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An Examination of Economic Sustainability Indicators in Forest Dependent Communities in Canada

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EXECUTIVE SUMMARY

The Canadian Council of Forest Ministers (CCFM) created a set of criteria and indicators to guide sustainable forest management in Canada (CCFM 1999). The need for more accurate economic sustainability indicators within sustainable forest management has been suggested by a number of authors. The intent of this study was to isolate the most credible economic indicators and examine them in forest dependent communities. Data were extracted and derived from the Canadian census at the census sub-division (CSD) level for the years of 1986, 1991, and 1996. Frequency and distribution graphs were used to provide some insight into the changes in indicators over time, and correlation analysis was employed to examine correlations between the indicators and forest dependence. CSD forest dependence is negatively correlated with median household income, and positively correlated with incidence of low income for people living in private households, and the unemployment rate. The Gini coefficient values, measures of income inequality, were not related to the degree of forest dependence. Some expected results were that increased forest dependence was correlated with decreases in the CSDs' diversity and increases in its trade exposure to the export market. While indicator patterns and their correlation to forest dependence were examined here in variety of communities, further research is necessary to identify the causal factors associated with these indicators. Further research using structural economic models is being conducted to uncover interactions between the indicators in forest and non-forest dependent regions. Sustainability is not achieved by examining sustainability in one sector; there are many economy-wide characteristics that determine how economic changes affect the residents of a community. It is these interconnections that need to be further researched and respected when making policy decisions in any sector.

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INTRODUCTION

The World Commission on Environment and Development (WCED) of the UN cites sustainable development as “...development that meets the needs of the present without compromising the ability of the future generations to meet their own needs...” (Bartelmus 1994). The general notion is that sustainable development can guide economic activity to maximize the overall benefits to present and future society. The concept of sustainability, now viewed as a guiding tool in resource management, encompasses the environmental, economic, and social dimensions of the economy and the environment in which we live.

The Canadian Council of Forest Ministers (CCFM) created a set of criteria and indicators to guide sustainable forest management in Canada (CCFM 1999). The need for more accurate economic sustainability indicators within sustainable forest management has been suggested by a number of authors. With economic systems, the challenge is to measure “well-being”, analyze the distribution of well-being, and ensure that well-being is not declining. Suitable economic sustainability indicators are normative, consistent with theoretical concepts of well-being or “economic welfare”, have the ability to be linked to management or policy options and can be predicted or forecasted. In addition, ideally these indicators should be measurable at relatively low cost, and reliable such that repeated measurements of the same indicator achieve the same quantitative result (IISD 2000).

Many researchers have incorporated economic sustainability indicators into their studies in attempts towards achieving economic sustainability. An effective model depends heavily on the scale of the analytical unit. Due to the significant interdependencies that exist between community and regional economies, especially the linkages between forest management practices and social and economic factors, most researchers agree that sustainability assessments should take place at either the regional or community level (Force and Machlis 1997).

Economic sustainability is often divided into four approaches: (1) augmented national/regional income accounts that cover the measurement of well-being including market and non-market goods, (2) personal income and community equity measures which highlight distributional concerns, and (3) resilience measures which help to explain how well-being in a community changes in response to shocks to its economy. Finally, a fourth group of indicators includes a variety of other economic and social indicators such as community capacity and human capital. In this study we have chosen to concentrate on the measurement of indicators in the areas of income, equity and resilience at the community level.

From the studies surveyed, there are a wide variety of indicators in the areas of income, equity and resilience that are used in attempts to quantify economic sustainability. As seen in this study, the national census is one source of information at a disaggregate level that, with some reorganization of the information, proves useful in understanding some of the economic dimensions of sustainability. The economic sustainability indicators that were extracted or derived from the Canadian census for 1986, 1991, and 1996 are among the most accepted

indicators in the areas of income, equity and resilience. Median household income was chosen to best represent the income component in economic sustainability assessment. Both income inequality (as represented by the Gini coefficient) and the incidence of low income among people in private households characterize equity. In capturing the resilience of an area, the unemployment rate, economic diversity measures, and trade exposure to exports were chosen as the best indicators in the dataset. Although this study retained as many of the census subdivisions (CSDs) as possible, special attention was paid to how the chosen indicators varied over time in CSDs deemed ‘forest dependent’.

This report outlines each economic sustainability indicator’s trends over time in forest and non-forest dependent regions. These patterns are exemplified using frequency and boxplot graphs. Correlation analysis was used to examine correlation between forest dependence and the various economic indicators. While such descriptive analysis provides a foundation for the characterization of these indicators over time and in different regions, more research is necessary to account for the underlying factors driving the indicator trends.

The economic indicators in this study should be used together to assess the overall economic condition of an area. This concept, however, raises challenges for sustainable forest management. It is possible that one sector (the forestry sector for example) attempts to make management changes to improve economic sustainability but that these changes are counteracted by changes in other industrial sectors or by factors arising outside of the region. A single industry or sector should not be responsible for achieving sustainability when other agents are also influencing economic conditions. In order to truly evaluate economic well being, however, this economy-wide perspective is important.

IDENTIFYING THE INDICATORS

Income

Median Household Income

Median income is considered a more robust indicator of income than average income as it is less sensitive to the influence of a small number of high values. Both Beckley (2000) and Force and Machlis (1997) are advocates for the use of median income as an indicator in assessing sustainability. Median income has been examined at the community or regional level. These scales are probably the most appropriate for determining the impacts from economic activity. Although median income may prove to be better than average income, concerns have been raised about its use as an adequate indicator as well. Thompson (1997) suggested that median income could be misleading as it ignores specifics about the top and bottom incomes. Toman et al. (1998) are also concerned that median income presents only a partial picture of how the local economy affects income distribution and the well-being of the people. They argue that “...at the local level, it is important to examine the spatial decomposition of important economic flows...”. For example, is the region’s income high due to local economic flows or do income

supports or tax breaks exist that may distort the economy's actual impact on income? (Toman et al. 1998). Also, even though median income was used as an indicator in Beckley (2000), the author warns that its interpretation should be taken with care. The traditional measures of income do not take into account any non-wage subsistence activity that may exist within an area. Such activity may be highly valued by the resident people. In such cases, it is likely that traditional measures of income and income distribution would be inappropriate indicators for measuring sustainability. Instead it would be necessary to try to capture these non-market values with measures of augmented income. Despite these concerns, median income is still often used as an economic sustainability indicator.

Equity Measures

It is recognized that the concept of welfare depends not only on individual income measures, but also on the inequality of incomes (Osberg and Sharpe 2001). However, it is very difficult to specify the relative weights to be applied to these features of an economy to assess economic well-being. One reason is that the measurement of inequality depends on the relative value which an observer places on the utility of individuals at different point along the income distribution (Atkinson 1970). For example, a Rawlsian¹ would only gain utility by observing positive changes in the well-being of the least well off in society (i.e. the poor). For others, positive weights would be sought for income gains of the non-poor, or negative weights may be applied to inequality among the non-poor. Thus, two areas of indicators could shed some light on the issue of well-being. The first is a measure of the distribution of income or some measurement of income inequality. The second involves an indicator that reveals the extent of poverty.

Income distribution – the Gini coefficient

In assessing sustainability, it is important to account for the distributional consequences of economic activity, rather than just measuring the economic net benefits in the region (Toman et al. 1998). Communities are usually comprised of very diverse populations; as such, these economic benefits may not be equally distributed (Beckley 2000). This explains why income distribution measures are advocated as empirical measures of economic well-being. One disadvantage to using income distribution as a sustainability indicator is the fact that it is difficult to transform it into a normative measure (Adamowicz 2001). In other words, we do not have a concrete yardstick that reports how much income inequality is acceptable. However, there are still many researchers who use income distribution as a sustainability indicator. There are many different ways to measure income distribution. A common measure is the Gini coefficient of inequality. The Gini coefficient "...measures the extent to which the distribution of income (or, in some cases, consumption expenditures) among individuals or households within an economy deviates from a perfectly equal distribution." (United Nations Development Programme 1999). The World Bank Group (2000) cites Gini's original 1912 definition as:

¹ A Rawlsian is someone who wishes to maximize the welfare of the minimum members of society. This idea has its roots in John Rawls treatise "A Theory of Justice" (1971: Harvard Univ Press).

$$Gini = \frac{1}{2n^2 ybar} \sum_{i=1}^n \sum_{j=1}^n |y_i - y_j|$$

where n = the number of individuals in the sample, $ybar$ = the arithmetic mean income, and y_i = income of individual i , $i \in (1,2,\dots,n)$. The Gini coefficient can take values between 0 (perfect equality) and 1 (complete inequality) (World Bank Group 2000). This single number is easy to calculate and understand and income data at any scale can be used. Thus, the Gini coefficient can detect distributional changes in the middle of the income spread as well as at either extreme (Thompson 1997). The Gini coefficient is also considered a robust measure of inequality, as it meets the desirable conditions for such a measure, including scale independence. This characteristic states that the Gini coefficient is independent of the units of measurement of income. This enables comparisons to be made across distributions (Prus 2000). For example, the 1994 Gini coefficient of after-tax income in the US (0.387) was much higher than that of Canada (0.287) suggesting that income inequality was much higher in the US than in Canada in 1994 (Osberg and Sharpe 2001). Thus, the Gini coefficient is a common indicator for income distribution and it can be set in a model context for perspective and specific interpretation. Examples of the Gini coefficient as a sustainability indicator can be found in Chevan and Stokes (2000) and Sharpe and Zyblock (1997).

When examining income distribution, Krugman (1994) cautions not to place too much emphasis on the distribution of income in any given year. This exercise may be misleading, given the issue of income mobility. As people's employment and positions change over time, so does their income. Thus, families or individuals can move up and down in the income ranking. It is known that economic welfare is more dependent on average income earned over time than on the level of income in any given year. If the distribution of income is separated into quintiles, as it often is, income mobility would see some people moving between quintiles over time. However, even with the considerable amount of income mobility in the United States, it is not enough to make the distribution of income irrelevant. The recognition of income mobility is important to assessing changes in the income distribution over time (Krugman 1994).

Poverty – the incidence of low income

Measures of poverty are increasingly being used to help characterize the economic sustainability of an area. The most popular way to capture poverty in a single measure is the poverty rate. This measures the number of people with poverty status relative to the overall population of the area. The poverty rate reflects the distribution of income; thus it can complement measures of income distribution. Together, these two equity measures produce a good indication of economic distress (Stewart, Schuster, and McGinnis 1996). The use of poverty rates as a sustainability indicator can be found in Stewart et al. (1996), Force and Machlis (1997) and others.

The poverty rate is sometimes defined a slightly different manner. For example, in Beckley's (2000) study of Canadian communities, he represented the poverty rate by the

percentage of families below the poverty line. Beckley (2000) also reminds the readers that the placement of the poverty line differs according to location. Major urban centres may have higher costs of living, so the cut-off for low income may be elevated relative to smaller centres or rural areas. The Canadian census reports a similar statistic of incidence of low income for various groups of people. In this study, the incidence of low income among the people living in private households is examined.

Resilience Measures

Another group of indicators that help characterize sustainability is those measuring resilience. Resilience refers to the notion that the economic system is not overly sensitive to shocks (prices, demands, etc). Economic resilience consists of measures of employment and income diversity among economic sectors (Horne and Haynes 1999). The most common resilience measures are the unemployment rate and different measures characterizing employment, and employment diversity. The unemployment rate is the proportion of people looking for work compared to the total labour force (Stewart et al. 1996). Employment diversity refers to balanced employment across industry sectors (Ashton and Pickens 1995).

Unemployment rate

The unemployment rate is a popular indicator used to measure economic sustainability as it can be used at any scale. As a performance indicator, it helps to determine how resilient the economy is to changes in some or all of its sectors. Stewart et al. (1996), Ashton and Pickens (1995), Force and Machlis (1997), and others have used the unemployment rate to help quantify economic change. While economic sustainability is a multi-faceted concept, the unemployment rate can be examined in relation to other indicators to characterize the sustainability of an area. These various linkages are important to understanding economic sustainability overall, but the unemployment rate does fare well on its own as a single measure of economic resilience. However, when using unemployment as an economic sustainability indicator, it is important to recognize some of the disadvantages as well. Due to the nature of its calculation, the unemployment rate will not include involuntary part-time workers, underemployed workers, or discouraged workers who are no longer in the labour force. In addition when examining economic sustainability at the community level, the unemployment rate may disguise economic distress if previously unemployed workers have moved elsewhere to find work (Stewart et al. 1996).

