proportional change in the respective variables (e.g.. $X_F' = dX_F/X_F$). Hence, the 1[st] equation (for instance) relates the proportionate change in the supply of forest products to the proportionate changes in the cost-minimizing amount of factor inputs.

B. Commodity Demand

From the obvious identities that the total demand for the output of each of the two sectors' products equal to the sum of the demands for final consumption, intermediate input use and exports (no accumulation of inventories are assumed), we can derive equations (56) and (57) by taking the total differential of the identities. While, from the commodity demand equations that follow from the households' utility maximization and firms' profit maximization problems, equations 58 – 69 can be derived:

(56) $X'_F = \varepsilon_{11}X'_{FF} + \varepsilon_{12} X'_{FC} + \varepsilon_{13}X'_{FH} + \varepsilon_{14}NX'_{FE}$

(57) $X'_C = \varepsilon_{22}X'_{CC} + \varepsilon_{21}X'_{CF} + \varepsilon_{23}X'_{CH} - \varepsilon_{24}NX'_{CE}$

(58) $X'_F = \varphi_1 P'_F$

(59) $X'_C = \varphi_2 P'_C$

(60) $NX'_{FE} = \theta_{14} PW'_F$

(61) $NX'_{CI} = \theta_{24} PW'_C$

(62) $P'_F = \theta_{1W} PW'_F$

(63) $P'_C = \theta_{2W} \; PW'_C$

(64) $X'_{FF} = \theta_{11}P'_F$

(65) $X'_{FH} = \theta_{F2F3} X'_{FC}$

(66) $X'_{CH} = \theta_{C1C3} X'_{CF}$

(67) $NX'_{FE} = \theta_{F4F1} X'_{FF}$

(68) $NX'_{CE} = \theta_{C4C2} X'_{CC}$

(69) $X'_{FF} = \theta_{F1C1} X'_{CF}$

where, X_{FF} and X_{CC} respectively are the demand for the forest and composite sector products as intermediate inputs in the forest and composite sectors them selves, X_{Fc} and X_{CF} are the demand for the forest and composite sector products as intermediate inputs in the composite and forest sectors respectively, X_{FH} and X_{CH} are the demand for the forest and composite sector products for domestic consumption and NX_{FE} & NX_{CE} are the net exports of the forest and the composite sectors respectively. P_F and P_C are market prices of forest and composite sector products and PW_F and PW_C are world prices of the forest and composite sector products respectively. ε_{ij} is the share of sector j's consumption/intermediate demand in total output of sector i, φ_1 and φ_2 are the own price elasticities of demand for the forest sector and composite sector products, θ_{14} and θ_{24} are the price elasticities of demand for net exports from the forest sector and net imports by the composite sector with respect to the world prices of the forest and the composite sectors respectively, θ_{1W} and θ_{2W} are elasticities of the forest and composite sector domestic prices with respect to their respective world prices, θ_{11} is the price elasticity of demand for the forest sector products as intermediate inputs in the forest sector it self and the θ_{ijkl}'s are the price elasticities of Xij with respect to X_{kl} (for instance, θ_{F4F1} is the price elasticity of export demand the forest sector faces (NX_{FE}) with respect to the demand for forest sector products as intermediate inputs in the forest sector it self (X_{FF}). Where, P_F' and P_C' respectively are the proportionate changes in the prices of the forest and composite sector products while φ_i's are the respective price elasticities of demand.

C. Factor Demand

Given a Neo-classical production function that allows for smooth substitution among several factor inputs, the degree of substitutability is governed by the elasticities of substitution (Dervis et al., 1982). Hence, from the cost share equations derived for each factor inputs in Part I of this report (the econometric work), the following cost minimizing factor demand equations are derived (Hertel, 1988), where each of the factor prices are weighted by their respective cost shares and elasticities of substitution:

$$(70) \quad L'_F = \theta_{LF}\sigma^F_{LL}W'_F + \theta_{KF}\sigma^F_{LK}R' + \theta_{MF}\sigma^F_{LM}S' + \theta_{EF}\sigma^F_{LE}G' + X_F'$$

