PRAIRIE PROVINCES FOREST DEPENDENT COMMUNITIES: METHODOLOGY, EMPIRICAL RESULTS, AND WELFARE IMPLICATIONS

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INTRODUCTION

Economic development in Canada has been driven historically by natural resource based activities. Nowhere is this more prevalent than in the prairie provinces of Alberta, Manitoba, and Saskatchewan where development began with the fur trade, followed by agriculture, forestry, and energy resources utilization activities. These latter three sectors rank among the largest economic sectors in the prairies. The forest industry on the prairies has played a somewhat subordinate role to the agricultural and energy sectors in terms of its share of employment and Gross Domestic Product (GDP). To various communities and regions in the prairies, however, the forest industry is a major economic force. Wood harvesting and processing provide direct community employment and capital utilization. Forests with merchantable stands and good regeneration potential are widely distributed throughout the local regions of the prairies. Because harvesting and processing is a weight reducing activity, wood processing mills are also widely distributed in more remote communities near raw material sources. This establishment of resource based activity at or near the wood fibre source leads to the formation of single-industry communities.

Single-industry communities, especially remote ones, have special needs and problems which may not be present in communities with more diverse economies. They are characterized by a narrow economic base and vulnerability to industry market fluctuations. In times of industry slow-downs, base employment and household incomes are reduced. Supporting service activities linked to forestry are in turn also reduced. Even when the key industry is buoyant and appears stable, the region or community continually faces the risk of reduced economic activity. This risk may represent a deterrent to community infrastructure, services and amenities development such as medical, recreational, religious, educational, and utilities facilities and services. These factors detract from the quality of life in single-resource communities. Formulation of public policies and programs to address the special problems of such communities can benefit from methods and analyses that identify degrees of single-industry dependency of various communities and likely consequences of economic shocks to them.

This paper has three objectives. The first objective is to propose an improved method for identifying communities dependent on the forest industry. The second objective is to apply the method to communities throughout the prairies. In so doing, an important information base for policy analysis is established. The third objective is to verify the performance of the improved method as an implicit indicator of potential amenity welfare effects from economic shocks. A general equilibrium model is developed and applied to accomplish this objective.

BACKGROUND

There are studies that define community dependency in the forest industry. In Canada, the Department of Regional Economic Expansion (DREE 1979) conducted a Canada-wide study to identify single-sector communities using 1971 census employment data. Employment in an industry was compared to total employment in the community. If employment in the industry was greater than an arbitrarily chosen critical level then the community was deemed dependent on that industry. A second stage of the methodology employs a device called the Herfindahl index to find dependent communities missed in the first stage. Inconsistencies arose but were not dealt with.

White et al. (1986) conducted a study identifying forest dependent communities in British Columbia using a methodology based on the DREE one, but with modifications. In particular, categories other than forest dependency for different degrees of forestry were used. They were dual communities (those dominated by the forest sector and one other), diverse communities (those with at least three dominant sectors, including forestry), specialized non-forest communities (those dependent on another sector, but with forestry employment still in the top five), and minor or no forest sector communities (forestry employment not in the top five).

Pharand (1988) conducted a Canada-wide study describing the demographic characteristics of communities dependent on forestry. It is also similar in method to the DREE study. A community was dependent on forestry if forest sector employment as a percentage of total employment exceeded an arbitrary critical level. Steele et al. (1988) used a location quotient to define dependency on forestry in Saskatchewan. The provincial average of forestry employment to total employment was used as a benchmark. In essence, the method is similar to that used by Pharand, but made no adjustment for population.

These Canadian studies are similar to studies elsewhere. For example, one of the earlier American studies by Schallau, Maki, and Beuter (1968) classified communities in the northwestern United States as highly, moderately, or slightly timber dependent. Communities were placed into these categories by comparing forestry employment to economic base employment. The economic base was estimated using a crude location quotient technique and the cut-offs for the categories were arbitrarily chosen.

All of these studies used methods that lacked a theoretical base. Despite efforts to adjust for population size in some cases, critical levels to define degrees of dependency were arbitrarily chosen and inconsistencies not generally resolved. A consistent, theoretically based empirical method of identifying degree of forest dependency of communities was clearly called for.

METHODOLOGY

An improved method for measuring degrees of dependency of communities on the forest sector begins with an understanding of economic base theory. The concept of the basic sector was first conceived in the 1930s when city planners required a method for estimating total impact on a community from the introduction or expansion of a base industry (Weimer and Hoyt 1954). The economic base of a community includes any activity that brings income into the regional economy, that is, it is the driving force of the economy. Therefore, most regional economists view a small economy as being dependent on exports for its well-being (Tiebout 1962; Pleeter 1980; and Richardson 1985). The non-basic or service sector in the community provides goods and services to the basic sector. While appropriate units of measurement including sales, value added, income, and employment have been debated in the literature (Tiebout 1962), employment has emerged as the unit of choice because of ease of measurement and the fact that it tends to be co-linear with the other measures. Highly disaggregated employment data can be obtained from the national censuses, precluding the need to carry out expensive and time consuming direct measurement surveys. The methodology presented below relies on the location quotient indexing technique and avoids the arbitrary critical values prominent in the literature.

The location quotient (LQ) method is the most popular method of indirectly measuring the economic base of a community. It is based on the underlying assumption that if a community is highly specialized in an industry in relation to the national average, that portion of the industry's activity is considered to be export activity. The mathematical form of this technique is as follows:
Community *j's* location quotient for industry *i* is:

$$\mathrm{LQ}^{i}_{j} = \frac{E^{i}_{j} / E^{T}_{j}}{E^{i}_{N} / E^{T}_{N}}$$

where E is employment, T is the total for all sectors, and N is the national total. If the LQ is 5, for example, employment is five times more concentrated in the community than in the nation as a whole. Base employment is considered to be employment above and beyond the national average because it is assumed the national average is what is required to serve local needs.

The accuracy of this technique depends on four major assumptions. First, there are no net exports at the national benchmark level. If the nation is a net exporter in an industry then this technique will underestimate base employment. Conversely, if the nation is a net importer in an industry, the LQ method will overestimate base employment. This can be corrected by adjusting the benchmark employment in an industry. Second, consumption patterns are assumed to be identical across the nation.

The use of provincial, rather than national, benchmark employment can help correct this problem. Third, labour productivity is assumed to be equal across regions of a nation. This can be corrected by using regional productivity measures. Finally, it is important to address the degree of homogeneity of products within an industrial classification. If there is more than one product within a group, errors could be introduced by failing to differentiate between them (for example treating pulp and lumber as a single commodity rather than as separate products). The solution to this problem is to use as highly disaggregated data as possible.

For this study a methodology that could be used easily and at reasonable cost for a large number of communities was sought; thus secondary data sources were used. The only source of employment data classified by industry and community is the national census conducted every five years in Canada, with the most recent one from which data was available being in 1986. The next item of concern was how to use census employment data to identify dependent communities. The data must be used to estimate the economic base and then determine the relative size of the forest sector to that base.