Employment diversity

Employment diversification plays a relatively large role in economic development, especially in smaller communities. As mentioned above, employment diversity refers to the mix of employment across sectors. It can be stated with some certainty that "...counties with high employment diversity are better able to cope with changing economic conditions than less diverse counties over time." (Ashton and Pickens 1995). Resilience can be measured according to the employment diversity index (Horne and Haynes 1999). This index can be calculated using industrial employment or earnings. The Shannon-Weaver entropy index is commonly used as

the vehicle for this calculation (Stewart et al. 1996). In this study we use the Shannon-Weaver index to calculate employment diversity based on employment income. However, like many economic sustainability indicators, employment diversity is not without faults. For example, a study done by Attaran in 1986 concluded that there was only very weak support for the claim that employment diversity leads to more resilient communities. However, Attaran stresses that the industrial mix in the region is more crucial than the level of diversity. For example, in forest-dependent communities, industries that follow different business cycle trends as those driving the wood product industry should be encouraged more than industries whose trends are similar (Ashton and Pickens 1995). Diversity is important in relation to technical change. Technical change affects individual sectors differently, thus diversity would help to balance employment expansions or contractions among the different sectors.

Trade exposure

Trade exposure is also a useful economic sustainability indicator, especially at the CSD level. Due to exchange rate changes and global market shocks, trade exposure can open up communities to economic fluctuations (Osberg and Cyrus 2000). Three different kinds of trade exposure can be measured: trade exposure to exports, trade exposure to imports, and trade exposure to both exports and imports. These calculations can be made using the employment or employment income in each sector of the economy. These indicators all serve to reveal how vulnerable a CSD's economic state is to external market influences.

METHODOLOGY

This section begins with a discussion of the Canadian census and other data sources; it describes the data extracted as well as the manipulations used to create a standardized dataset across three census years. This section also details the forest dependence calculations and methods used to derive other indicators included in the dataset.

Canadian Census

The database created for this study used the Canadian census as its foundation. Extracts were performed from the 1986, 1991, and 1996 Canadian censuses to obtain the desired variables (Statistics Canada 1986, 1991, 1996). For purposes of this study, the phrase 'each census year' will pertain to the years examined here: 1986, 1991, and 1996. Reasons for the exclusion of 1981 from this study are given in Point 1 in Appendix A. All extracts were obtained at the Census Subdivision (CSD) (municipality) level of geography. A complete definition of a CSD can be found in Point 2 of Appendix A. Two separate extracts were performed for each year; one from Profile 2A, whose data are gathered from a 100% sample of Canadians, and one from Profile 2B, whose data pertain to a 20% sample of Canadians. To obtain a single variable list for each year, the data from the two profiles were merged into one. When aggregating the two 1991 profiles, it was discovered that some CSDs were not common to both profiles. To create a complete dataset for 1991, all of the CSDs had to match for the entire list of variables. Thus, the

missing CSDs (21 in all) were completely removed from the 1991 dataset. A list of these CSDs as well as further description of the 2 profiles of data can be found in Appendix A under Point 3. Due to the time series nature of our analysis, these CSDs were removed from the 1986 and 1996 datasets as well to avoid missing data points for these CSDs.

The data in each of the three years then had to be standardized to allow for comparisons across time. Therefore, the variables from each census were matched across the three years. The 1996 Census Dictionary clarified terminology and assisted in this matching process (Statistics Canada 1999). However, for the variables pertaining to employment by industry, the industry categories for 1986 did not match those in 1991 and 1996. The 1996 Census Dictionary (1999) stated that the industry categories in all three years were based on the 1980 Standard Industrial Classification (SIC) system and thus, should have been directly comparable. A search within the Statistics Canada Data Library Information series produced a table of 1986 industry data in the same 1980 SIC format as the 1991 and 1996 industry tables (Statistics Canada 1986). This table was inserted into the 1986 dataset to replace the original table from the census database.

There have been changes to CSD boundaries, codes, and names across the 10 year span. Due to the complex nature of the charts pertaining to these changes, it was determined that the CSD changes would not be applied to the data until a final dataset was complete.

The last thing done to standardize the census extracts was to convert the monetary variables into constant dollars using the Consumer Price Index (CPI). This was done using 1992 as the base year. The three monetary variables in each dataset were average household income, median household income and the standard error of average household income. To ensure a more accurate analysis, the monetary variables for CSDs in each province were adjusted by their respective provincial CPI numbers (Statistics Canada 2001). A table of the provincial CPIs for each year can be found in Point 4 of Appendix A.

Generated Variables

Although the extracted census variables are interesting economic indicators in and of themselves, some of these variables were modified to produce new variables that may help examine economic sustainability.

Gini coefficients

The household income classes from the census were used as a basis for calculating Gini coefficients for each CSD in each census year. This index of inequality provides a simplified look at each CSD's income distribution. A review of the literature revealed that many Gini coefficients were calculated with individual incomes. Due to the nature of the census variables, this was not possible. Hence, household income classes are the basis of Gini coefficient calculation in this study. It was also noted that the number of household income classes in each census were different. However, neither the nature (household income), nor the number of income classes, seem to compromise the quality of this variable. First, in calculating the Gini

coefficient, Chevan and Stokes (2000) chose family income data over individual incomes with the defense that a household's resources most directly affect an individual's lifestyle. Second, Chevan and Stokes (2000) and Lerman and Yitzhaki (1989) both concluded that very little of the variance in the Gini coefficient across time could be attributed to the different number of income class categories. However, when interpreting the Gini coefficient, two things must be kept in mind. By calculating the Gini coefficient from household income classes, the coefficient may underestimate the level of income inequality in a CSD as the income of unrelated individuals is omitted. Also, due to the fact that the household income classes are formed from a 20% sample of the CSD, cross-sectional estimates such as the Gini coefficient are based on the representative sample (Chevan and Stokes 2000). In our study, the calculation of Gini coefficients based on household income classes was performed by modifying the method of calculation used by Yao (1999). Hence, our study produced a derived Gini coefficient for each CSD in each census year.

Forest dependence

One of the main interests of this study is to examine economic sustainability indicators in communities (CSDs) which can be deemed forest dependent. The economic base theory (EBT) of regional economic growth provides the foundation for calculating a measure of forest dependence for each CSD in each census year. EBT states that a region's economy consists of a basic sector (export industries) which characterizes all local economic activity that is exogenously determined, and a non-basic sector (all other local economic activity) (Korber 1997). Non-basic activity is dependent on the basic sector, so a region's economic growth is strongly determined by activity in the basic sector. Increases in basic sector activity cause an inflow of income into the region which creates a multiplier effect in the non-basic sector as this money is spent and re-spent in the region's economy (Pleeter 1980; Mayo and Flynn 1989; Korber 1997). However, regional economic growth is not *solely* determined by exogenous demand. As population and economic activity increase in a community, internal factors such as labour productivity, entrepreneurship, and capital play larger roles in determining economic growth (Blair 1991). Thus, EBT is most appropriate when applied to studies of small communities, such as CSDs. By measuring the amount of basic activity in a CSD, EBT provides a theoretically solid framework in determining a CSD's dependence on external income in any industry. Thus, we can use this theory to estimate a measure of forest dependence.

Forest industry dependence is defined as the proportion of activity in the forest sector that contributes to the CSDs total basic economic activity (Korber 1997). Accurate measurement of a CSDs basic activity is the chief difficulty in applying EBT to any community. Although the location quotient is sometimes criticized for its restrictive assumptions (discussed below), it is commonly used to measure basic activity due to its low costs and for the ability to use publicly available data (Blackley 1992). Alternatives to estimating basic sector activity are discussed in Isserman (1980), Pleeter (1980), and Richardson (1985). The location quotient formula offers several possible measurement units, including employment, income, sales, and value added (Korber 1997). For purposes of this study, we will use employment income. Employment income for an industry can be defined as: the number of people employed in the industry, multiplied by the average income for the industry. The source for the employment numbers by industry was the Canadian census (Statistics Canada 1986, 1991, 1996). Although employment

data implicitly assume all jobs are the same type (full-time, part-time, seasonal, temporary), employment income data at least differentiate the jobs in terms of remuneration (discrete average incomes) (Korber 1997). Additional problems with using census employment numbers and other census data are discussed in Point 5 in Appendix A. In this case, the location quotient can be interpreted as a ratio of a CSD's share of employment income in industry i to a benchmark (province's) share of employment income in the same industry. The formula, which measures basic employment income, is as follows:

$$LQ_j^i = \left[\frac{(E_j^i/E_j^T)}{(E_p^i/E_p^T)} \right] \quad [2]$$

where LQ_j^i = CSD's location quotient for industry i

E_j^i = CSD's total employment income for industry i

E_j^T = CSD's total employment income over all industries

* E_p^i = provincial employment income for industry i

E_p^T = total provincial employment income over all industries

* E_p^i was replaced with this equation:

$$E_p^{i*} = \left[\frac{(T_n^i - X_n^i + M_n^i)}{T_n^i} \right] E_p^i \quad [3]$$

where E_p^{i*} = weighted share of employment income needed for provincial self-sufficiency in a province where there are no net exports

T_n^i = total national output from industry i

X_n^i = national exports from industry i

M_n^i = national imports from industry i

E_p^i = total provincial employment income for industry i

- Korber (1997)

The benchmark (province) represents the level of employment income that is necessary to provide for domestic consumption. If the location quotient is greater than one for industry i , this means that the industry is producing more than is necessary (i.e. more than the benchmark) for local consumption in the CSD. It is assumed that the excess production is intended for exogenous demand, which constitutes basic activity in that industry. Implicit in this calculation is the assumption that each industry has equal average productivity and consumption in both the CSD (region) and the province (benchmark) (Isserman 1980). Thus, by using the province as a benchmark, the likelihood that average productivity and consumption would differ greatly from the benchmark levels in any given industry would be small (Korber 1997). Another assumption implicit in using the location quotient is that neither the CSD nor the province are net exporters or net importers for any industry (Isserman 1980; Richardson 1985). However, since exports and imports are seen at both levels (which invalidates this assumption), some modifications are necessary. The distorting effects of imports and exports in the location quotient formula at the CSD level can be alleviated somewhat by using the most disaggregated industry data possible

(i.e. the most detailed 3 or 4 digit SIC codes) (Pleeter 1980; Richardson 1985). This is a drawback in our study. Since the accuracy of location quotients increase with disaggregation, our location quotients based on industry data at the division level should be interpreted with caution. A modification at the provincial level is seen in the modification to provincial employment income by industry. This is necessary to adjust for the fact that a province exports and imports to meet provincial consumption demands (Isserman 1980). Thus, a province's share of employment income in each industry is weighted by the proportion of its output minus net exports to show the amount of output needed to meet domestic consumption.

Given a positive location quotient, the next step in the forest dependence calculation is:

$$X_j^i = \left[\frac{LQ_j^i - 1}{LQ_j^i} \right] E_j^i \quad [4]$$

where X_j^i = proportion of employment income in industry i that is attributed to basic sector activity

Following this, we can calculate the total base employment income for a CSD:

$$X_j^T = \sum X_j^i \quad [5]$$

where X_j^T = total of all basic sector employment income. Finally, forest dependence is calculated as:

$$\text{FDI (Forest Dependence Index)} = \frac{X_j^i}{X_j^T} \quad [6]$$

where X_j^i = basic forest industry sector employment income. Hence, the FDI is the proportion that the forestry sector contributes to a CSD's economic base. This forest dependence index is useful to categorize CSDs by the degree of forest dependence, whose basic forestry employment income is vulnerable to external market or policy shocks (Korber 1997).

Although the Canadian census was the source for the employment data, the census profiles used in this study did not include the average income by industry variable. The source of the average income by industry variable for 1986 and 1991 was a custom tabulation from Statistics Canada (1995). This database contained different employment related variables for each CSD and province in Canada (in their respective years). Any industry data from this source were presented according to 1970 SIC classification. However, the industry structure for the census employment data is presented according to 1980 SIC at the Division level (least detailed list of industries). A list of these 1980 SIC divisions can be found as Point 6 of Appendix A. Thus, a concordance file was necessary to transform the 1970 SIC data to the 1980 SIC format (Statistics Canada 2000). After completing the concordance, most 1980 SIC industry categories from the custom tabulation contained more detailed industry sub-sectors. Each of the sub-sectors in an industry contained two categories of data relevant for this study: one for employment, the other for the sub-sector's average income. For industries that contained sub-sectors, the average

incomes of the sub-sectors were weighted by their respective employment numbers to produce an overall average income for each industry. If a sub-sector was missing either an employment number or average income, the entire sub-sector was ignored; the industry's overall average income was calculated using the remaining sub-sectors' data.