$$(71) \quad K'_F = \theta_{LF}\sigma^F_{KL}W'_F + \theta_{KF}\sigma^F_{KK}R' + \theta_{MF}\sigma^F_{KM}S' + \theta_{EF}\sigma^F_{KE}G' + X_F'$$

$$(72) \quad M'_F = \theta_{LF}\sigma^F_{ML}W'_F + \theta_{KF}\sigma^F_{MK}R' + \theta_{MF}\sigma^F_{MM}S' + \theta_{EF}\sigma^F_{ME}G' + X_F'$$

$$(73) \quad E'_F = \theta_{LF}\sigma^F_{EL}W'_F + \theta_{KF}\sigma^F_{EK}R' + \theta_{MF}\sigma^F_{EM}S' + \theta_{EF}\sigma^F_{EE}G' + X_F'$$

$$(74) \quad L'_C = \theta_{LC}\sigma^C_{LL}W'_C + \theta_{KC}\sigma^C_{LK}R' + \theta_{DC}\sigma^C_{LD}V' + \theta_{EC}\sigma^C_{LE}G' + X_C'$$

$$(75) \quad K'_C = \theta_{LC}\sigma^C_{KL}W'_C + \theta_{KC}\sigma^C_{KK}R' + \theta_{DC}\sigma^C_{KD}V' + \theta_{EC}\sigma^C_{KE}G' + X_C'$$

$$(76) \quad D'_C = \theta_{LC}\sigma^C_{DL}W'_C + \theta_{KC}\sigma^C_{DK}R' + \theta_{DC}\sigma^C_{DD}V' + \theta_{EC}\sigma^C_{DE}G' + X_C'$$

$$(77) \quad E'_C = \theta_{LC}\sigma^C_{EL}W'_C + \theta_{KC}\sigma^C_{EK}R' + \theta_{DC}\sigma^C_{ED}V' + \theta_{EC}\sigma^C_{EE}G' + X_C'$$

$$(78) \quad M' = \eta_d S'$$

where θ_{ij}'s are the share of factor i in total cost of producing one unit of output in sector j, W_F =Wages in the forest sector; R = Rental price of Capital; S = Stumpage cost; G = price of electricity, V = Rental price of land; σ_{ij}'s are the Morishma elasticities of substitution between factor inputs i and j estimated in Part I of this report and η_d is the price elasticity of demand for timber.

Restrictions on the cost share weighted Allen Partial elasticities of substitution permit one of the demand equations from each sector to be dropped for they can be determined residually (Hertel 1988). As the same restrictions apply to the share weighted Morishma elasticities of substitution, we can drop one equation from each sector to be determined residually. Accordingly, the shaded equations (i.e., the timber demand equation from the forest sector and the land demand equation from the composite sector) have been dropped out from the system.

D. Factor Supply

From households' utility and firms' profit maximizing input supply functions, the following equations can be derived,

$$(79) \quad E'_F = \psi_F\, G'$$

$$(80) \quad E'_C = \psi_C\, G'$$

$$(81) \quad L'_F = \beta_F\, W'_F$$

$$(82) \quad L'_C = \beta_C\, W'_C$$

$$(83) \quad K'_F = \gamma_F R'$$

$$(84) \quad K'_C = \gamma_C R'$$

$$(85) \quad M' = \eta_s S'$$

While both the provision for free mobility of factors of production across the two sectors and the possibility of mobility of energy and capital in to or out side the economy can be imposed in to the system by the following equations:

$$(86) \quad E' = \Omega_F E'_F + \Omega_C E'_C$$

$$(87) \quad L' = \rho_F L'_F + \rho_C L'_C$$

$$(88) \quad K' = \alpha_F K'_F + \alpha_C K'_C$$

As labor in such small communities is not likely to be highly mobile across regions for a variety of social reasons, we impose the restriction that the total labor force (employed and unemployed) in the community remains the same, at least in the short run, by the following equation:

$$(89) \quad TL' = \rho_U U' + \rho_L L'$$

where, ψ_F & ψ_C are price elasticities of energy supply in the two sectors, β_F and β_C are wage rate elasticities of labor supply in the forest and composite sectors respectively. γ_F and γ_C are supply elasticities of capital in the forest and composite sectors, (Ω_F & Ω_C) are the share of each sector in total energy demand, α_F and α_C are shares of each sector in total capital employment and η_s is supply elasticity of Timber. *TL* represents the total labour power in the economy (both employed and unemployed), *L* is total employment and *U* is total unemployment in the economy. ρ_F and ρ_C are shares of each sector in total labour employment, ρ_U and ρ_L respectively are the proportions of unemployed and employed people out of total labor force.

E. Profits

In the case of constant returns to scale production functions in perfectly competitive markets, we expect zero pure profits. This results because factors are paid their opportunity costs and, as shown above, factor payments exhaust the total revenue in each industry (Euler's theorem). However, since these properties may not characterize the markets in Petitcodiac economy, profits are not necessarily zero. We therefore depict the profit functions of the two sectors in the economy as follows:

(90) $\pi_F = P'_F - \theta_{LF}W'_F + \theta_{kF}R' + \theta_{TF}S' + \theta_{EF}E'$

(91) $\pi_C = P'_C - \theta_{LC}W'_C + \theta_{kC}R' + \theta_{DC}V' + \theta_{EC}E'$

where, π_F and π_C are the profits of the forest and composite sectors per unit of their respective outputs.

F. Income of the Community

Given their utility function, households (as being rational economic agents) try to maximize their utility subject to their income constraint. Accordingly, they allocate their income among the consumption of the different sector products and savings (future consumption) thereby attaching some weights to each consumption item depending on their tastes and preferences. Hence, the following equation relating income and outputs of the different sectors and saving is used to reflect the allocation decision of households, which follow from their utility maximization endeavor:

$$(92) \qquad Y' = A_{13} X'_{FH} + A_{23}X'_{CH} + A_{24}NX'_{CE} + A_Z Z'$$

where the A_{iQ}'s are the shares in total house hold income of consumption of sector i products, A_Z is the saving rate and Z is savings.

Equations *(78)* and *(85)* represent the equations for price elasticities of demand and supply of timber. As can be seen, the two equations are the same except for the elasticity measures, which are constants. These equations give intuitive sense theoretically, but mathematically, they will appear fallacious for the quotient (M'/T') cannot have two distinct values. Hence, the two equations will be used only as appropriate. For instance, while simulating for the 1% reduction in the AAC (M'), talking about the price elasticity of supply doesn't make sense or we cannot have a supply elasticity function (supply is no more a behavioral variable, but an exogenously determined variable). Therefore, in this case, the demand elasticity equation *(78)* will be used while disregarding the supply elasticity equation.

Likewise, in the simulation for 1% reduction in the world price of forest sector products, the first reaction to this shock will likely be from the suppliers. Hence the supply elasticity equation *(85)* will be used while the demand elasticity equation will be disregarded. It should also be noted here that despite the fact that either of the equations will be dropped as appropriate, the net effect of the shock on the variables will be captured by the other structural equations in which the timber and price of timber variables appear.

Hence, for each simulation, we have 37 unknown variables in 36 equations for which the system can be solved thereby uniquely determining each unknown variable if we exogenously set one of them (i.e., simulating for any variable of interest).

II.IV Data Source and Organization

As explained in Part I, the Saw and Planning Mill industry in New Brunswick has been used as a typical forest sector in the case study region, and hence sector-specific analysis has been conducted using provincial data from the Statistics Canada database. Accordingly, such previously determined measures as elasticities of factor substitution, own and cross price elasticities of factor demand and share of factor i in total cost of producing one unit of output in the forest sector are adopted from this analysis. For composite sector elasticities, however, there is no data available in New Brunswick (or for Canada as a whole). As such, a decision has been made to adopt the elasticity of substitution estimates calculated for the United States by Thompson (1997), Klein (1974), Paraskevopoulos (1979) and Fishelson (1979).