The location quotient has the support of prominent authors such as Richardson (1985), Isserman (1977) and Schwartz (1982) as the best technique in its class provided steps are taken to reduce the error caused by violation of its assumptions. In the case of forest sector dependence on the prairies the following measures are taken to increase the accuracy of the location quotient:

- benchmark employment figures are adjusted for net exports in an industry[1];
- provincial benchmarks are used rather than national ones (Schwartz 1982); and
- census employment data is very highly disaggregated.

The final consideration is to determine the minimum percentage of base employment which places a community in the forest dependent category. Previous literature has used only ad hoc methods. Each author has made a subjective decision on the appropriate cut-off levels for their studies. The following procedure is proposed for this study:

- rank the communities by percentage forestry employment of economic base employment; and

[1]The adjustment is made as follows, where T_i is total output in sector i, X_i is total exports in sector i, M_i is total imports in sector i, and E_i is provincial employment in sector i:

$$\text{Benchmark employment} = \frac{(T_i - X_i + M_i)}{T_i} E_i$$

- using cut-off levels employed in the past as a rough guide, look for natural breaks in the rankings. If breaks exist they may indicate the structural differences in the economies of the communities being identified.

While the methodology presented here is not perfect, it has been developed with attention to the pertinent theoretical literature as well as the strengths and weaknesses of previous single sector community studies. In particular, the study was designed to be applied easily to a large number of communities.

DEPENDENCY ANALYSIS

INTRODUCTION

This section identifies the degree of forest-sector dependency of all prairie communities where people are employed in forestry. The identification is done using the methodology outlined in the previous section. Also, efforts are made to describe important aspects of community dependence on forestry. These include changes in community dependency between 1981 and 1986, comparison of overall provincial levels of dependency between provinces and census years, and segregation of communities into categories by degree of forest dependency.

The intent of this section is not to test *a priori* hypotheses about the forest sector in the prairie provinces. The objective is to discover the degree and characteristics of forest dependency, and to present these findings in such a way as to answer any questions regarding forest dependency that the reader may have.

The forested region makes up over two-thirds of the area of the prairie provinces and contains over three hundred communities, or one third of the total for the three provinces. These communities, with very few exceptions, are small (only four with population above 10,000 and none above 40,000) and resource based. Important sectors in this region besides forestry are oil and gas, agriculture, mining, and hydro-electric power.

The fact that these communities are small is an important consideration to this project. Authors in economic base literature have indicated that the relevance of economic base theory and its applications are inversely related to the size of the community or region in question (Pleeter 1980). Cities such as Edmonton or Regina are much more self-sufficient than small communities in goods and services provided. This self-sufficiency means the export/import relationship crucial to economic base theory is of diminished importance in the large city's economy.

THE DATA

The following analysis is based on data obtained from the Statistics Canada national censuses of 1981 and 1986. The data are comprised of employment figures for each census sub-division disaggregated by Standard Industrial Classification (SIC), of which there are 257. In the forested region of the prairie provinces (in Alberta census divisions 3, 6, 9, and 12-19; in Saskatchewan census divisions 9, and 14-18; and in Manitoba census divisions 1, 2, 13, 14, and 16-23) there are 698 census sub-divisions, of which 333 are communities, 180 are rural districts, and 185 are Indian reservations. The term *rural district* is a generic term used to describe counties, rural municipalities, local government districts, and improvement districts.

The rural districts are not examined for forest dependency because they are agglomerations of dispersed rural populations and do not represent communities as such. Indian reservations are also not examined because their inherent cultural and governmental differences do not allow direct comparison. The study of rural districts and Indian reservations would be a worthy subject of future research, but is beyond the scope of the present project.

RESULTS

Employment Ratios

The first step in the analysis is the calculation of the economic base of each community using the LQ. The results from this stage of the analysis are of interest in their own right. Some of the studies discussed earlier that identified forest dependency by comparing forestry employment to total employment used critical values which decreased with population. The authors did this because of the common assumption that the base/total employment ratio decreases with increasing population. Another hypothesis, put forward by Christaller (1966) in his central place theory, suggests that this ratio would be affected not only by the community's size but also by its place in the hierarchy of communities. The economic base estimates of the LQ technique can be examined to see if these relationships hold.

Figure 1 plots the base/total employment ratio (measured by the location quotient) versus total population in the community. As expected from the discussion in the previous section, there is an inverse relationship. Using logarithmic transformations of both variables a regression line is fitted. For regression purposes the base/total ratio was also adjusted downwards so that the fitted line could converge to a positive minimum value instead of converging to zero[2].

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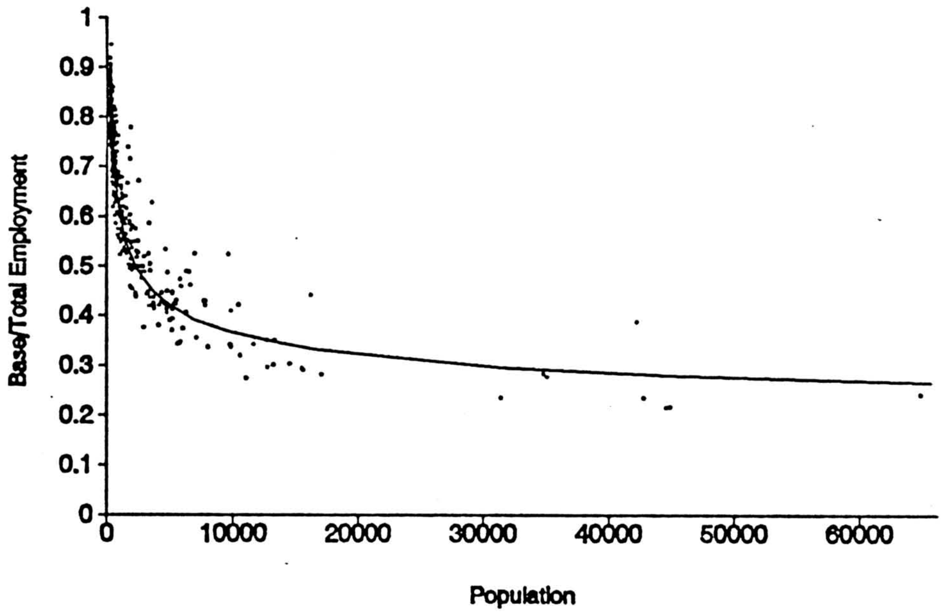
[2] As community size increases the regression line converges to 0.15. This was determined by iteration, maximizing R^2. The regression equation, where ln is the natural log, is:

$$\ln(\text{ratio} - 0.15) = 1.824 - 0.3669 \ln(\text{employment}); \quad R^2 = 0.857$$

FIGURE 1

BASE/TOTAL EMPLOYMENT RATIO VS. TOTAL POPULATION



A relationship between residuals from this regression and the characteristics of the communities would indicate that using the economic base measured by the LQ would be preferred to using the predicted value from the regression. If there is no relationship or pattern of any kind to the residuals then the size of the economic base predicted by the regression would be preferred to the individual economic base measured by the LQ. Table 1 shows the communities whose residuals are plus or minus two standard deviations from zero.