In this database, some sub-sectors reported negative average incomes. These negative values were mostly confined to very small communities and are explained by the presence of self-employed individuals who may have incurred a loss in that year. The negative values were preserved in the overall average income calculation, but if the overall average income was a negative number, the number "1" was inserted in its place. This was to avoid error messages (from a negative number) in future calculations, yet it still portrayed the fact that the average income in that industry was *very* small. There were instances where an industry's overall weighted average income was zero, due to the fact that each of that industry's sub-sectors was missing either employment or average income data. In these cases, that industry's average income for that particular CSD was replaced with the CSD's respective provincial industry average income.

The average incomes for Divisions K (Finance and Insurance Industries) and L (Real Estate Operator and Insurance Agent Industries) within each CSD for 1986 and 1991 are identical. Since the original data from this database existed in 1970 SIC form, Divisions K and L were one category (Finance, Insurance, and Real Estate). According to the 1980 SIC, they were split into the current two categories. Since it was impossible to divide the data knowingly, an overall average income (weighted by the respective employment numbers) was calculated (for each industry in each CSD) for the one 1970 division and applied to both of the 1980 divisions.

The 1986 and 1991 average incomes by industry are not perfect, as they were weighted by the employment numbers from that source, not the census employment numbers used later in this study. These two sources referenced the same CSDs in the same years, but the employment numbers between them differed slightly. Due to the fact that there are various census tabulations for the same geographic areas and variables, minor differences are expected (Statistics Canada 1999).

Upon comparing the 1986 and 1991 list of CSDs and their average incomes, it was discovered that 1991 was missing information for 787 CSDs that were in the 1986 dataset. The reason for this lay in the Statistics Canada rules for data suppression in 1991. The possible rules that accounted for the omission of information for the 787 CSDs are documented in Point 7 of Appendix A. To avoid deleting these 787 CSDs from every census year, we had to create a viable estimate of average incomes for each industry in each of the 787 CSDs. This was achieved with the help of the remaining CSDs that had reported average incomes. Using provincial maps that displayed the locations of all Canadian CSDs, the average incomes for each industry in each of the missing 787 CSDs were determined by taking the closest true values of the average incomes in neighbouring CSDs (Statistics Canada 1992). Thus, if the closest CSD had two industries with provincial averages (from having an original zero value), the next closest

CSD was searched for an actual value in these two industries that would complete the list of average incomes for the missing CSD. By estimating the average incomes for these 787 CSDs, the list of CSDs for the 1986 and 1991 average incomes now matched.

The data for average income by industry for 1996 was taken from a separate custom tabulation (Statistics Canada 1999). The data were presented by the 1980 SIC, so Divisions K and L have their own respective average incomes by industry in each CSD. This year of average incomes was treated the same as 1986 and 1991, in the fact that any negative average incomes were changed to a “1”, and any zero values were replaced with the proper provincial industry average income.

Once the average incomes were derived for each industry in each CSD in each census year, they were multiplied by the census employment by industry numbers. This gave employment income values by industry for each CSD (the first variable needed in the Location Quotient formula). Even though Divisions K and L had identical derived average incomes for 1986 and 1991, they had discrete employment numbers from the Canadian census. Hence, these divisions remained separate in the forest dependency calculations. The multiplication of the derived average incomes to the census employment numbers also required that the CSD lists for the two variables to be identical. Thus, the 21 CSDs that were missing from the initial census data aggregation had to be removed from the average income files for each year. Once this was complete, the average income and census employment files for 1986 and 1991 matched, but 1996 required some modifications. The list of CSDs for the 1996 average incomes and census employment numbers differed by only 15 CSDs. Since 13 of the 15 CSDs had populations below 670, the missing CSDs could be due to data suppression. The average incomes by industry for these 15 communities were treated the same as zero average income values for an industry in 1986; they were replaced with provincial averages. Once these average incomes in each CSD were given the same values as their respective provincial average incomes by industry, the 1996 list of CSDs matched between the average income and employment files. Since the average income and employment files now had matching lists of CSDs for each year, they were multiplied to give the employment income values for each industry in each CSD for each census year.

In the Location Quotient formula, each CSD’s employment income is compared to its respective province which serves as the benchmark. The provincial employment income variable was calculated in the same way as the CSD variables, as the required provincial data were resident on the both databases. As seen in equation [3], the provincial employment income in each industry must be replaced with a new formula, one that shows how the employment income value is modified by its provincial output, imports, and exports.

However, here we have used national output, imports, and exports. This is due to the fact that each province collects its own input-output data, so the content and presentation across provinces vary. Without a standardized collection process, the provincial numbers cannot be adequately compared. To test the validity of using the national numbers, the correlation was

studied between Location Quotient values using national numbers and Location Quotient values using regional numbers (found for just one year). Since the values were approximately 99% correlated, the inclusion of national numbers can be considered valid.

Although the national output values for each industry can be found in each year's Output Matrices, this was not the source used for 1986 and 1991. In 1998, Statistics Canada released a 1997 historical revision of the Canadian System of National Accounts (CSNA). It contained 32 years of revised data (1961-1992) from the Canadian Input-Output Accounts that completely superseded all previous national input-output account data for all of these years. This historical revision was undertaken for a number of reasons, including making the CSNA more internationally comparable, and enhancing its analytical usefulness. As such this historically revised document was used to reflect the most accurate national output by industry for 1986 and 1991 (Statistics Canada 1998). Since a similar historically revised document has yet to be published for 1996, the national output by industry was taken from the 1996 Output Matrix (Statistics Canada 2001). All of the national output data were presented at the 1980 SIC Division level – the same level at which the census data are presented. However, national imports and exports by industry at this level are not publicized documents. The details surrounding this issue are discussed as Point 8 in Appendix A. Thus, this data had to be obtained by a custom tabulation (Statistics Canada 2002).

The national output, imports, and exports by industry data were used to modify the original Location Quotient formula for each of the 18 industries. It must be noted that even though Division K and L were managed as discrete industries, the import/export data reported a single number for these two industries combined. Although we could have chosen to divide each import and export in half and apply the result to Divisions K and L, we choose to retain the import and export numbers as given and to make the full formula modification to Division K, and no modification to Division L. The reason for this is that it is more likely that Division K (Finance and insurance industries) reports imports and exports than Division L (Real estate operator and insurance agent industries). Following through the rest of the calculations, equation [6] can be used to calculate a measure of dependence for any industry. Equation [4] yields basic employment income for each industry. Thus, to determine an area's dependence on a certain industry, the numerator in equation [6] will be the value obtained in equation [4] for the desired industry.

In order to capture all forest related activity within our measure of forest dependence, we must include all forestry associated industries or sub-sectors in the final dependence calculation. With the original 1986 and 1991 industry data in terms of 1970 SIC, it allowed us to see the more detailed sub-sectors that exist within each industry. By its sub-sectors, and 1980 industry name, it is clear that Division C (Logging and Forestry Services) will be used in the dependence calculation. The sub-sectors in each industry were used to further examine every other industry for other forestry activity. The only other applicable industry was Division E (Manufacturing industries), which contained 3 major sub-sectors: Base Manufacturing Industries, Wood Industries, and Paper and Allied Industries. The Base Manufacturing Industry sub-sector

includes manufacturing of almost all goods except forestry products. The manufacturing of forest products is contained in the Wood Industries and Paper and Allied Industries sub-sectors (Statistics Canada 1995). Therefore, it was necessary to isolate the proportion of employment income that comes from Wood Industries and Paper and Allied Industries, which would then be multiplied by Division E's total forest dependence index. By retaining the data in 1970 SIC format, we used the raw data of employment numbers and average income for the Wood Industries and Paper and Allied Industries sub-sectors to calculate forestry related employment income in this division. The same data for Base Manufacturing Industries was used in conjunction with the other two sub-sectors to give an overall measure of Division E's employment income. The proportion of forest activity in Division E was then calculated as follows:

$$DivEP_{FA} = \frac{W_j + Pap_j}{\sum W_j + Pap_j + M_j} \quad [7]$$

where W_j = CSD's employment income in Wood Industries

Pap_j = CSD's employment income in Paper and Allied Industries

M_j = CSD's employment income in Base Manufacturing Industries

Thus, the final calculation to determine the amount of forest dependence in a CSD is:

$$\text{Total FD} = \text{Div C FD} + (\text{Div E FD} * \text{Div E } P_{FA}) \quad [8]$$

This procedure was performed for every CSD on the 1986 and 1991 industry database, but the 787 CSDs that were missing from 1991 still posed a problem. These CSDs were small communities with suppressed data. Since we had no data with which to calculate the proportion of forest activity in Division E, we assumed that the proportions were zero for these 787 CSDs. Hence the forest dependence in these CSDs was based on the Division C dependence index only. Although this is conservative, we can be sure that the forest dependence index in these communities is not overestimated.

The same formulas for determining the proportion of forest activity in Division E were used for 1996, but the sources of all the industry data were different, which made a few data modifications necessary. The Statistics Canada (1999) file that was used for average incomes by industry in each CSD was combined with a new file, also a custom tabulation from Statistics Canada. This file was the related employment numbers for each industry in each CSD. Used together, the two files derived Division E total employment incomes for each CSD. Since neither of these files gave information by industry sub-sector, we had to use yet another source for this data. In a tabulation similar to the other two, Statistics Canada presented employment and average incomes in each industry's sub-sectors (Statistics Canada 1999). Thus, equations 5 and 6 were derived. The same modifications that were needed to match the average income file to the census data were made to the proportion files. Also, the 15 missing CSDs in 1996 that had to be added in to the proportions to match the CSDs, were treated like the 787 CSDs in 1991. The proportion of forest activity in Division E was assumed to be zero. Thus, the forest

dependence index in these 15 CSDs is entirely represented by activity (if any) in Division C. Due to some problems within the different data sources used, the proportions for 64 CSDs had to be estimated on the basis of employment in each of Division E sub-sectors, rather than employment income. Although this does not fully correspond to the rest of the data calculations, it was the best solution for this small group of CSDs. The final forest dependence indices for each CSD were inserted as a new variable into each year of our database.

Trade exposure

Trade exposure also likely affects the economic activity of a CSD. If a CSD's trade exposure is substantial for exports or imports, it means that the community is vulnerable to outside markets. The exposure of a CSD to international trade can be measured as the sum product of the trade exposure of its industries and the CSD's employment income of its industries (Osberg and Cyrus 2000). Although trade exposure can be calculated strictly by employment, the employment income method was chosen here to be consistent with the other variable calculations. A popular measure of trade exposure is one that is derived from combining exports and imports. The equation used here is as follows:

$$\text{Trade Exposure (of exp and imp)} = \sum \left[\frac{E_j^i}{E_j^T} * \frac{(X_n^i + M_n^i)}{T_n^i} \right] \quad [9]$$

where E_j^i = CSD's employment income in industry i
 E_j^T = CSD's total employment income over all industries
 X_n^i = national level exports in industry i
 M_n^i = national level imports in industry i
 T_n^i = national level output in industry i

- Osberg (2000)

The impacts that exports alone and imports alone have upon a CSD are also worth examining. With the appropriate modifications, equation 9 serves as a way to derive these two variables as well. These three trade exposure variables were added to the dataset.

Diversity

In keeping with measuring a communities' vulnerability, we also chose to derive a diversity variable. Again, this variable may be derived strictly in terms of employment, or in terms of employment income. To see the sensitivity between the two methods, diversity was derived using both the employment and employment income methods. Our diversity variable is calculated by using a variation of the Shannon entropy index. The employment income method of deriving diversity of a CSD is as follows:

$$D (P_1, P_2, \dots, P_n) = - \sum_{i=1}^n [P_i * \ln P_i] \quad [10]$$

where n = number of industries
 P_i = employment income in industry i

The employment method uses the same formula with the appropriate modifications (Ashton and Pickens 1995). Using the 1980 SIC “S” level of categorization, the number of industries in all cases here is 18. Thus, the maximum level of diversity a CSD can obtain is $\ln(18) = 2.890$. Every derived diversity value is compared to this maximum value to determine the diversity of a CSD. A diversity value of 0 can only be obtained if all of a CSD’s employment income is contained in one sector (Attaran and Zwick 1989).

CSD Boundary and Other Changes

Once a final dataset had been constructed, we had to make the CSDs compatible across all three years. Most of the discrepancies existed from various name, type, code, and boundary revisions that had occurred from 1986 to 1996. The extent of the changes that were applied to the full dataset, as well as their sources are described in detail in Point 9 of Appendix A.