Much of the data for the community of Petitcodiac has been collected from group discussions and interviews with key informants from the community. The Appendix provides the list of questions asked of the participants. Such information as the value of total output from each of the forest and the composite sectors, total employment and share of the two sectors in total employment in the community, average annual wage in each sector, value of total timber/lumber used as input in the forest sector, total capital in each sector, amount of electric power consumed in the two sectors, price per KWH of energy, percentage of income spent on each sector's products and savings have been estimated by the informants.

It is worth mentioning here that most of the data that has been collected from the village council and business community interview involve economic concepts like elasticities, which are difficult to coin without the use of mathematical equations. Hence the respondents did have some difficulty coming up with some estimated values. Another issue of concern that should be re-emphasized here is that the elasticities of substitution figures for the composite sector adopted from other studies on the US economy may not perfectly characterize the situation in Petitcodiac. Therefore, the reliability of the simulation results in this study is contingent up on the reliability of these estimates.

II.V Empirical Results and Discussion

Using the modified computable general equilibrium model specified for the community of Petitcodiac presented above, simulations have been made for 1% exogenous reduction in world price of forest sector products and 1% exogenous reduction in the annual allowable cut (AAC). One percent changes were simulated so that the results can be interpreted as elasticities. The results are presented in Table 6 below.

Table 6: The impact of 1% reduction in the world price of forest sector products or the Maximum Annual Allowable Cut (AAC) in Petitcodiac

Variable	Base Value of Variable (2001 figures)	Impact of 1% reduction in: (All values are in terms of % changes)	
		The World Price of forest sector products (PW_F)	Annual Allowable Cut (AAC)*
Forest sector output (X_F)	$150 million	-0.002	-0.007
Composite sector output (X_C)	$350 million	-0.005	0.0007
Total labor force (TL)	5,300	0.000	0.000
Unemployed labor (U)	530	0.053	0.002
Employed labor force (L)	4,770	-0.006	-0.002
Forest sector employment (L_F)	600	-0.003	-0.004
Composite sector employment (L_C)	4,170	-0.007	-0.0009
Timber used (M)	2.5 mill. cords	-0.002	-0.010
Land used for composite sector production (D)	270 KM^2	-0.007	-0.003
Total capital supply in the economy (K)	$190 million	-0.004	0.001
Capital used in the forest sector (K_F)	$15 million	-0.004	-0.002
Capital used in the composite sector (K_C)	$175 million	-0.004	0.002
Total energy supply in the economy (E)	$42.5 million	+EPS	0.004
Energy used in the forest sector (E_F)	$7.5 million	+EPS	0.004
Energy used in the composite sector (E_C)	$35 million	-0.002	-0.007

Variable	Base Value of Variable (2001 figures)	Impact of 1% reduction in: (All values are in terms of % changes)	
		The World Price of forest sector products (PW_F)	Annual Allowable Cut (AAC)*
Intermediate demand for forest sector products by the forest sector itself (X_{FF})	$30 million	-0.010	0.004
Intermediate demand for forest sector products by the composite sector (X_{FC})	$4.5 million	0.230	-0.316
Final consumption demand for forest sector products by households (X_{FH})	$3 million	0.092	-0.126
Net-export demand for forest sector products (NX_{FE})	$112.5 million	-0.012	0.005
Intermediate demand for composite sector products by the composite sector itself (X_{CC})	$87.5 million	0.023	-0.012
Intermediate demand for composite sector products by the forest sector (X_{CF})	$52.5 million	-0.020	0.008
Final consumption demand for composite sector products by households (X_{CH})	$140 million	-0.022	0.009
Net-export demand for composite sector products (NX_{CE})	-$227.5 million	-0.005	0.002
Average price of forest sector products (P_F)	---**	-0.010	0.004
Average price of composite sector products (P_C)	---	0.004	-0.002
Average annual salary in the forest sector (W_F)	$24,000	-0.003	-0.004
Average annual salary in composite sector (W_C)	$21,000	-0.007	-0.0009
Rental price of capital (R)	---	-0.005	-0.002
Stumpage price per M^3 of round wood (S)	$40	-0.001	0.007
Price of energy (G)	---	+EPS	0.004
Rental price of land per ha per annum (V)	$1,297	-0.035	0.027
Profit per unit of forest sector output (π_F)	---	-0.011	0.010
Profit per unit of composite sector output (π_C)	---	-EPS	+EPS
Income of the community as a whole (Y)	---	-0.003	-0.002