TABLE 1

COMMUNITIES WITH LARGEST REGRESSION RESIDUALS

COMMUNITY	RESIDUAL
FORT MACMURRAY	.5710
HINTON	.5410
LEAF RAPIDS	.5258
THOMPSON	.4619
GRANDE CACHE	.4584
FLIN FLON	.4396
SWAN HILLS	.4297
SNOW LAKE	.4228
FOX CREEK	.4109
COLD LAKE	.3460
GRAND CENTRE	.3305
CROWSNEST PASS	.3103
SPRUCE GROVE	-.3053
INNISFAIL	-.3056
SWIFT CURRENT	-.3098
TISDALE	-.3556
BRANDON	-.4463
AIRDRIE	-.5164
GRANDE PRAIRIE	-.5430
ST. ALBERT	-.6642
MEDICINE HAT	-.6767

Examination of these results requires some subjective and qualitative interpretation. An argument was put forth above that was based on central place theory. This argument stated that a community with a high place in the hierarchy of communities would have a lower base/total ratio than would be expected from its population, and vice-versa for communities low in the hierarchy. Many of the communities with the large negative residuals, particularly Medicine Hat, Grande Prairie, Brandon, and Swift Current, are regional service centres with a large outlying population below them on the hierarchy. Many of the communities with the large positive residuals, particularly Fort McMurray, Leaf Rapids, Thompson, Flin Flon, Snow Lake, Swan Hills, and Fox Creek, are isolated communities with very sparse population in outlying areas.

These results are entirely consistent with the hierarchy of communities hypothesis. The location quotient technique is sensitive to such differences in communities, and its use in this instance is supported.

Degree of Dependency

The next step is to identify the degree of forest dependency of each community. Forest dependency is measured as the employment the forest sector contributes to the base divided by total base employment. This ratio is the forest dependence index (FDI) and can be interpreted as follows: a value of 0.3 means that the forest sector makes up 30 percent of the economic base. Tables 2 and 3 show prairie communities ranked by forest dependency in 1981 and 1986. Also shown in these tables are other details of these communities, including employment in other important resource sectors.

The most striking feature of these tables is the two highest ranked communities in 1986. Endeavour and Albertville both have an FDI ranking of 1.000, which means all of the basic employment is in the forest sector. Closer examination of the data for these reveals that forestry makes up not only all of the basic employment in the communities but all total employment as well. The reason for these odd results is the size of these communities. Both Endeavour and Albertville are extremely small communities, and in fact may not be self-contained communities in the true sense.

Another feature of interest in Tables 2 and 3 is the fact that there are not many communities where forestry dominates the economic base. There are only six communities where forestry makes up over 50 percent of the base and four of these, Endeavour, Albertville, Smeaton, and Meath Park, are extremely small communities. Despite the lack of communities dominated by forestry there are many where the forest sector is a significant component of base activity. This result is consistent with the perception of forestry on the prairies being a diversifying rather than a dominant agent.

The overall provincial levels of community dependence on forestry can also be represented in this analysis. The concept of overall dependency in a province as used here is meant to describe the aggregation of community dependency in a province, **not** the provincial forestry employment total. A quantitative estimate of overall dependency is the sum of all communities' FDI in a province weighted by community size. These sums are represented in Table 4.

The overall level of dependency in Alberta is much higher than in either Saskatchewan or Manitoba. This is a result of two factors: Alberta has more communities with some forestry employment and Alberta has larger communities with some forestry employment.

TABLE 2
PRAIRIE COMMUNITIES RANKED BY FOREST DEPENDENCE INDEX (FDI) 1981

COMMUNITY	PROV	CD	TOT EMP	BASE	FOR	AG	EN	MIN	FH&T	HYDRO	FDI
POWERVIEW	M	1	250	219.3	174.9	0.0	0.0	0.0	0.0	0.0	0.7974
HUDSON BAY	S	14	900	575.4	366.3	9.1	0.0	0.0	0.0	0.0	0.6365
SMEATON	S	14	40	35.1	19.9	6.0	0.0	0.0	0.0	0.0	0.5667
MEATH PARK	S	15	20	18.0	10.0	8.0	0.0	0.0	0.0	0.0	0.5547
BIG RIVER	S	16	220	183.9	89.1	0.0	0.0	0.0	9.9	0.0	0.4846
HINTON	A	14	4040	1951.9	829.0	10.6	582.7	0.0	0.0	0.0	0.4247
COWLEY	A	3	85	73.6	29.9	0.0	0.0	0.0	0.0	0.0	0.4069
THE PAS	M	21	2875	1332.5	538.5	0.0	0.0	0.0	0.0	0.0	0.4041
MAYERTHORPE	A	13	440	308.4	103.9	0.0	0.0	24.7	0.0	0.0	0.3368
SANGUDO	A	13	75	66.8	19.9	0.0	0.0	0.0	0.0	0.0	0.2984
GRANDE PRAIRIE	A	15	13160	3805.7	1094.2	8.7	0.0	402.5	0.0	76.7	0.2875
LEOVILLE	S	16	85	69.2	19.8	21.5	0.0	0.0	0.0	0.0	0.2864
HIGH LEVEL	A	15	1055	590.7	164.1	0.0	0.0	47.4	0.0	9.9	0.2779
GLASLYN	S	17	160	115.8	24.9	4.0	0.0	0.0	0.0	0.0	0.2146
NIVERVILLE	M	2	390	274.5	58.7	9.6	0.0	0.0	0.0	0.0	0.2139
BOYLE	A	13	185	141.8	29.8	3.5	0.0	0.0	0.0	0.0	0.2106
WHITECOURT	A	13	2735	1269.1	253.9	12.0	133.4	247.3	0.0	6.8	0.2001
PADDOCKWOOD	S	15	55	50.0	10.0	0.0	0.0	0.0	0.0	0.0	0.1996
SLAVE LAKE	A	15	2045	970.2	190.2	0.0	44.2	210.5	0.0	30.2	0.1960
STEINBACH	M	2	2845	1331.5	256.0	96.3	0.0	0.0	0.0	0.0	0.1923
CHOICELAND	S	14	125	103.7	19.7	37.5	0.0	0.0	0.0	0.0	0.1904
HINES CREEK	A	15	150	131.3	24.9	0.0	0.0	23.2	0.0	0.0	0.1895
SUNDRE	A	6	610	384.5	68.5	0.0	63.4	0.0	0.0	7.1	0.1780
PRINCE ALBERT	S	15	14505	4280.4	693.0	8.3	0.0	0.0	0.0	0.0	0.1619
WILDWOOD	A	14	70	64.0	9.9	0.0	0.0	0.0	0.0	0.0	0.1543
HIGH PRAIRIE	A	15	1070	553.6	84.1	0.0	14.7	0.0	0.0	0.0	0.1520
KINUSO	A	15	115	101.7	14.9	16.0	23.9	0.0	0.0	0.0	0.1466
DELBURNE	A	8	140	105.5	14.6	0.0	0.0	13.3	0.0	0.0	0.1385
SPIRIT RIVER	A	15	445	291.6	38.6	29.5	10.7	0.0	0.0	0.0	0.1322
MAGRATH	A	3	385	266.1	33.9	31.6	0.0	0.0	0.0	0.0	0.1276
EDAM	S	17	100	84.0	9.8	35.0	0.0	0.0	0.0	0.0	0.1166
WABAMUN	A	11	200	173.2	20.0	0.0	29.1	0.0	0.0	79.0	0.1153
MARYFIELD	S	1	105	85.1	9.8	24.5	0.0	0.0	0.0	0.0	0.1149
CARROT RIVER	S	14	365	224.1	24.8	13.4	0.0	20.0	0.0	0.0	0.1106
WEMBLEY	A	15	320	229.1	24.2	3.8	11.9	31.2	0.0	0.0	0.1056
CROWSNEST PASS	A	9	2955	1521.7	151.3	0.0	792.4	0.0	0.0	0.0	0.0994
ROBLIN	M	16	550	321.7	29.8	11.5	0.0	0.0	0.0	5.0	0.0925
SMOKY LAKE	A	12	295	214.8	19.5	19.7	2.6	0.0	0.0	0.0	0.0910
SWAN RIVER	M	20	1285	599.4	52.1	0.0	0.0	0.0	0.0	0.0	0.0869
BARRHEAD	A	13	1420	694.5	58.8	60.7	26.4	0.0	0.0	8.2	0.0847
MANITOU	M	4	245	179.3	14.9	44.2	0.0	0.0	0.0	0.0	0.0832
COCHRANE	A	6	1595	632.7	50.5	18.3	107.7	0.0	0.0	12.3	0.0798
MEADOW LAKE	S	17	1460	681.3	51.1	0.0	0.0	0.0	0.0	0.0	0.0751