After all plausible changes, the entire database was filtered to exclude any CSD that did not have all three census years of data. Following this, the entire dataset contained 5051 CSDs in each year. For reference, the total number of CSDs for the 1986, 1991, and 1996 censuses were 6009, 6006, and 5984 respectively (Statistics Canada 1987, 1999). Next the dataset was further cleaned. Any CSD that was missing a value for the Forest Dependency variable for any year was taken out of the dataset. Due to the nature of the forest dependency calculation (see equation 2) this meant that the CSD was also missing raw employment data, thus missing values for the diversity and trade exposure variables. This process resulted in the deletion of 111 CSDs. The same procedure was repeated for the Gini coefficient. Any CSD missing a value for a Gini coefficient in any year was also missing important income data such as incidence of low income for all groups, median household income, average household income, and the household distribution among income classes. This income data were suppressed in the census if the CSD had a population below 250 people. This essentially resulted in the deletion of 737 CSDs, most of which had populations below 250. The missing data in all cases were key variables for this study, thus the deleted CSDs would not have added to the results at all. Also, although some CSDs were only missing the key variables in one year only, there were still deleted as the temporal component of our study is crucial for the comparison of indicators over time. These two methods of deleting CSDs left 4202 CSDs in our final dataset. All CSDs have a population above 250 in any year, except three CSDs. However these three had all of the data for all 3 years, so they were retained in the dataset.

RESULTS AND DISCUSSION

In this section the indicator data are explored using descriptive statistics. The section begins with an examination of the distribution of the forest dependent CSDs across Canada, and continues to describe each indicator over the time series. In addition, the relationships between the indicators are examined using correlation analysis. This section concludes with an examination of forest dependent vs. non-forest dependent CSDs in Canada.

Forest Dependent CSDs

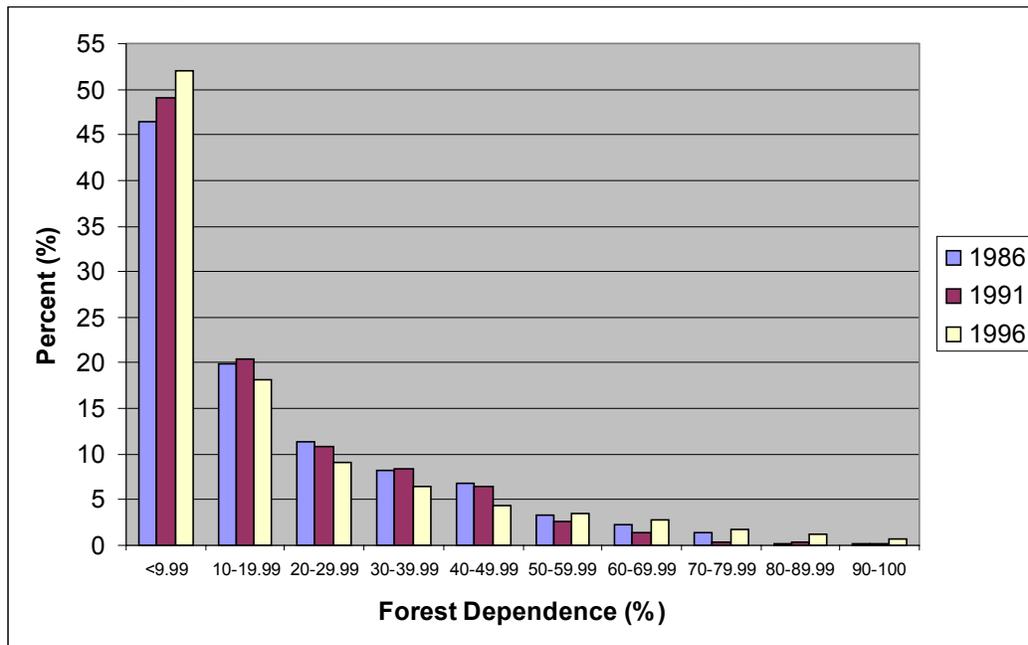
Frequencies – forest dependence

The proportion of forest dependent CSDs in each year is compared to non-forest dependent CSDs and the total number of CSDs in the dataset in Table 1. For purposes of general exploration of the data, a simple frequency distribution was constructed for all CSDs in Canada (in the dataset) by degree of forest dependence. Because of their large number (Table 1), CSDs with zero forest dependence were excluded for this distribution. The resulting distribution of the percent dependent on forestry is shown in Figure 1.

Table 1: Table comparing CSDs by type to total number of CSDs from 1986-1996

	Number of Forest Dependent CSDs (% of the total for each year) ²	Number of Non-Forest Dependent CSDs ³	Total Number of CSDs
Year			
1986	2104 (50.1)	2098	4202
1991	2000 (47.6)	2202	4202
1996	2305 (54.9)	1897	4202

Figure 1: Degree of forest dependence among forest dependent CSDs.



² Forest Dependence Index > 0

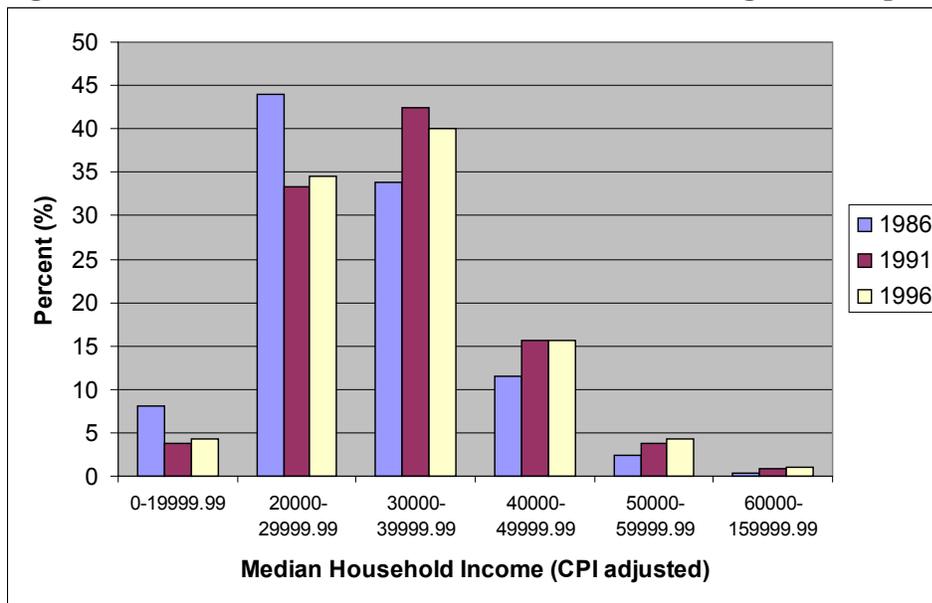
³ Forest Dependence Index = 0

Over the period 1986-1996, there was an increase in the proportion of CSDs in the categories of high forest dependence (more than 50%) and low forest dependence (less than 10%). There was a reduction in the percentage of CSDs in the moderately forest dependent categories. Thus, over the time period some of the CSDs that were in the middle categories became either more or less forest dependent. For this group of forest dependent CSDs across Canada, we examine the various economic sustainability indicators in the categories of income, equity and resilience over the period 1986-1996 and as a function of forest dependence level.

Income

At the CSD level, median household income is reported in the Canadian census for 1986, 1991, and 1996. According to the census a household is "...a person or a group of persons who occupy a private dwelling." (Statistics Canada 1999). The distribution of median household income among the forest dependent CSDs is shown in Figure 2.

Figure 2: Median household income distribution among forest dependent CSDs.



Over the period of 1986-1996, the number of households in the lowest categories of median income declined and the frequencies in the higher median household income categories increased. This shift in the distribution suggests that the median household income increased slightly among the forest dependent CSDs from 1986-1996.

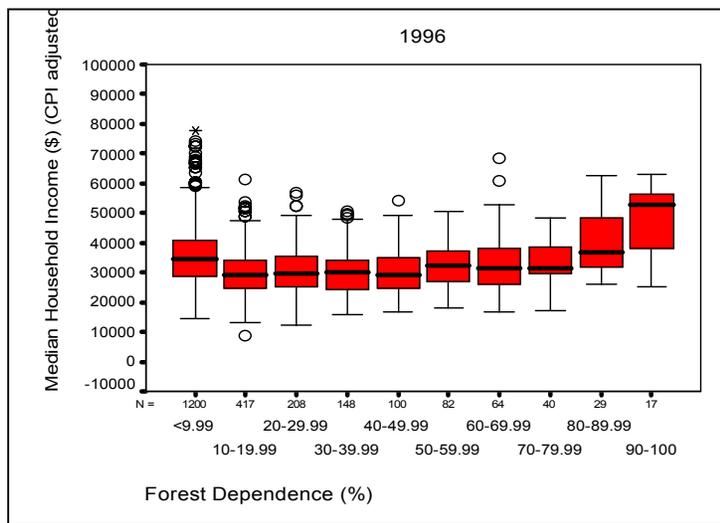
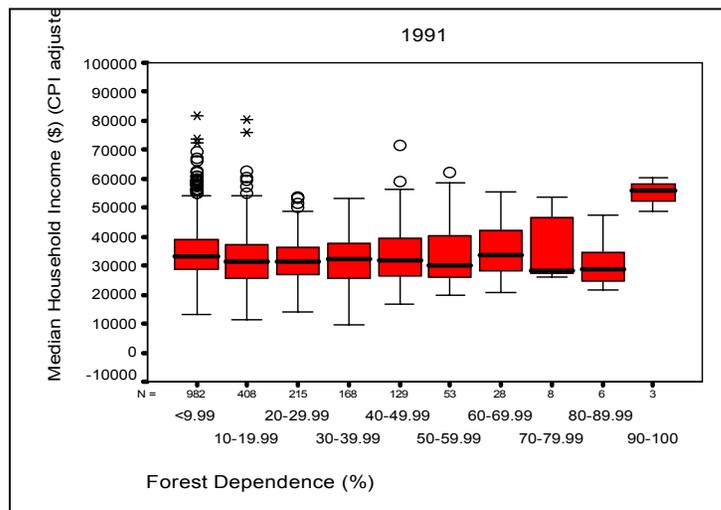
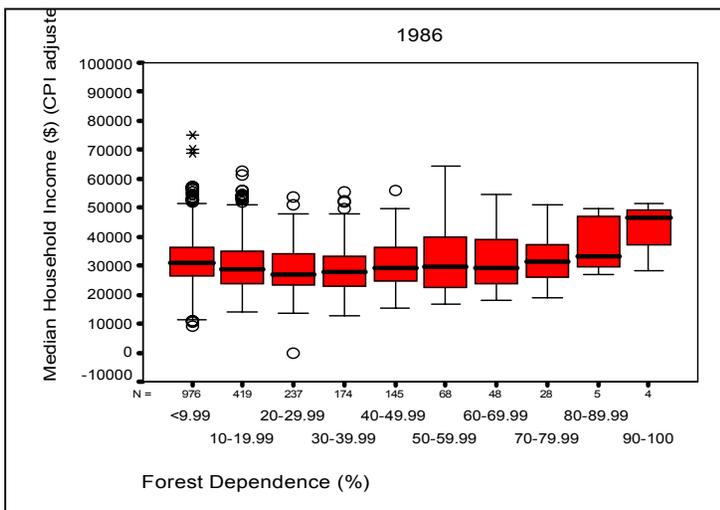
A boxplot of median income against the degree of forest dependence for each year can help to clarify the relationship between these two variables. These boxplots are shown in Figure 3.⁴ The number of CSDs that exist within each forest dependence class is also specified along

⁴ The boxes represent the interquartile range which contains 50% of the values, while the center line in the box is the median of the variable in that category. The 'whiskers' that extend past the box in either direction are lines to the

the 'x' axis. If we exclude the highest two classes in 1986 and 1991 (due to the small number of CSDs in those classes), we observe that median household income was relatively stable over the 1986-1991 period. However, in 1996 not only did the number of communities in the highest three forest dependent classes increase markedly, there was also a rise in median household income in these classes. Both of these events can be at least partially explained by looking at the national forestry product price indexes where 1986=100. The average indexes for 1986, 1991, and 1996 in the lumber, sawmill and other products category were 99.99, 105.73, and 160.09 respectively. In the paper and other paper products category, the average indexes for 1986, 1991, and 1996 were 100.01, 109.88, and 141.74 respectively (Statistics Canada, 1997). Thus, between 1991 and 1996 there was a substantial increase in the forest products price indexes, most likely causing forestry activity (including employment and income in this sector) to increase. Thus, the graphs show that as CSDs became more forest dependent, they also experienced a rise in their median household income in 1996. This implies that a positive relationship exists between forest dependence and median household income. This issue will be further addressed in the correlation section below.

highest and lowest values, excluding outliers. Observations that lie within 1 ½ - 3 box lengths from the top or bottom of the box are outliers, and values beyond three box lengths are called extreme values (Norusis, 2000).