*/ The timber supply variable (M) which is believed to be highly and positively correlated with the Annual Allowable Cut (AAC) restrictions has been used to simulate for reduction in (AAC).

**/ The dotted lines (---) indicate that the absolute value is not required for the simulations. The percentage change calculations for these variables emerge once we include the elasticity estimates determined in Part I of this report. This is consistent with other CGE studies mentioned in this report.

As we can see from column 3 of Table 6 above, a 1% reduction in the world price of wood products (among many other things) results in a reduction in the output of both the forest and composite sectors in Petitcodiac by 0.2% ($0.3 million) and 0.5% ($1.75 million), respectively. One of the justifications for the decrease in output of the forest sector is that, as is reflected by the NX_F variable, the net-export demand (by exporters to the rest of the world) for forest sector products, which has the lion's share in the total sectoral output, have decreased more than proportionately (by 1.2%) and hence the supply has responded to the reduced demand.

It should be noted here, however, that the demand for forest sector products by households and the composite sectors for final consumption and for intermediate input have increased by 9.2% and 23% respectively, which could be explained by the households' and firms' utility and profit maximizing behaviors respectively. Demands increase because agents are substituting the forest sector products (which now have become relatively cheaper) for other inputs. As prices of the forest sector products have fallen by much a higher proportion than its volume of output and the price of inputs, it is intuitively not surprising to observe a reduction in the profit of the forest sector industries by 1.1%.

With regard to the composite sector, we see that net imports (which again constitute the biggest part of total composite sector production) reduces by 0.5%. This has occurred because of the 2.2% reduction in the households' demand for imported goods following a 0.3% reduction in their incomes, the major part of which was spent on imported composite sector goods. Due to the overall reduction in the output of the forest sector, the intermediate demand by the forest sector for the composite sector products has also fallen by 2%. These reduced demands from the principal consumers will then force the total output of the composite sector to decrease.

In the factor market, the reduction in total output in both sectors (short supplies) cause the reduction in the demand for almost all factor inputs with the exception of energy, which shows an infinitesimally small positive change (denoted by +EPS for positive epsilon). Reduced demand for these factor inputs in turn puts a downward pressure on the prices of the factor inputs for which demand decreases. Moreover, the reduction in the demand for factors of production results in a 5.3% increase in unemployment in the labor market while the total labor supply in the economy remains more or less the same.

Another interesting result is that, if world price for forest sector products decreases by 1%, not only the supply of capital in each sector will reduce (each by 0.4%), but also the total supply of capital in the economy will reduce by the same proportion, which shows that capital would flow out of Petitcodiac to the rest of the world.

Column 4 of Table 6 reports on the percentage changes in the endogenous variables from a 1% exogenous reduction in the Annual Allowable Cut (AAC). We have tried to capture the effect of changes in the AAC by the timber supply variable (M) for under normal circumstances, the two variables are believed to be highly and positively correlated. In this simulation, we observe that a reduction in the timber supply causes a production constraint in the forest sector for which forest sector output is reduced by 0.7% ($2.45 million). Moreover, this puts an upward pressure on the prices of the forest sector products (0.4%), which in turn depresses the demand for final consumption and intermediate demand for the forest sector products by the households (12.6%) and the composite sector (31.6%) respectively. This causes an even further depressing effect on output.