CD	census division
TOT EMP	total employment
BASE	base employment
FOR	forestry employment
AG	agricultural employment
EN	energy employment
MIN	mining employment
FH&T	fishing, hunting, and trapping
HYDRO	hydroelectricity employment
FDI	forestry dependence index

TABLE 3
PRAIRIE COMMUNITIES RANKED BY FOREST DEPENDENCE INDEX (FDI) 1986

COMMUNITY	PROV	CD	TOT EMP	BASE	FOR	AG	EN	MIN	FH&T	HYDRO	FDI
ENDEAVOUR	S	9	15	15.0	15.0	0.0	0.0	0.0	0.0	0.0	1.0000
ALBERTVILLE	S	15	10	10.0	10.0	0.0	0.0	0.0	0.0	0.0	1.0000
POWERVIEW	M	1	200	170.6	124.9	0.0	0.0	0.0	0.0	0.0	0.7322
HUDSON BAY	S	14	815	481.5	257.3	8.7	0.0	0.0	0.0	0.0	0.5343
BIG RIVER	S	16	265	208.9	94.3	0.0	0.0	0.0	0.0	0.0	0.4515
CHITEK LAKE	S	16	25	24.3	9.9	0.0	0.0	0.0	0.0	0.0	0.4088
TOGO	S	9	30	26.1	10.0	7.1	0.0	0.0	0.0	0.0	0.3821
HINTON	A	14	4370	2286.9	867.1	4.8	769.1	0.0	0.0	0.0	0.3792
HINES CREEK	A	17	185	154.7	54.5	8.5	0.0	23.1	0.0	0.0	0.3524
THE PAS	M	21	3005	1389.0	459.1	0.0	0.0	0.0	0.0	0.0	0.3305
HIGH LEVEL	A	17	1500	787.9	254.1	0.0	51.0	94.5	0.0	0.0	0.3225
PADDOCKWOOD	S	15	60	49.6	14.9	9.2	0.0	0.0	0.0	0.0	0.3008
WEMBLEY	A	19	355	221.2	64.1	7.5	0.0	16.3	0.0	0.0	0.2898
GRANDE PRAIRIE	A	19	14235	3358.3	923.1	0.7	72.5	448.0	8.9	6.1	0.2749
GRANDE CACHE	A	18	1615	1011.2	258.6	0.0	324.1	0.0	0.0	37.2	0.2557
MAYERTHORPE	A	13	375	246.1	59.6	1.8	0.0	6.1	0.0	0.0	0.2424
WHITECOURT	A	13	2845	1357.7	323.7	0.0	242.6	135.6	0.0	0.0	0.2384
KINUSO	A	17	85	76.7	14.9	0.0	0.0	0.0	0.0	0.0	0.1946
DONNELLY	A	19	155	128.7	24.9	0.0	0,0	0.0	0.0	0.0	0.1931
HIGH PRAIRIE	A	17	1180	590.3	111.8	0.0	0.0	0.0	0.0	0.0	0.1894
STEINBACH	M	2	3480	1492.6	226.5	88.0	0.0	0.0	0.0	1.0	0.1518
CARROT RIVER	S	14	330	232.9	34.4	43.0	0.0	0.0	0.0	0.0	0.1478
SLAVE LAKE	A	17	2660	1187.0	168.2	0.0	157.5	172.5	0.0	32.1	0.1417
DEBDEN	S	16	80	69.6	9.8	0.0	0.0	0.0	0.0	0.0	0.1414
CHOICELAND	S	14	95	76.9	9.8	0.8	14.5	0.0	0.0	0.0	0.1275
EDSON	A	14	3530	1446.3	179.3	10.8	371.3	53.5	0.0	0.0	0.1240
ROBLIN	M	16	700	435.5	53.7	59.3	14.6	0.0	0.0	0.0	0.1233
PELICAN NARROWS	S	18	90	80.5	9.9	0.0	0.0	0.0	0.0	0.0	0.1229
MIRROR	A	8	95	85.8	10.0	16.5	9.1	0.0	0.0	0.0	0.1160
MEADOW LAKE	S	17	1495	670.3	75.7	6.9	0.0	8.1	0.0	0.0	0.1129
PRINCE ALBERT	S	15	15755	4463.3	491.3	36.3	0.0	60.5	0.0	0.0	0.1101
BOYLE	A	13	180	136.6	14.8	13.7	0.0	0.0	0.0	0.0	0.1086
DENARE BEACH	S	18	110	96.3	9.9	0.0	0.0	25.0	0.0	0.0	0.1025
SUNDRE	A	6	685	399.9	39.4	0.0	49.7	17.9	0.0	6.7	0.0984
SMOKY LAKE	A	12	280	212.1	19.5	14.7	0.0	0.0	0.0	0.0	0.0920
BUFFALO NARROWS	S	18	400	271.3	24.5	0.0	0.0	9.1	9.9	0.0	0.0904
AIR RONGE	S	18	200	170.1	14.8	0.0	0.0	0.0	0.0	0.0	0.0867
COCHRANE	A	6	1970	850.3	67.2	12.7	33.3	0.0	0.0	30.5	0.0790
SEXSMITH	A	19	465	314.6	24.6	0.0	10.7	0.0	0.0	0.0	0.0781
CROWSNEST PASS	A	15	2945	1434.2	111.9	24.6	774.3	0.0	0.0	0.0	0.0780
PREECEVILLE	S	9	370	249.5	19.3	14.1	0.0	0.0	0.0	0.0	0.0772
GLASLYN	S	17	170	131.9	9.9	18.5	0.0	0.0	0.0	0.0	0.0753
NIVERVILLE	M	2	550	376.0	28.0	100.9	0.0	0.0	0.0	0.0	0.0746