Figure 3: Boxplots of median household income by degree of forest dependence among forest dependent CSDs.



* = extreme
O = outlier

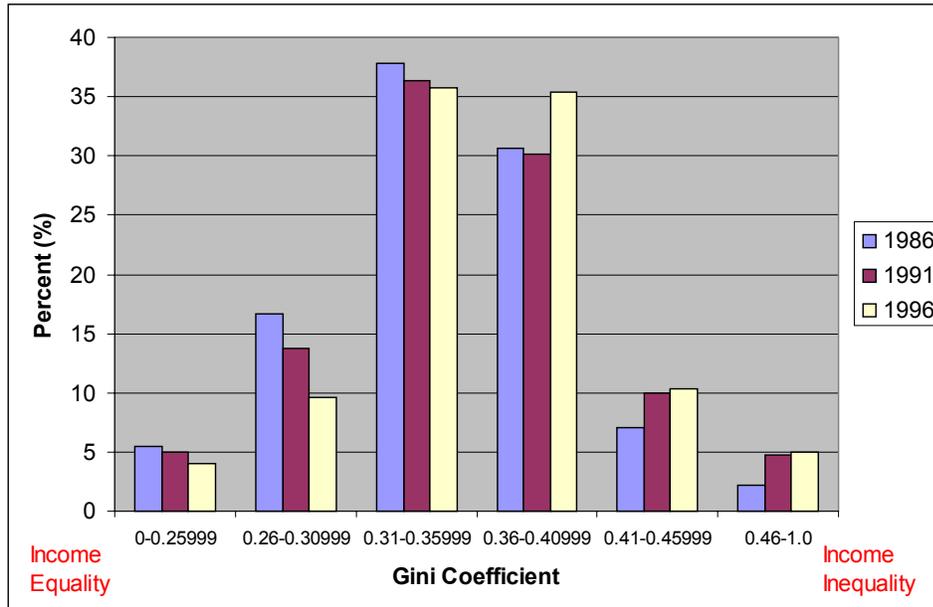
Equity measures

The distribution of income and the number of families in low income situations is also of concern when examining the level of well-being in a community. These measures are explored below.

Gini coefficient

The Gini coefficient is calculated from the distribution of households within a CSD among various income classes. The Gini coefficient measures the equality (or subsequent inequality) of the distribution of income in the CSD. A Gini of 0 reflects perfect income equality where every household earns the same proportion of the total income earned in the same CSD. A Gini of 1 reflects complete inequality where one household earns all of the total income earned in the CSD. The distribution of the Gini coefficient among the forest dependent CSDs is shown in Figure 4.

Figure 4: Frequency distribution of the Gini coefficient among forest dependent CSDs.

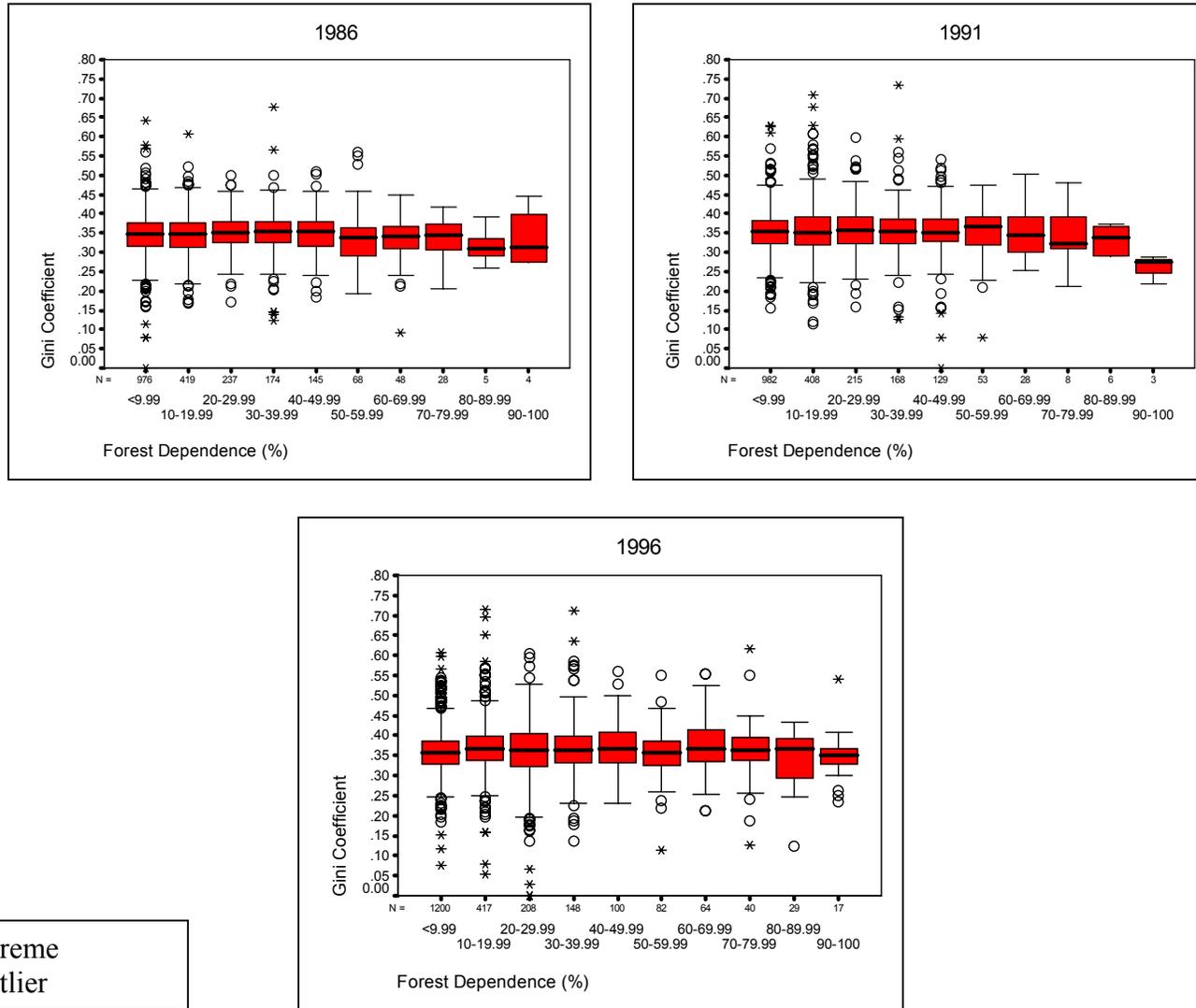


This distribution suggests that there was a shift towards greater income inequality over the period 1986-1996 for forest dependent CSDs in Canada.

The boxplots for Gini coefficient against forest dependence, shown in Figure 5, provide further explanation of the Gini coefficient in the various forest dependence classes. Again excluding the top two forest dependence classes for 1986 and 1991, the Gini coefficient remains relatively stable from 1986-1996 regardless of the degree of forest dependence in the CSD. Thus, the increases in income inequality in 1996 (as observed in the frequency distribution graph) were most likely spread across the forest dependence classes, as this result did not show up in the boxplots. The stability of the Gini coefficient across the forest dependence classes and through the time series suggest that the Gini coefficient values in a CSD are independent of

forest dependence. We will attempt to confirm this result by examining the degree and direction of their correlations in a later section. However, it must be noted that the stability of the Gini coefficient across the forest dependence classes does not mean that the Gini coefficient is stable over time within any given CSD. The distribution is relatively stable, but this does not prevent CSDs from moving across classes of forest dependence (reflecting changes in forest dependence) and within their forest dependence class (reflecting changes in income inequality).

Figure 5: Boxplots of the Gini coefficient by degree of forest dependence among forest dependence CSDs.

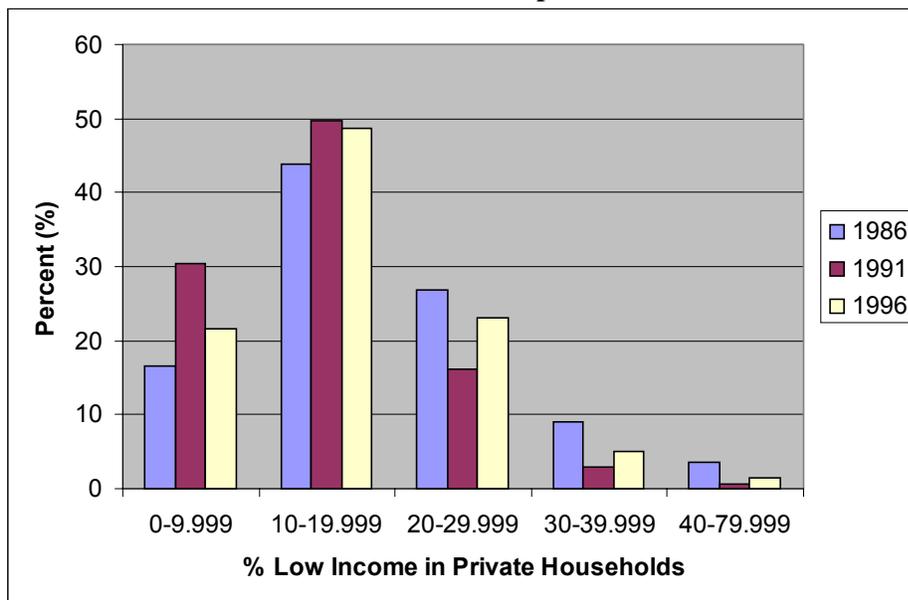


* = extreme
O = outlier

Incidence of low income among people in private households

Although the measurements may vary, an indicator representing poverty is common in most studies of economic sustainability. One variable related to poverty provided by the Canadian Census is incidence of low income for various groups of people such as economic families, unattached individuals, and people in private households. This indicator also helps to portray the equity (or inequity) in an area since it can reflect the incidence of poverty in a CSD. For consistency with our other variables of interest, we have chosen only to report this statistic for private households. A private household is defined as "...a person or a group of persons (other than foreign residents) who occupy a private dwelling and do not have a usual place of residence elsewhere in Canada." (Statistics Canada 1999). Also in the census, the incidence of low income among people in private households is the percentage of people living in private households below the low income cut-offs. In turn, the low income cut-offs (LICO) are determined by the proportion of expenditure on food, shelter, and clothing (basic necessities). An appealing characteristic of this poverty indicator is that the LICO's are set at income levels differentiated by household size and degree of urbanization, which are updated yearly by changes in the Consumer Price Index (Statistics Canada 1999). This validates the use of this indicator as it doesn't apply a universal LICO to all households or all CSDs as some poverty indicators do. Thus, the incidence of low income among people in private households is the proportion of people in households that are classified as 'low income' (by their expenditure on basic necessities) due to their household size and the size of their CSD. The graph depicting this statistic for the forest dependent CSDs is shown in Figure 6.

Figure 6: Incidence of low income among people living in private households among forest dependent CSDs.