An interesting observation here is the change in the intermediate demand for forest sector products by the forest sector itself (X_{11}), which despite the reduction in total output, rises by 0.4%. The possible explanation for this is that, when the timber supply reduces, the forest sector will tend to devise new production strategies, such as focusing on the sales of value added products (requiring less timber). If so, the increased price and reduced factor prices would adequately explain the 1% increase in profit to the forest sector amidst reduced volume of output. The increase in net export demand for forest sector products (NX_F) amidst increased local prices is not, however, palatable unless there already existed excess demand in the rest of the world.

In this simulation, what likely attracts our attention the most is the increase in the output level of the composite sector in response to a decrease in the AAC. The explanation for this phenomenon is that, due to the reduction in the output level of the forest sector, factors of production are released from the forest sector and hence the supply of capital and labor increases. As a result, the price of the principal factors (capital and labor) that the composite sector would face will be lower than before by 0.2% and 0.0009%, respectively. Given that the price of capital has fallen more than proportionately as compared to the other inputs, and the fact that capital is the major factor of production in the composite sector, the composite sector will substitute capital for the other inputs and ultimately will be able to produce at a lower cost. In view of the reduced cost of production and the reduced household income, the composite sector would decrease its price and hence provoke the demand for the composite sector products. As a result, the final demand by households and the intermediate demand by the forest sector for the composite sector products increase by 0.9% and 0.8% respectively. The composite sector output will therefore increase by 0.0007% ($0.23 million) to respond to the increased demand. This finding is consistent with that of other such studies of the forest industry discussed previously.[7]

In the factor market, due to the release of factors from the forest sector and due to the substitution of capital for labor and land in the composite sector, the overall use of capital increases. More specifically, increase in the demand for capital by the composite sector (0.2% x 175 million) is higher than the amount of capital released by the forest sector (0.2% x 15 million) there by attracting more capital to flow in to Petitcodiac from the rest of the world. Other variables, such as labor and land employment tend to decrease (by 0.1% and 0.3%, respectively). Thus, labor unemployment in this sector increases by 0.2%.

[7] Another possible reason for the expansion of the composite sector output is that the reduction in the AAC may increase in the esthetic values of forests, which give rise to the expansion of the tourism industry, which will have a multiplier effect on the expansion of the other sectors. This factor, however, has not been captured in this model specification, and we leave this to future research.

Conclusions

The forest sector is a significant contributor to the GDP of the Petitcodiac community in New Brunswick. Any changes that affect the forest sector are likely to have substantial effects (for better or worse) on the socio-economic stability of the community. Appropriate forest sector policies, such as the determination of the AAC, depend on an understanding of the consequences of alternative harvest levels on the incomes, employment, and GDP values affected by such policies. In an effort to examine potential future socio-economic impacts of market and policy changes in the forest sector on the community of Petitcodiac, this paper has developed a modified computable general equilibrium model for the region.

Simulations have been conducted for a 1% reduction in the world price of forest sector products and a reduction in the Annual Allowable Cut (AAC). In general, we observe that both of these changes will have negative impacts (at least in the short run) on the economy. Particularly, the two changes tend to reduce the total GDP of Petitcodiac ($2.05 million and $0.8 million respectively), reduce households' income (by 0.3% and 0.2% respectively), and negatively affect the factors of production (significantly decreasing the employment of labor and land).

The reduction in the AAC, however, would tend to have some indirect positive effects in the community of Petitcodiac for it has an expansionary effect on the composite sector output. It also has a positive effect in terms of increasing the demand for capital in the composite sector and hence attracting more capital to flow from outside of the community into the Petitcodiac economy. This would result in increased investment and hence employment in this sector.

Although not modeled here, a reduction in AAC may also tend to increase the esthetic values of the forest, which might induce the expansion of eco-tourism. This may have a multiplier effect on the overall growth of the economy creating more employment and hence stimulating the local economy. Other such 'value' considerations (not addressed in this report) include the ecological effects on wildlife, environmental quality, and the existence values people attach to forest vistas. Incorporating such values into the analysis by extending this basic model is left for future research. Indeed, a complete impact study on changes to the forest sector would require the inclusion of all socio-economic benefits or losses from timber and non-timber uses associated with reduction in AAC. While it is beyond reasonable doubt that reductions in the AAC cause significant short-term costs (as revealed in this report), it is imperative that decision-makers accommodate the increasing public demand for non-timber values that can be derived from the forest (van Kooten, 1993, Binkley et al. 1994).[8]

[8] Due to problems associated with availability of data and difficulty of measuring non-market values, such benefits or losses have not been included in this analysis and hence, the benefits and or losses reported here do not give the full picture of the whole process.