CD census division
TOT EMP total employment
BASE base employment
FOR forestry employment
AG agricultural employment
EN energy employment
MIN mining employment
FH&T fishing, hunting, and trapping
HYDRO hydroelectricity employment
FDI forestry dependence index

TABLE 4

OVERALL PROVINCIAL DEPENDENCE ON FORESTRY
(Sum of all Communities' Forest Dependence Index)

PROVINCE	1981	1986	CHANGE
ALBERTA	19.29	17.61	-1.68
SASKATCHEWAN	4.96	4.09	-0.81
MANITOBA	6.38	5.64	-0.74
TOTAL	30.63	27.34	-3.29

The second notable feature in Table 4 is the decline in overall dependency of all three provinces between 1981 and 1986. The decrease in overall dependency levels could be brought about by growth in other sectors or by a decrease in the forest sector itself. Both of these factors played a part in the decline in overall dependency (Table 5). Total forestry employment did fall in all three provinces, while at the same time the two larger resource sectors, agriculture and energy, both showed increases in employment.

TABLE 5

PROVINCIAL EMPLOYMENT IN RESOURCE SECTORS IN 1981 AND 1986

	FORESTRY		AGRICULTURE		ENERGY	
PROVINCE	1981	1986	1981	1986	1981	1986
ALBERTA	14875	13725	92465	98810	62135	69165
SASKATCHEWAN	4565	4030	89505	95805	4105	5360
MANITOBA	7385	6740	48000	51580	715	860

Despite the decline in forestry employment, the sector remains an important diversifying agency in the prairie provinces. The declines in employment can be traced to improvement in technology rather than a downsizing of the industry. This has produced a more competitive forest sector that will be less susceptible to downturns in the industry. Since 1986 new mills have been built on the prairies and others have expanded. These changes may well have reversed the trend of decreasing employment.

Another feature of interest regarding forest dependency is how this dependency has changed for individual communities between 1981 and 1986. Table 6 shows the communities with the twenty largest increases and decreases in FDI between the census years. (The communities of Albertville, Denare Beach, Buffalo Narrows, and Air Ronge are all new census sub-divisions to the 1986 census.)

TABLE 6

COMMUNITIES WITH THE LARGEST CHANGES IN FDI BETWEEN 1981 AND 1986

COMMUNITY	PROVINCE	CHANGE IN FDI
ENDEAVOUR	SASK	1.0000
CHITEK LAKE	SASK	0.4088
TOGO	SASK	0.3821
GRANDE CACHE	ALB	0.2344
DONNELLY	ALB	0.1931
WEMBLEY	ALB	0.1842
HINES CREEK	ALB	0.1629
DEBDEN	SASK	0.1414
PELICAN NARROWS	SASK	0.1229
MIRROR	ALB	0.1160
PADDOCKWOOD	SASK	0.1012
SEXSMITH	ALB	0.0781
PREECEVILLE	SASK	0.0772
EDSON	ALB	0.0752
PORCUPINE PLAIN	SASK	0.0555
SHELLBROOK	SASK	0.0536
KINUSO	ALB	0.0480
HIGH LEVEL	ALB	0.0446
STONEWALL	MAN	0.0386
WHITECOURT	ALB	0.0383
MAGRATH	ALB	-0.0674
THE PAS	MAN	-0.0736
SUNDRE	ALB	-0.0796
MANITOU	MAN	-0.0832
MAYERTHORPE	ALB	-0.0944
BOYLE	ALB	-0.1020
HUDSON BAY	SASK	-0.1022
MARYFIELD	SASK	-0.1149
WABAMUN	ALB	-0.1153
EDAM	SASK	-0.1166
SPIRIT RIVER	ALB	-0.1322
DELBURNE	ALB	-0.1385
GLASLYN	SASK	-0.1393
NIVERVILLE	MAN	-0.1393
WILDWOOD	ALB	-0.1543
LEOVILLE	SASK	-0.2864
SANGUDO	ALB	-0.2984
COWLEY	ALB	-0.4069
MEATH PARK	SASK	-0.5547
SMEATON	SASK	-0.5667

There is an important point to be made regarding the communities with the more extreme changes in FDI. Endeavour, Chitek Lake, Togo, Smeaton, Meath Park, Cowley, Sangudo, and Leoville are all very small communities. There are three possible reasons for this pattern. First, with these very small communities, small absolute changes in the forest sector mean relatively larger changes in FDI. Second, the census data contains only a 20 percent sample of employment in a community. In smaller communities there is greater variability in the estimation of employment levels, leading to greater variability in FDI changes between census years. Finally, employment numbers are randomly rounded to multiples of five by Statistics Canada to protect confidential sources. In small communities this could introduce significant error.

Categories of Dependency

This section examines the problem of segregating prairie communities into dependency categories. The method as described above is to look for natural breaks in the distribution of communities' forest dependency. If these breaks exist, they may indicate the structural differences in the communities that are to be identified. Also, this technique will avoid separating communities which have very similar dependency rankings. Some subjective reasoning will be required to determine the number of categories and the general location of the cut-offs.

Figures 2 and 3 depict the distribution of FDI in all three prairie provinces for 1981 and 1986. The vertical scale of the figures is the FDI ranking of the community and is primarily a visual aid. The figures show that there are breaks in the distribution. The vertical lines show the cut-offs for the following proposed categories:

- greater than 0.50 FDI, forest dependent community;
- between 0.23 and 0.50 FDI, moderately dependent community; and
- between 0.07 and 0.23 FDI, slightly dependent community.

These cut-offs correspond with the horizontal lines in Tables 2 and 3. Note that communities with an FDI below 0.07 are not listed.

GENERAL EQUILIBRIUM ANALYSIS

INTRODUCTION

The question of how well the forest dependency indices reflect community welfare effects from economic shocks is to be addressed. The underlying relationship for targeting policy and program initiatives is as follows. The more dependent a community is on forestry, the greater the welfare impact, positive or negative, will be on that community from supply or demand shocks.