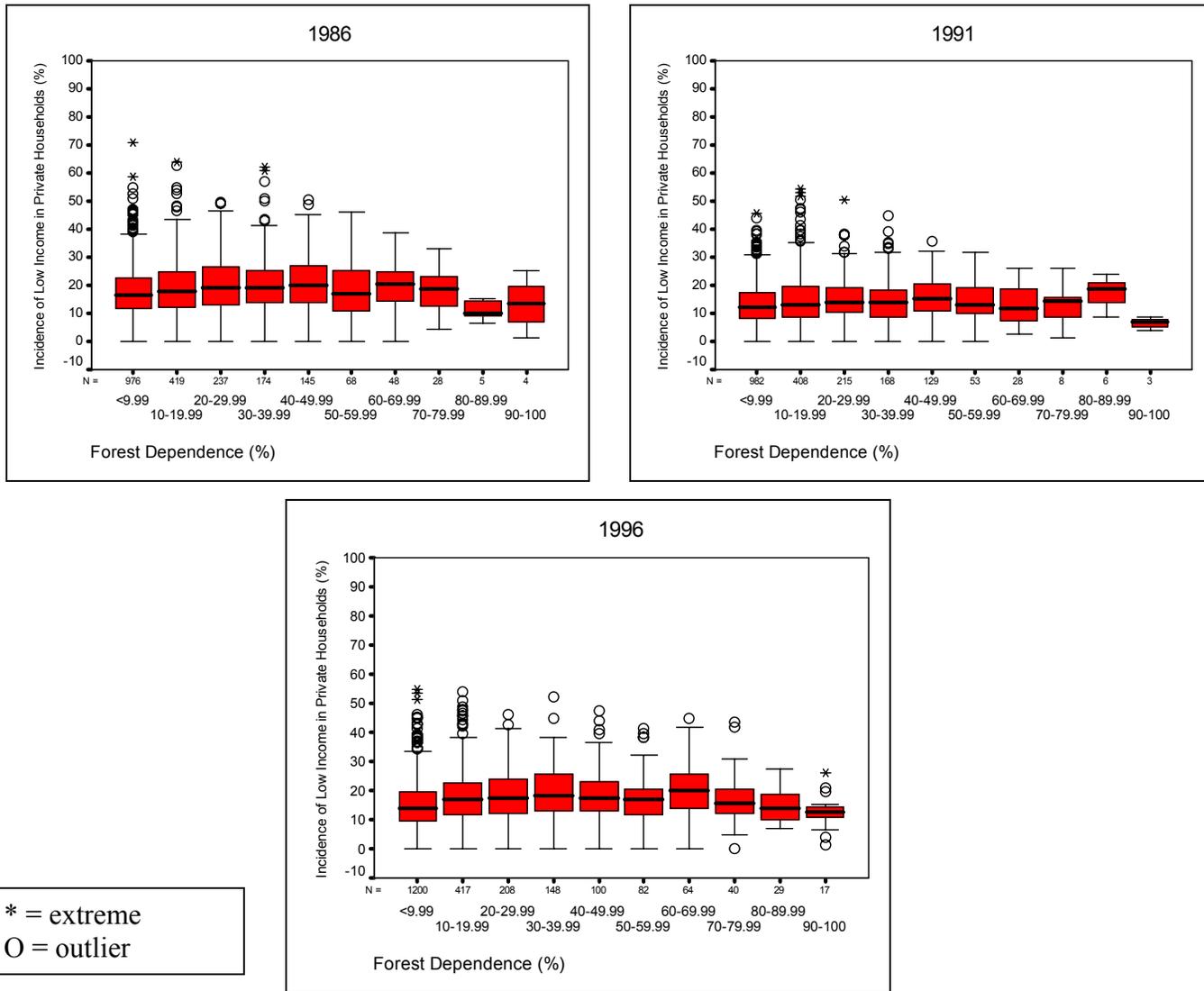


Over the period of 1986-1996, the distributions suggest that among forest dependent CSDs in Canada, there was a slight shift in the distribution of CSDs from the higher percentages of low income to the lower categories. This is most evident from 1986-1991, but in 1996, there

was an upward shift in the distribution. This suggests that in forest dependent communities the incidence of low income for people living in private households increased.

The boxplots in Figure 7 further illustrate the relationship between incidence of low income among people living in private households and forest dependence. For 1986 and 1991, there was not much variation in the incidence of low income as the degree of forest dependence increased. However, in 1996 the incidence of low income among people in private households increased slightly for the CSDs in the 60-69.99% forest dependence class, and declined in the three remaining higher dependence classes. As with median household income, it is difficult from these plots to characterize the relationship between this incidence of low income and forest dependence. The correlation analysis in a later section may provide a less ambiguous answer.

Figure 7: Boxplots of incidence of low income among people living in private households by degree of forest dependence among forest dependent CSDs.



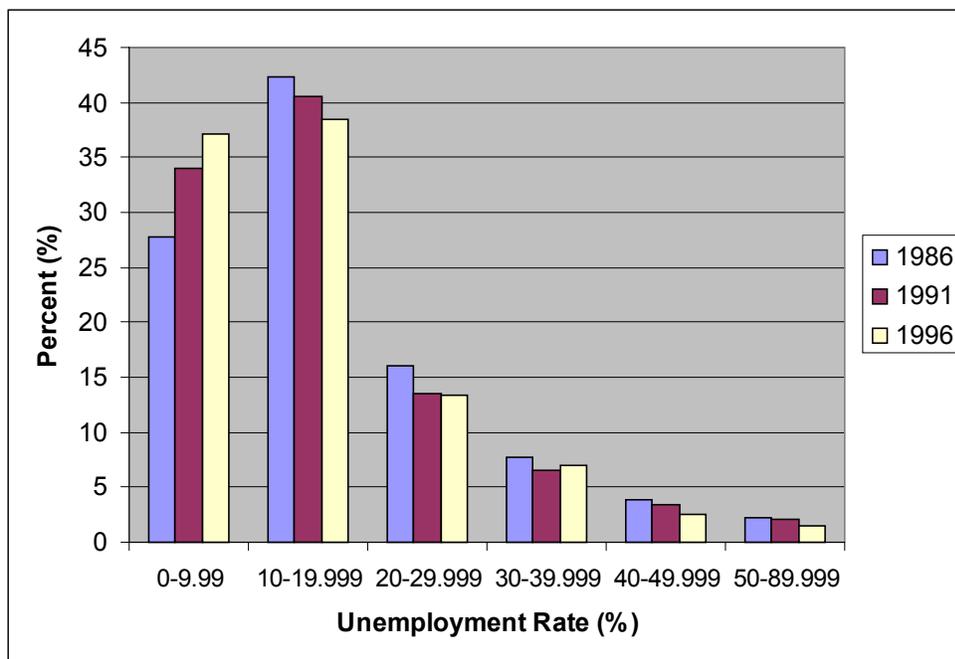
Resilience measures

Some economic sustainability indicators help to characterize a CSD in terms of its resilience to internal and external shocks to the economy.

Unemployment

The unemployment rate is one example of a resilience indicator and it is reported in the Canadian census for each CSD. This statistic refers to the proportion of the total labour force in the CSD that is unemployed in the week prior to enumeration. The ‘unemployed’ represents people 15 years or older (excluding institutional residents), who were “...without paid work and were available for work and either: (a) had actively looked for work in the past four weeks; or (b) were on temporary lay-off and expected to return to their job; or (c) had definite arrangements to start a new job in four weeks or less.” (Statistics Canada 1999). It should be noted that this definition of unemployment does not include discouraged workers who had to relocate to find work, involuntary part-time workers, and underemployed workers. The distribution of the unemployment rate among the forest dependent CSDs is shown in Figure 8.

Figure 8: The percent distribution of level of unemployment among forest dependent CSDs.

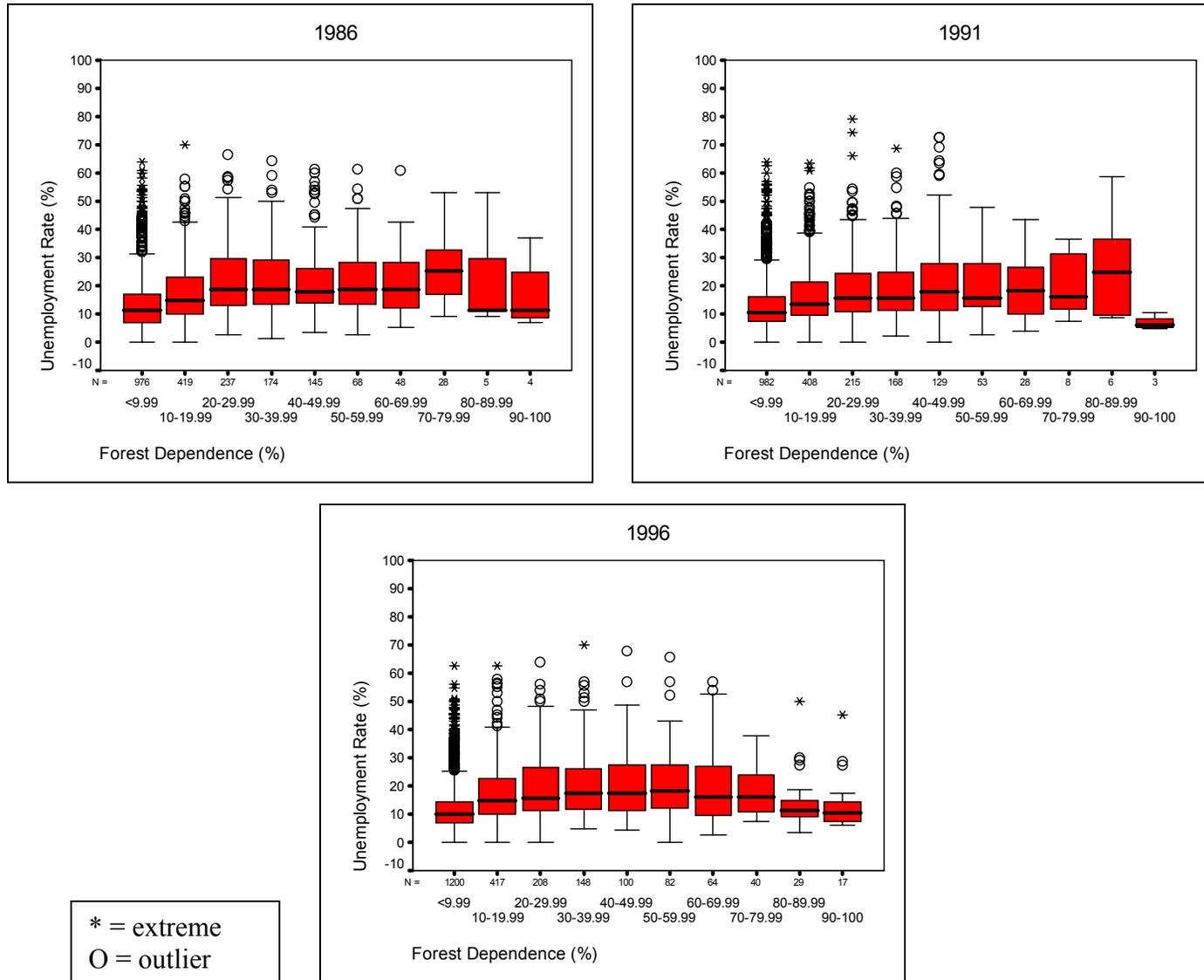


It is apparent that the proportion of CSDs with higher unemployment rates declined over time, which explains some of the increase in the 0-9.99% category.

The relationship between the unemployment rate and degree of forest dependence can be explored by using the boxplots of these two variables displayed in Figure 9. Ignoring the top two dependence classes for 1986 and 1991, there was an increase in unemployment as forest dependence increased. In 1996, this was the case for the first few classes, but in the higher forest dependence classes, there was a decline in the rate of unemployment for those CSDs. This

decline in the higher dependence classes might be attributed to the 1996 increase in the forestry price indexes which in turn reflect improved economic conditions and job opportunities in the forest sector. If these CSDs responded by increasing their forestry activity, this may have caused the unemployment rates to decrease. However, overall these graphs suggest that as forest dependence increases, so does the rate of unemployment.

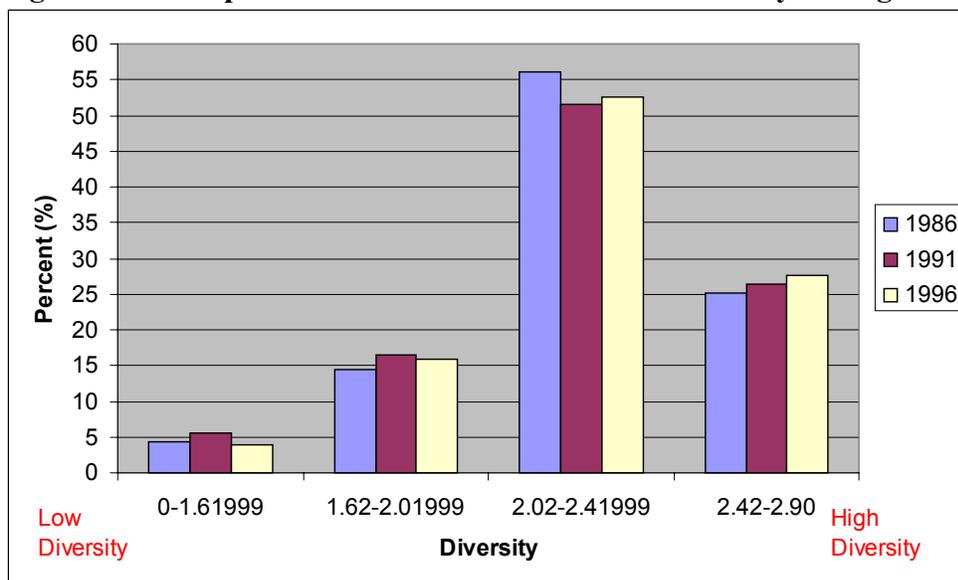
Figure 9 – Boxplots for unemployment by degree of forest dependence among forest dependent CSDs.