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Appendix

QUESTIONNAIRE FOR KEY INFORMANTS GROUP INTERVIEW AT PETITCODIAC

The Fundy Model Forest project is currently sponsoring me, a graduate student at the University of New Brunswick, to do my Master's thesis on a Computable General Equilibrium (CGE) analysis of the effects of Market and policy changes on the economy of the rural forest dependent communities. To this effect, Petitcodiac has been identified as a representative community for the study. I will therefore build a model to simulate for different market and policy scenarios that represent possible future changes that the forest sector in Petitcodiac might face. For instance, the effect of a decrease or an increase in forest sector product price and the reduction by policy of the Maximum Annul allowable cuts (MAAC) are among the scenarios to be simulated for. To this effect, the study will divide the economy of Petitcodiac in to two sectors, the forest sector and the rest of the other sectors aggregated in to one, which we have called it **"the composite sector"**. Each sector is believed to be dependent on the other and hence any development or change in one sector is expected to have some effect on the other as well. To do this study, apart from the data, which I have adopted from the Statistics Canada's entries for the New Brunswick province, data particularly from Petitcodiac are required, which the village council is expected to provide to the graduate student or facilitate a group interview with representatives from the council it self and also well informed individuals in the community (key informants). The list and description of the variables on which data is required are listed below. In as much as possible, all the data should refer to any one of the recent years (eg. 2001 or 2000, or 1999).

1) Gross Domestic Product of the town (i.e., the worth in Canadian dollars of the total goods and services produced in Petitcodiac) ____________________
2) The total worth of the products from the forest sector__________________
3) Total worth of the products from the composite sector (the term composite is as defined in the introduction above)_________________
   NB: The sum of the values in items 3 and 2 should be equal to the value in item 1.
4) Out of the total production of the forest sector, what percentage is exported to places outside Petitcodiac?_____________, what percentage is used by the local saw mills and other wood products industries and pulp mills?_________, what percentage is bought by the other business sectors for final use________, what percentage is bought for house hold (residential) purposes ___________;
   NB: The sum of the four values in item 4 has to be equal to 100.
5) What is the worth of the items imported from outside Petitcodiac _________?
6) Out of the total production of the composite sector, what percentage is used by the local saw mills and other wood products industries and pulp mills?___________ , what percentage is consumed by the composite sector it self __________________, what percentage is bought for house hold (residential) purposes _______________________
   NB: The sum of the four values in item 6 has to be equal to 100.
7) Total population of the village____________________________________
8) Population in the economically active (working) age range ______________

9) Out of the economically active population, percentage unemployed________

10) Out of the employed labor force, what percentage is employed by the forest sector? ___________________________

11) Total Capital (i.e., total worth of buildings, machineries, vehicles, and other fixed assets) used for production of goods and services in the economy of Petitcodiac? _________________________

NB: worth of buildings in item 11 should not include the value of land.

12) Out of total capital (item 11 above), what is the percentage of capital that has been used in the forest sector? ______________________________

13) What is the average annual wage or salary in the forest sector ?__________

14) What is the average annual wage or salary in the composite sector (i.e., the average annual wage or salary in the other sectors) ?__________

15) Do you think the forest sector or the composite sector is more profitable? _____________ How much more in percentage?____________________

16) How much forestland in hectares has been cleared for export outside of Petitcodiac or local saw mills? _____________

17) What is the average stumpage cost per hectare of forest land?___________

18) How much land in hectares has been used for production purposes (excluding residential houses and forest land) _______________________

19) What is the average rental price of land per hectare per annum __________________