FIGURE 2

DISTRIBUTION OF ALL COMMUNITIES' FDI IN 1981

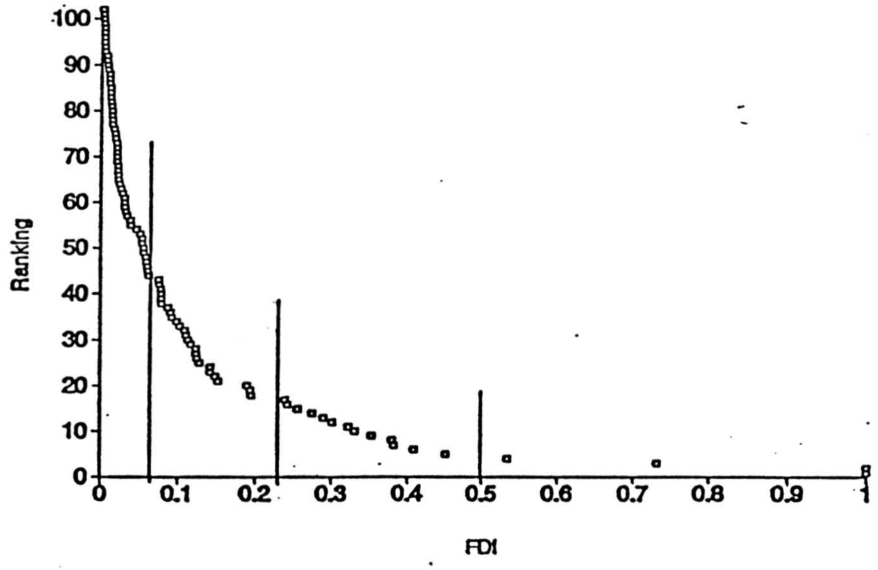
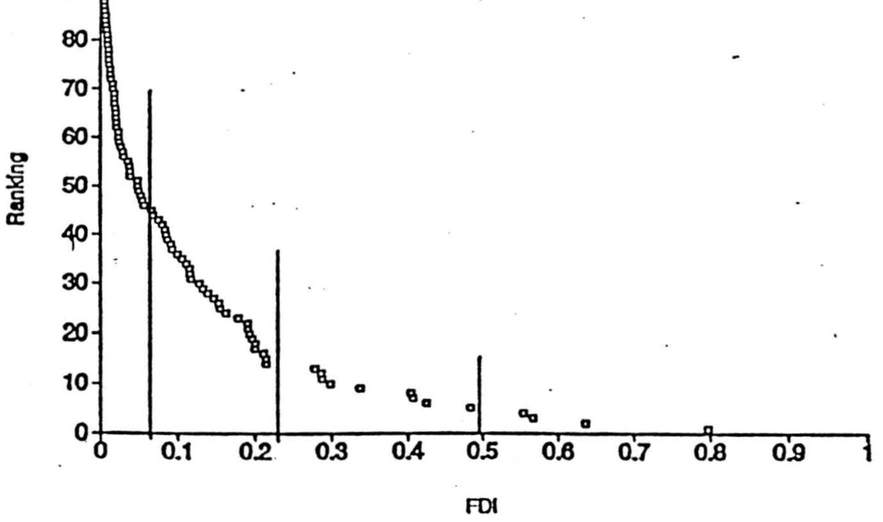


FIGURE 3

DISTRIBUTION OF ALL COMMUNITIES FDI IN 1986



Supply side shocks include depleting forests which is an issue in much of Canada. Prairie Canada has received a reprieve from the adoption of newer mill technology that allows the widespread use of aspen along with traditional conifer species utilization. Demand side shocks include output price fluctuations. The lumber market has been weak. The pulp market has been strong, but prices are currently falling. The question is how reliable are the dependency indices in differentiating effects of shocks among communities? This is the subject of this third part of the paper.

MODEL

In order to address the reliability issue a general equilibrium (GE) model has been developed following Percy et al. (1989), Boyd and Hyde (1989), and others. The model developed here is well grounded in economic theory, more so than the index methodology. It is a simplified representation of community conditions but can accommodate data limitations.

The model itself consists of three sectors, forestry, other tradeable goods, and non-traded goods. There are three functions of production involved in the model. They are labour, capital, and timber. The resultant system of equations includes production functions, cost functions, product markets, factor markets, and consumer income.

Welfare measure is limited to community income because of data limitations. Community income consists of wages and salaries earned plus returns to capital from the service sector. The assumption is made that returns to capital of exporting industries leave the community.

RESULTS

This section uses the GE model to test the hypothesis that there is a positive, monotonic relationship between FDI and the magnitude of welfare impacts from shocks to the forest industry. This test will involve inserting different sectoral employment shares into the model. There are two aspects of a community's economy, FDI and the size of the community (more specifically base/total employment ratio), which influence the sectoral employment shares. In order to understand the importance of each of these factors their welfare impacts are examined in isolation using hypothetical communities.

The shocks simulated here are price and supply shocks. The price shock is a one percent decrease in the world price of forest products. The supply shock is a one percent decrease in available timber. In using this GE model it is important to remember that all relationships have been made linear by the rate of change format. This means that the predictions of the model are more reliable for small changes in exogenous variables. The effects of shocks larger than one percent can be extrapolated linearly, but with decreasing reliability.

Figure 4 and Table 7 show welfare effects, measured as percentage change in community income, of price and supply shocks. The model predicts that with constant community size, for both price and supply shocks, there is a nearly linear relationship between FDI and income changes. This relationship supports, but does not confirm, the previously stated hypothesis. It remains to be shown if this monotonicity holds over varying community size. Table 8 shows the effects of price and supply shocks for varying levels of community size (total employment is used as a proxy for community size) and fixed FDI. The model predicts that changing community size has no effect on percentage change in income.

If the partial effect of community-size on income changes is zero, then welfare impacts from forest sector shocks predicted by this model are strictly monotonic with FDI. This result is important because it means a ranking of communities by FDI (such as the one derived above and shown in Tables 2 and 3) also represents a ranking of communities by welfare impacts from forest sector shocks. The further conclusion can be drawn that, in the event of policy changes or external shocks, a ranking of communities by FDI, *ceteris paribus*, also represents a priority ranking for any government intervention which may be undertaken.