Economic diversity

As a measure of the mix of employment or employment income across sectors, economic diversity is a good indicator of the CSDs' resilience to economic shocks. The nature of its measurement (economy-wide) also makes economic diversity highly preferable to other indicators of the employment or employment income in a particular sector. There are two common ways to calculate diversity – one method uses employment in each of the sectors and the other uses the level of employment income in each of the sectors. We calculated diversity both ways and found the resulting measures were highly positively correlated. Thus, either diversity calculation can be used for analysis. Here, we have chosen to focus on diversity using employment income, as our definition of forest dependence also used employment income in its base calculations. The distribution of economic diversity among the forest dependent CSDs is shown in Figure 10.

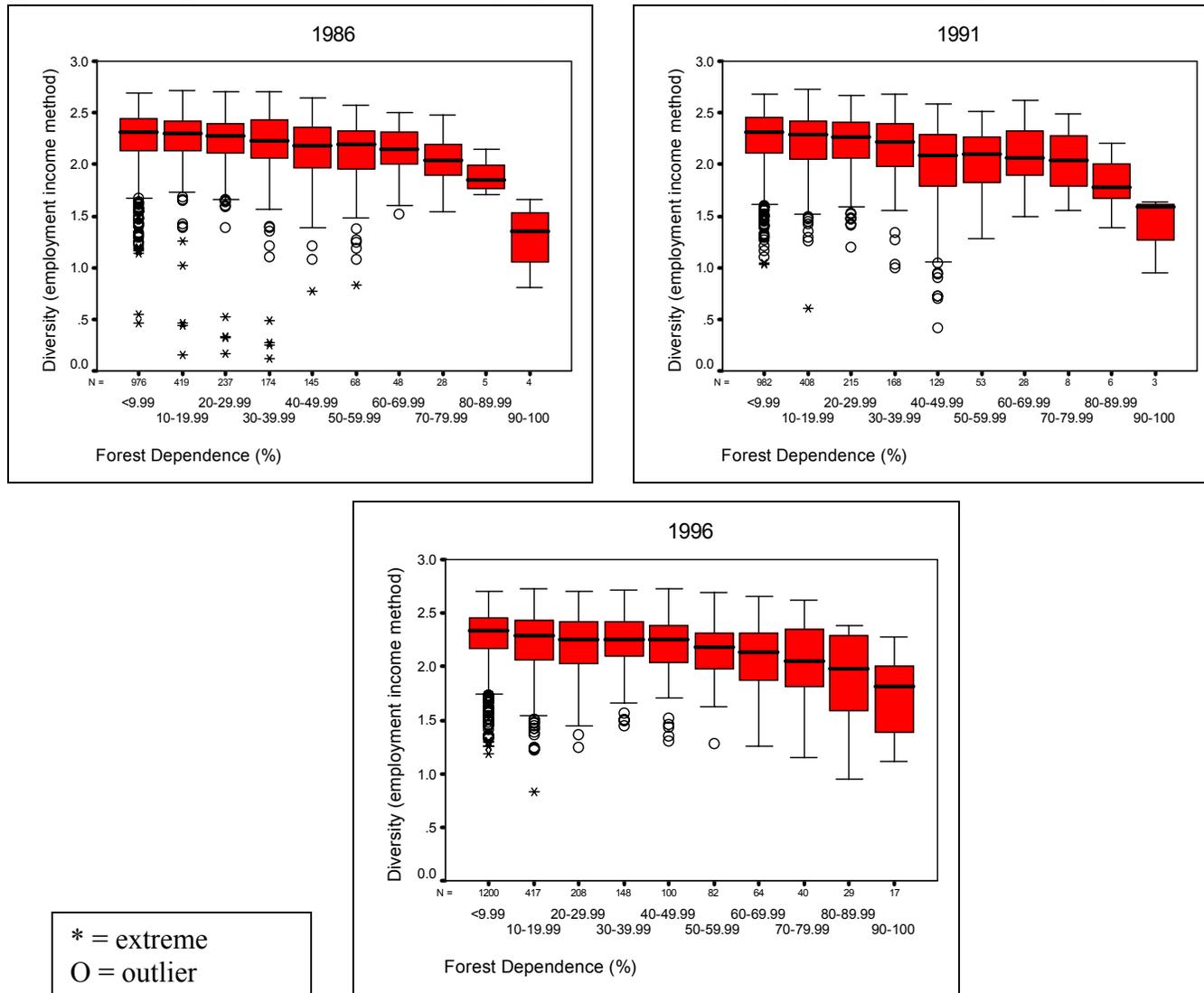
Figure 10 – The percent distribution of economic diversity among forest dependent CSDs.



As mentioned earlier, our calculation of diversity using employment income can take a value of zero if all of a CSD's economic activity is concentrated in one sector. In turn, the maximum value of diversity possible is $\ln(18) = 2.89$, with 18 being the number of economic sectors in each CSD. Thus, Figure 10 shows that in each census year, over 50% of the forest dependent CSDs exhibited moderately high diversity, while the other 25% enjoyed high diversity despite some reliance on forestry or forest related activities. The remaining 20-25% of CSDs in each year exhibited low to very low diversity. The distribution of CSDs among the economic diversity classes is similar in each of the three census years.

The boxplot in Figure 11 also portrays the relationship between diversity and forest dependence. As expected, as forest dependence increases, economic diversity decreases. This suggests that there is a negative correlation between forest dependence and diversity. Thus, an increase in forest dependence in a CSD may bring the risk of decreased resilience to economic shocks.

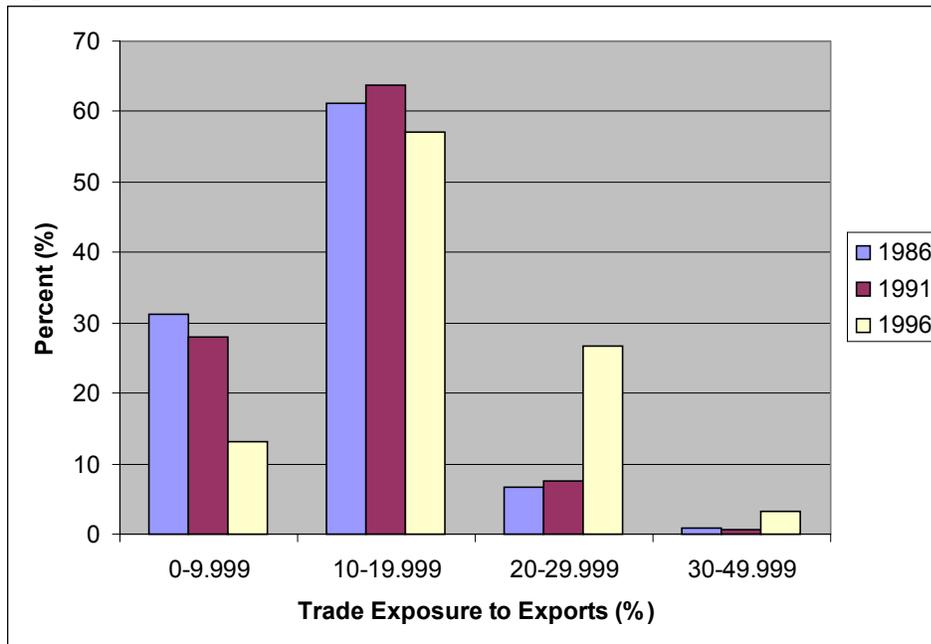
Figure 11 – Boxplots of economic diversity by degree of forest dependence among forest dependent CSDs.



Trade exposure to exports

Also mentioned above, a CSD's trade exposure to exports can make its local economy vulnerable to fluctuations in global market shocks and exchange rate influences. Trade exposure can be calculated from employment or employment income in each of the economic sectors. To maintain consistency with other variables, we derived trade exposure to exports using employment income. The distribution of trade exposure to exports among the forest dependent CSDs is depicted in Figure 12.

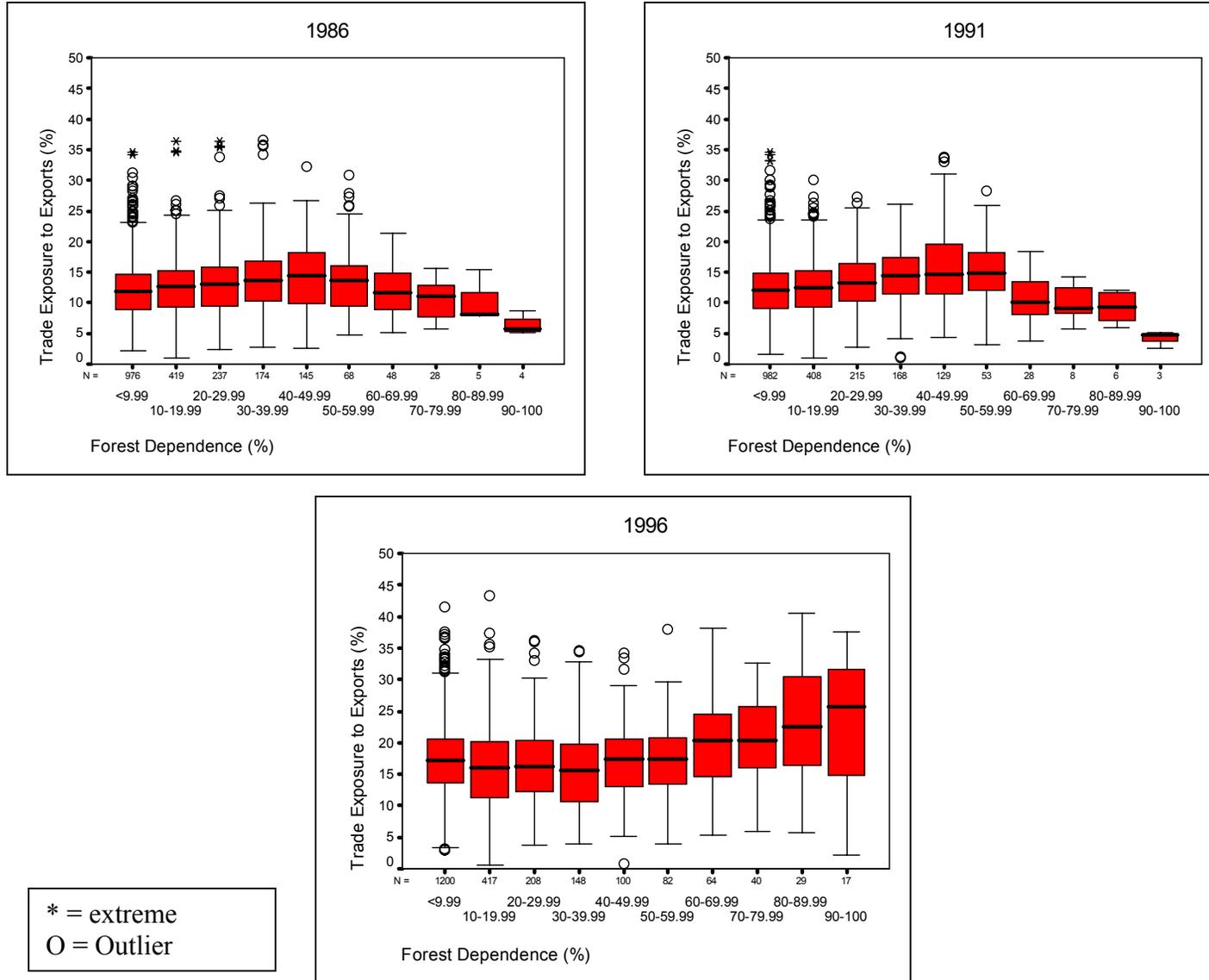
Figure 12 – The percent distribution of level of trade exposure to exports among forest dependent CSDs.



Between 1986 and 1991 there was a slight shift in distribution from the lowest category of trade exposure to exports to the higher categories. However, in 1996 there was a marked increase in trade exposure to exports among the forest dependent CSDs.

This relationship between trade exposure to exports and forest dependence is further examined in Figure 13. In 1986 and 1991, as forest dependence increased, trade exposure to exports increased up to the 50% dependence level, and steadily declined for each subsequent dependence class. However, quite a different result is seen in 1996. As forest dependence increased, trade exposure to exports markedly increased throughout all of the dependence classes. The increase in forest products price indexes between 1991 and 1996 likely explains the shift towards more reliance on exports, as forestry companies tried to maximize their economic opportunities in the external markets. Hence, forest dependence seems to be positively correlated to a CSDs trade exposure to exports. Thus, throughout this time series, the CSDs were becoming more susceptible to outside economic shocks.