20) What is the total electric energy consumed in Petitcodiac (excluding the household consumption) in Kilowatts _________________

21) What is the total electric energy consumed by the forest sector in KWH_____

22) What is the average price per KWH of energy for business establishments?_______________

23) If all other things remain unchanged but the wage rate in the forest sector increases by 10% (for instance people who used to earn $30,000 now earn $33,000), by how much (in percentage) do you think the number of people who will want to get a job in the forest sector increase (here not only those unemployed but also think of people who are employed in the other sectors who would want to change a job in to the forest sector)? ________________

24) If all other things remain unchanged but the wage rate in the composite sector increases by 10%, by how much (in percentage) do you think the number of people who will want to get a job in the composite sector increase?(think the same way as in item 23 above now for the composite sector)___________

25) If all other things remain unchanged but the rental price of houses for offices or for business increases by 10%, how much more residential houses do you think will be availed for rent or how much new houses will be built for rental (in percentage) ? ___________________________

26) If all other things remain unchanged but the rental price of any wood work machine increases by 10%, how much more wood work machines (in percentage) do you think will people buy and rent out? _______________

27) If all other things remain unchanged but the price that the forest sector firms are willing to pay for electricity increases by 10%, how much more electricity do you think will be availed by the power company for forest sector establishments (think

in terms of the amount of new power line that the power company would want to install)? ______________________________

28) If all other things remain unchanged but the price the composite sector firms are willing to pay for electricity increases by 10%, how much more electricity do you think will be availed by the power company for composite sector establishments? ________________________

29) If all other things remain unchanged but the stumpage price increases by 10%, how much more logs or timber do you think will be availed for sale? _______

30) If all other things remain unchanged but the rental price of land increases by 10%, how much more land do you think will be availed for rental? ________

31) Out of the total income earned by all households, what percent is earned:
From wage earning from the forest sector, ___________, from wage earning from the composite sector__________, from rental of capital ____________, from rental of land ________________, from stumpage__________________
NB: The sum of the figures in all the blanks in item 31 has to be 100.

32) Assuming that nothing is saved out of total income earned by households and assuming that all the income is spent in Petitcodiac, what percent is spent on forest sector products___________, on composite sector products_________

33) Cost share (in percentage) of factor F (e.g. labor) in the production of one unit of output in sector S (e.g. composite)

	forest	composite
labor		
capital		
logs/timber		0
land	0	
Energy		
Total	**100**	**100**

NB: Vertically, they have to sum up to 100 and here, the forest and not the forestland is considered as an input for forest sector production (forestland=0) and also amount of timber as an input for the composite sector production is assumed to be zero. (Please check if figures are consistent with items 10, 11, 12, 13, 14)

34) If all other things remain the same and the domestic price of timber increases by 10%, by how much do you think will the quantity supply of timber increase?

35) If all other things remain the same and the domestic price of the composite sector products increases by 10%, by how much do you think will the quantity supply of composite sector products increase?

36) If all other things remain the same and the world price of timber increases by 10%, by how much do you think will the local price of timber increase?

37) If all other things remain the same and the world price of garments increases by 10%, by how much do you think will the local price of garments increase?

38) If all other things remain the same and the world price of timber increases by 10%, by how much do you think will the export demand for timber increase?

39) If all other things remain the same and the world price of garments increases by 10%, by how much do you think will the import of garments decrease?

40) If all other things remain the same and the intermediate demand for forest sector products by the forest sector itself increases by 10%, by how much do you think will the export demand for the forest sector products increase or decrease?

41) If all other things remain the same and the intermediate demand for composite sector products by the composite sector itself increases by 10%, by how much do you think will the import of composite sector products increase or decrease?

42) If all other things remain the same and the intermediate demand for forest sector products by the composite sector increases by 10%, by how much do you think will the consumption demand by households for the forest sector products increase or decrease?

43) If all other things remain the same and the intermediate demand for composite sector products by the forest sector increases by 10%, by how much do you think will the intermediate demand for the forest sector products by the forest sector itself increase or decrease?