FIGURE 4

INCOME LOSS VS. FDI

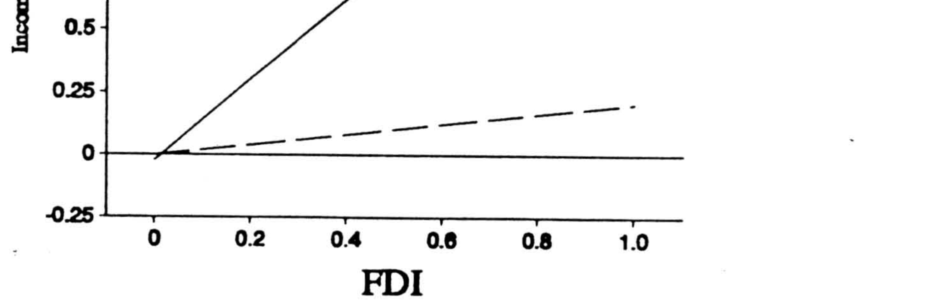


TABLE 7

INCOME EFFECTS OF PRICE AND SUPPLY SHOCKS IN A COMMUNITY WITH 4000 INITIALLY EMPLOYED

FDI	PROPORTIONAL LOSS IN INCOME (%)	
	P_x = -1%	T_x = -1%
0.0	-0.023	0.000
0.2	0.306	0.041
0.4	0.619	0.082
0.6	0.917	0.124
0.8	1.201	0.165
1.0	1.472	0.206

where FDI is the forest dependence index, P_x is the percentage change in the price of forest products, and T_x is the percentage change in timber supply

TABLE 8

INCOME EFFECTS OF PRICE AND SUPPLY SHOCKS IN A COMMUNITY WITH 0.400 FDI

TOTAL EMPLOYMENT	PROPORTIONAL CHANGE IN INCOME (%)	
	P_x = -1%	T_x = -1%
1000	0.619	0.082
2000	0.619	0.082
4000	0.619	0.082
8000	0.619	0.082
16000	0.619	0.082
32000	0.619	0.082

where FDI is forest dependence index, P_x is the percentage change in the percentage price change of forest products and T_x is the percentage change in timber supply

WELFARE IMPACTS OF SPECIFIC SHOCKS

This section examines in more detail the welfare impacts of specific shocks which may affect forestry communities. These shocks are: cyclic forest product prices; a price shock to the community's other exporting sector; and a decrease in timber supply. Such issues are brought into a more realistic context by using real communities as examples and by measuring welfare impacts in dollars rather than in proportional change.

The model predicts proportional changes but, for community income (the current measure of welfare), monetary change can be calculated indirectly. This is done by assuming an initial wage rate of $1945.62/month, the 1986 industrial average for Alberta (Alberta Bureau of Statistics 1990), and then finding the initial service sector capital returns from their share of community income[3]. Once initial community income is known, the post-shock income is easily found from the changes in the wage rate, employment, and the capital rental rate. To enable comparisons between communities of different sizes change in income is given in units of dollars per individual employee per month.

CYCLIC FOREST PRODUCT PRICES

The first set of simulations (Table 9) shows the effects that equal but opposite shocks in the price of forest products, such as might occur from the business-cycle, have on the income of communities with different degrees of forest dependency. Two communities from each forest dependency category are shown. The price shocks are one percent, positive and negative. Table 9 shows the resulting changes in income, as well as the net change.

The important result in Table 9 is the symmetry of the changes in welfare, suggesting that the effects of cyclic prices cancel out with no net change. This result could have been predicted given the symmetric structure of the model. The question of the net welfare effects of cyclic prices is not so easily answered, however, because of the possibility that the elasticity of supply of labour is not symmetric.

The concept of asymmetry in labour supply is well supported in economic literature (McConnell et al. 1990; Branson 1972). The underlying notion is that wages are more flexible upward than downward. If a sector's demand for labour increases, it is easy to increase wages to lure workers away from other sectors. Likewise, it is easy to offer workers a wage increase to keep them. If demand for labour decreases then, in order to maintain previous employment levels, wages would have to fall. This decrease may be less likely to occur than an increase due to labour unions or other barriers.

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[3]For example, if wage income is $1000, θ_{KzI} is 0.3 and service sector capital returns are x, then:

$$x = 0.3(1000 + x); \quad x = \$428.57$$

TABLE 9

WELFARE EFFECTS OF SYMMETRIC PRICE SHOCKS

INCOME CHANGE ($/EMPLOYEE/MONTH)

COMMUNITY	FDI	P_x = -1	P_x = 1	NET
POWERVIEW	0.732	-21.95	21.95	0
HUDSON BAY	0.534	-17.26	17.26	0
HINTON	0.379	-12.64	12.64	0
THE PAS	0.331	-11.34	11.34	0
SLAVE LAKE	0.142	- 4.74	4.74	0
PRINCE ALBERT	0.110	- 4.04	4.04	0

where FDI is the forest dependence index and P_x is the percentage change in the price of forest products

Table 10 shows the welfare impacts of the same symmetric shocks, but using a kinked labour supply curve. There is now a net loss from symmetric price shocks. The labour supply curve is steeper for the positive shock than for the negative shock. This result indicates that, under asymmetric labour supply, cyclic instability causes a welfare loss to the community as measured against stable forest product prices. Neo-classical economic theory suggests that a consideration in this issue is the degree to which these income changes are anticipated.

TABLE 10

WELFARE EFFECTS OF SYMMETRIC PRICE SHOCKS (P_X) WITH ASYMMETRIC LABOUR SUPPLY (Σ_L)

INCOME CHANGE ($/EMPLOYEE/MONTH)

COMMUNITY	FDI	σ_L = 5 P_x = 1	σ_L = 0.2 P_x = -1	NET
POWERVIEW	0.732	-30.07	16.42	-13.65
HUDSON BAY	0.534	-23.15	13.10	-10.05
HINTON	0.379	-16.68	9.70	- 6.98
THE PAS	0.331	-14.89	8.74	- 6.15
SLAVE LAKE	0.142	- 6.11	3.69	- 2.42
PRINCE ALBERT	0.110	- 5.21	3.15	- 2.06

where FDI is the forest dependence index, σ_L is elasticity of labour supply, and P_x is the percentage change in the price of forest products

Under continuing cyclic prices, the short-run nature of the model would predict cyclic wages, mirroring the price cycles, but with an increasing trend. The increasing trend is due to a ratchet effect caused by the asymmetric wage flexibility. Conversely, employment would decrease. Over the time period of multiple business cycles (longer than short-run) labour migration would act to keep wage and employment trends level. The important results remain intact: over any one price cycle, there is a net income loss compared to stable prices.

The size of the income loss is directly related to the community's degree of forest dependency. As Table 10 shows, the average monthly income loss in Powerview, Manitoba (FDI 0.73), is $13.65 compared to $2.06 for Prince Albert, Saskatchewan (FDI 0.11). Powerview was classed as a heavily dependent community, and its income loss is more than six times that of Prince Albert, a slightly dependent community. Even though community income was chosen as the measure of welfare, the true welfare loss is probably greater than the dollar figure indicates. Workers who are laid off during the downswing suffer a much greater income loss than those who suffer a small wage decrease. If there is diminishing marginal utility of money then the welfare loss to laid-off workers is greater than the income loss would suggest.

These income losses, even in heavily dependent Powerview ($13.65 per employee per month), may seem small but it should be remembered that they are the result of small, one percent, shocks. In reality the shocks may be much larger. In fact Boyd and Hyde (1989) use an 18 percent price shock, the largest price deviations from the mean over their fourteen-year study period, to drive their general equilibrium model. If the above result is extrapolated using 18 percent shocks, the result is an income loss of $247.70. This represents over 12 percent of their total income, certainly a significant loss.

A PRICE SHOCK TO THE COMMUNITY'S OTHER EXPORTING SECTORS

The prairie provinces are all dependent, at the macroeconomic level, on sectors other than forestry. Alberta is dependent on energy and agriculture, and Saskatchewan and Manitoba both depend on agriculture. Due to instability in these sectors the Alberta government intends to diversify the provincial economy and has stated that the forest sector is a prime candidate to contribute to this diversification. The model can be modified to show the effect of a stronger forest sector on welfare impacts from cyclic prices in the dominant sector.

Similar to forest dependency, energy dependency is measured as the employment the energy sector contributes to the base divided by total base employment. This ratio is the Energy Dependence Index (EDI). Crowsnest Pass, Alberta, is heavily dependent on the energy sector (EDI 0.55). Grande Cache, Alberta, is moderately dependent on the energy sector (EDI 0.32) as well as being moderately dependent on the forest sector (FDI 0.26). Table 11 shows the income losses to these communities of cyclic prices in the energy sector. The income loss in Crowsnest Pass is more than double that in Grande Cache, supporting the idea that diversification reduces instability. For the purposes of this analysis, FDI and EDI of these communities are adjusted so that they sum to one.

TABLE 11

WELFARE EFFECTS OF SYMMETRIC PRICE SHOCKS IN THE OTHER EXPORTING SECTOR

	INCOME CHANGE ($/EMPLOYEE/MONTH)		
COMMUNITY	$\sigma_L = 5$ $P_Y = -1$	$\sigma_L = 0.2$ $P_Y = 1$	NET
CROWSNEST PASS	-29.37	16.43	-12.94
GRANDE CACHE	-11.75	5.61	- 6.14

where σ_L is elasticity of labour supply, and P_Y is the percentage change in the output price of sector Y

A DECREASE IN TIMBER SUPPLY

The next type of shock to be simulated is a decrease in the supply of timber. As was shown above, as FDI increases so too does the loss of welfare to the community. Table 12 demonstrates this relationship again, this time with real communities and monetary change in income.

TABLE 12

WELFARE EFFECTS OF A DECREASE IN TIMBER SUPPLY

COMMUNITY	FDI	INCOME CHANGE ($/EMPLOYEE/MONTH) $T_x = -1$
POWERVIEW	0.732	-2.99
HUDSON BAY	0.534	-2.31
HINTON	0.379	-1.68
THE PAS	0.331	-1.51
SLAVE LAKE	0.142	-0.65
PRINCE ALBERT	0.110	-0.57

where FDI is the forest dependence index and T_x is the percentage change in timber supply

Hudson Bay, Saskatchewan, is a particularly interesting case. In recent years timber supply problems have forced one of Hudson Bay's three processing plants to be shut down. The size of the supply decrease can be estimated (in an admittedly *ad hoc* fashion) by reducing capital by one-third. The model predicts that a 25.32 percent decrease in timber supply would cause a one-third decrease in capital use. Such a decrease in timber supply would, in the short-run, decrease average community income by $227.44/month (10.8%) and put 68 (8.4%) people out of work.

SUMMARY AND CONCLUSIONS

The first goal of this paper was to outline and implement an improved methodology for identifying community dependence on a single sector. The methodology was applied to the forest sector in the Canadian provinces of Alberta, Saskatchewan, and Manitoba. The new methodology improves on past work by eliminating *ad hoc* assumptions wherever possible and by using instead techniques based on economic theory and empirical evidence. The methodology is only slightly more costly in terms of time and data resource requirements and yields superior results. These results were verified by the application of a general equilibrium model to measure welfare effect from a variety of economic shocks.

The paper was intended not to answer any specific questions about the forest sector in the prairie provinces, but to describe the nature of forest dependency in prairie communities. The results indicated that there are only two communities, Hudson Bay, Saskatchewan, and Powerview, Manitoba, that showed continuing dependence on the forest sector. There are, however, many cases where forestry, though not dominant, is a vital component of the economic structure of the community. These results do not come as a surprise considering the strength of other sectors in the region, such as agriculture and energy, and the distance of the forest resource from key United States markets. Another important result is a decline in overall forest dependency in all three provinces between 1981 and 1986. This decline is a result of both decreasing forestry employment and increasing employment in other important sectors. The role of forestry as a diversifying economic agent remains important, and the decreasing employment trend could be reversed by the recent expansion in the forest sector on the prairies.

The results of this study are of potential interest to both provincial and federal governments. The manner in which the database is derived and presented gives it relevance from a provincial perspective, as well as from the larger perspective of the prairie region as a whole, and could be applied nationally.

This information can be used in both proactive and reactive policy contexts. For example, proactively governments could use this database to aid in regional development and diversification programs. In a reactive sense, governments could use this information to be more prepared to engage in counter-cyclical programs to alleviate short-run unemployment or other income reduction. As well as short-run programs, governments may want to aid in long-term adjustment as communities expand or decline. Knowledge of the structure of the economy of communities, such as is provided in this study, will assist policy makers with these problems and help them better serve the people of the prairie region of Canada.

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FOREST DEPENDENT COMMUNITIES: CHALLENGES AND OPPORTUNITIES

Edited by
David Bruce and Margaret Whitla

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RURAL & SMALL TOWN
RESEARCH & STUDIES PROGRAMME

Mount Allison University
Sackville, New Brunswick E0A 3C0

August, 1993

Table of Contents

PREFACE

These papers are taken from those submitted for presentation at the June 1991 **Innovative Rural Communities** Conference held in Charlottetown, Prince Edward Island. This international conference provided a forum for researchers and practitioners to share with others the challenges and opportunities facing rural communities and the innovative ways to respond. Both of these papers represent innovative approaches to problem-solving in unique rural communities - those which are reliant upon a single resource base. In this case, forest dependent communities are examined.

The first paper was submitted to the conference but was not presented. *Prairie Provinces Forest Dependent Communities: Methodology, Empirical Results, and Welfare Implications* examines the vulnerability of primarily remote forest dependent communities to economic shocks of changes in price, labour supply, and timber supply. In particular, the effects upon worker and community incomes are explored. An improved methodology for determining dependency has been established in this paper, and the results provide important direction for policy makers with respect to diversification strategies.

The second paper describes a community development approach which might be used by forest dependent communities. *Community Foresty as a Forest-Land Management Option in Ontario* provides a detailed description of factors for successful community forestry. It then applies these factors in a systematic approach to identify communities in Northern Ontario which have the 'best chance' for succeeding in the implementation of such an approach. The paper concludes with recommendations for Native communities, for the provincial government, and for individual communities to ensure that community forestry initiatives are successful.

The editors would like to acknowledge the important contribution that the authors have made collectively to a better understanding of the challenges and opportunities facing forest dependent communities. Others have made significant contributions to the completion of this book: Charlotte Purdy completed formatting changes; Karen Oulton assisted with the preparation of diagrams.

David Bruce and Margaret Whitla
Sackville, New Brunswick
August, 1993