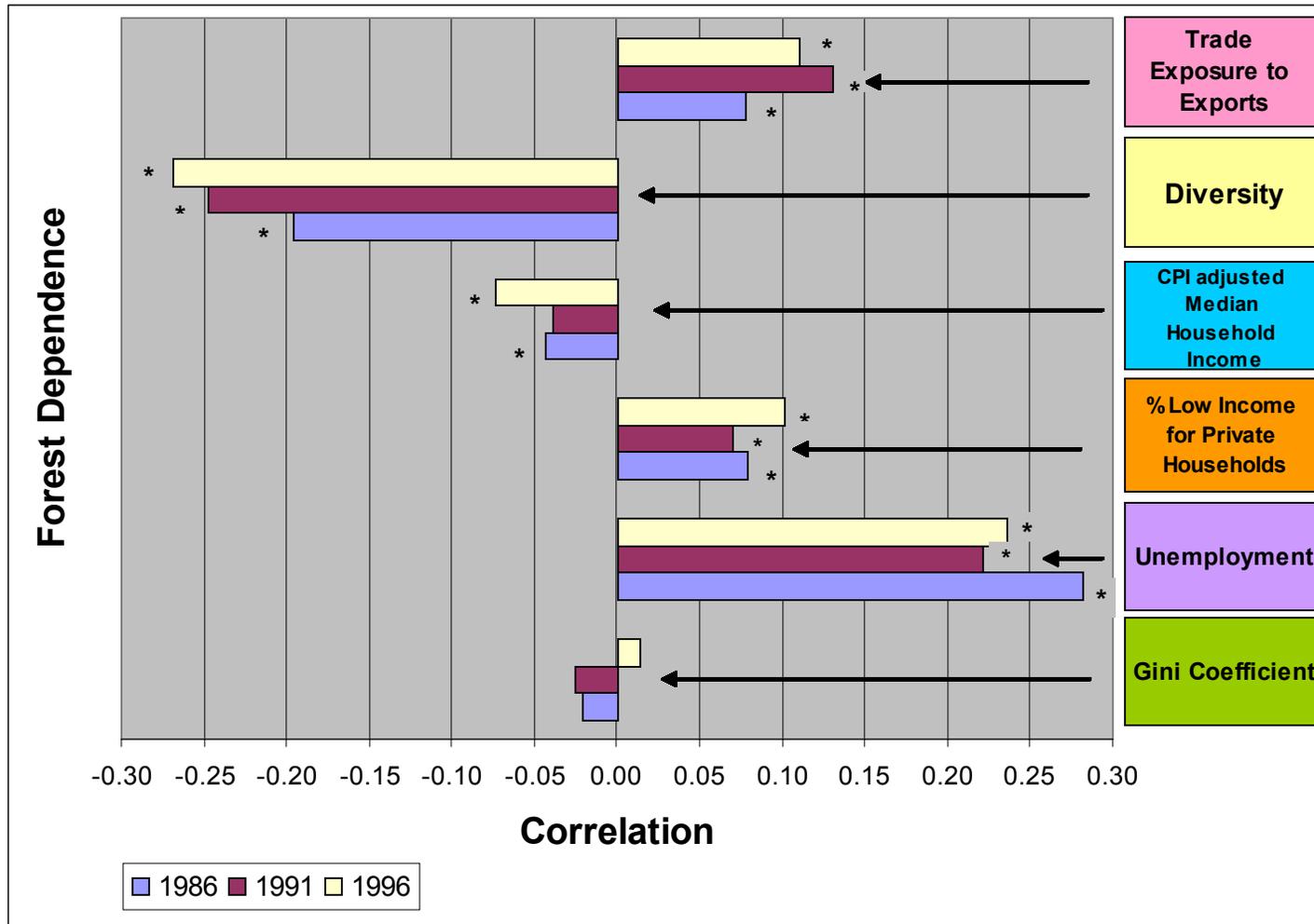
Figure 13 – Boxplots of trade exposure to exports by degree of forest dependence among forest dependent CSDs.



The direction and degree of correlation between forest dependence and various indicators

Observing the correlations between forest dependence and each of the economic sustainability indicators provides some additional insight into the relationships that may exist between these indicators. Significance was determined from the Pearson's correlation coefficient. As a measure of linear association, these coefficients range in value from -1 (a perfect negative relationship) to +1 (a perfect positive relationship). A value of zero indicates no linear relationship (Berenson and Levine 1996). However, as is always the case with correlation analysis these results should be interpreted carefully as they do not imply causality and are not derived from a conceptual model that proposes a causal structure. Further research is required to identify the causal structure.

Figure 14: The degree and direction of correlation between forest dependence and other variables in forest dependence CSDs.⁵



⁵ * means significant at the 0.05 level

A graph of these correlations and their significance is shown in Figure 14. Trade exposure to exports, incidence of low income among people living in private households, and unemployment are all positively correlated with forest dependence. Diversity, median household income, and income inequality (Gini coefficient values) are negatively correlated with forest dependence. All of the correlations are statistically significant at the 0.05 level, except the Gini coefficient for all three years and the median household income in 1991. To draw some adequate conclusions, we will compare the findings from the frequency, boxplot and correlation graphs for each indicator and study its relation to forest dependence from this particular dataset.

Median household income

From Figures 2 and 3, it was difficult to clearly define the relationship between median household income and forest dependence. Figure 2 showed only an increase in the number of CSDs with higher median household income over time. The boxplots in Figure 3 were used to examine the distribution of CSDs' median household income across the forest dependence categories. However, the distribution was relatively stable for 1986 and 1991 and 1996 showed a positive relationship between the two variables in only the highest forest dependence categories. In fact, we can see from Figure 14 that median household income is negatively correlated to forest dependence. The correlation was significant in 1986 and 1996, but not in 1991. This negative correlation should be evaluated carefully; these are correlations and may not imply a causal structure. As such, other forms of statistical analysis may be required to accurately portray the relationship between median household income and forest dependence.

Gini coefficient

The boxplots of Gini coefficient values against forest dependence showed that the distribution of Gini coefficient values was relatively stable over the forest dependence categories across all years. This result is explained in Figure 14. Although the Gini coefficient was negatively correlated to forest dependence in 1986 and 1991, and positively correlated in 1996, the correlation coefficients are not significant in any year. Thus, there appears to be no significant relationship between Gini coefficient values and forest dependence. Other factors must affect the Gini coefficient. Sharpe and Zybblock (1997) found that income inequality (as measured by the Gini coefficient) was highly dependent on the business cycle and other structural factors such as unemployment.

Incidence of low income among people in private households

As with median household income, the boxplots in Figure 7 did not clearly characterize the relationship between the incidence of low income among people living in private households and forest dependence. The correlation analysis provides a less ambiguous answer. The incidence of low income among people living in private households is positively and significantly correlated to forest dependence (Figure 14).

Unemployment

The boxplots in Figure 9 of the unemployment rate by degree of forest dependence suggested a trend that as forest dependence increases, the unemployment rates increase as well.

This is confirmed in Figure 14. Forest dependence and unemployment are positively and significantly correlated.

Diversity

Like the unemployment rate, economic diversity showed a clear trend in the Figure 11 boxplots over the time series. As forest dependence increased, there was a downward trend in economic diversity. The correlation analysis confirms this trend. This result is expected; increases in forest dependence mean that forestry and forest-related activity comprise a bigger share of the total economy, thus directly decreasing the CSD's diversity. There is much consensus that this result makes highly forest dependent CSDs less resilient to economic shocks, as well as technical change. Since technical change affects each sector differently, higher diversity in a CSD could help balance employment changes among the different sectors. However, a study done by Attaran in 1986 argued that the industrial mix of an economy is perhaps more important to its resilience than economic diversity. Attaran claims that forest dependent communities who have industries that follow opposite business cycle trends as the forest industry are considered more resilient than if these communities had industries that followed the same trends as forestry. While this may be a valid argument for CSDs of moderate diversity, the impact diversity has on resilience cannot be disputed in the 5-20% of forest dependent CSDs that exhibit low to moderately low diversity.

Trade exposure to exports

The boxplots of trade exposure to exports and forest dependence in Figure 13 showed a fairly strong trend in the time series that increased forest dependence was associated with an increase in the CSDs' trade exposure to exports. This was most prominent in 1996. The correlations in Figure 14 confirm this finding. Forest dependence and trade exposure to exports are positively and significantly correlated. Since trade exposure to exports means a direct reliance on the economy outside the CSD, the increase in trade exposure that accompanies increased forest dependence does make the CSD more vulnerable to outside economic shocks and exchange rate influences.

A Comparison of Forest Dependent CSDs to Non-Forest Dependent CSDs

We have examined the economic sustainability indicators over time in forest dependent communities. This section presents comparisons of those results to the indicator characteristics in non-forest dependent communities. To summarize the relationship of the indicators to forest dependence, we employ two categories of forest dependence: those CSDs who exhibit positive forest dependence but less than 50% and CSDs who are 50-100% dependent on forestry or forest-related activities.

Median household income

Figure 15 presents a series of three graphs that compare the distribution of median household income across forest and non-forest dependent CSDs for the time series. The relative stability of median household income across time seen in Figure 3 is again depicted here, despite

the addition of the non-forest dependent CSDs. There were more extreme values and outliers in the non-forest dependent group, and median household income did not vary much between this group and the groups of CSDs less than 50% forest dependent. However, there was a slight increase in median household income in the groups of CSDs that were more than 50% forest dependent for all three years. There was also a slight increase in the variance of the values in this group (as represented by the height of the boxes) in 1986 and 1991. However, there was a definite decrease in overall variance within this same group of CSDs for all years. This is partially due to the small number of observations in the >50% forest dependence group. Although the data for median household income may not raise any concern regarding increasing forest dependence, it is difficult to ignore the results of the correlation analysis that link increasing forest dependence with decreasing median household income.

Gini coefficient

The distribution of Gini coefficient values across forest and non-forest dependence are shown as 3 graphs in Figure 16. Across all three years, there was a decrease in the overall variance of the Gini coefficient as forest dependence increased. In 1986 there was a slight decline in the Gini coefficient as the CSDs became more forest dependent. For reference, this decline would suggest an increase in income equality. In 1991 and 1996, the Gini coefficient remained relatively stable as forest dependence increased. Whether the Gini coefficient was stable or not over the two forest dependence groups, it has already been determined in the correlation analysis that there is not a significant relationship between Gini coefficient values and forest dependence. There are undoubtedly other factors that control the behaviour of this indicator through time.

Figure 15: Boxplots of comparisons of median household income across forest and non-forest dependent CSDs.

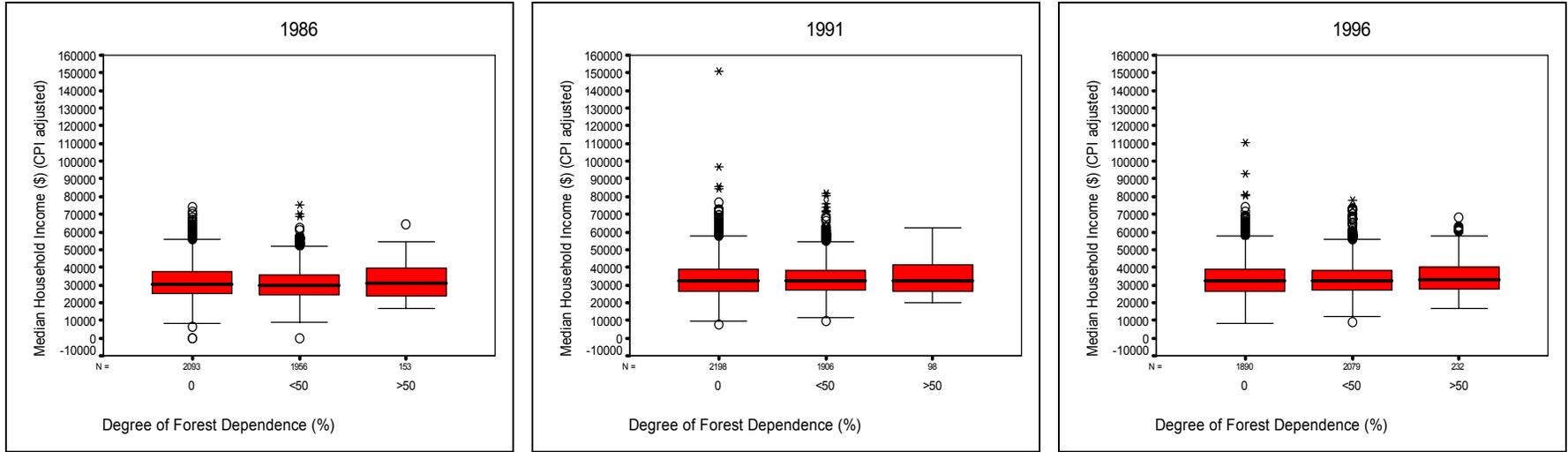
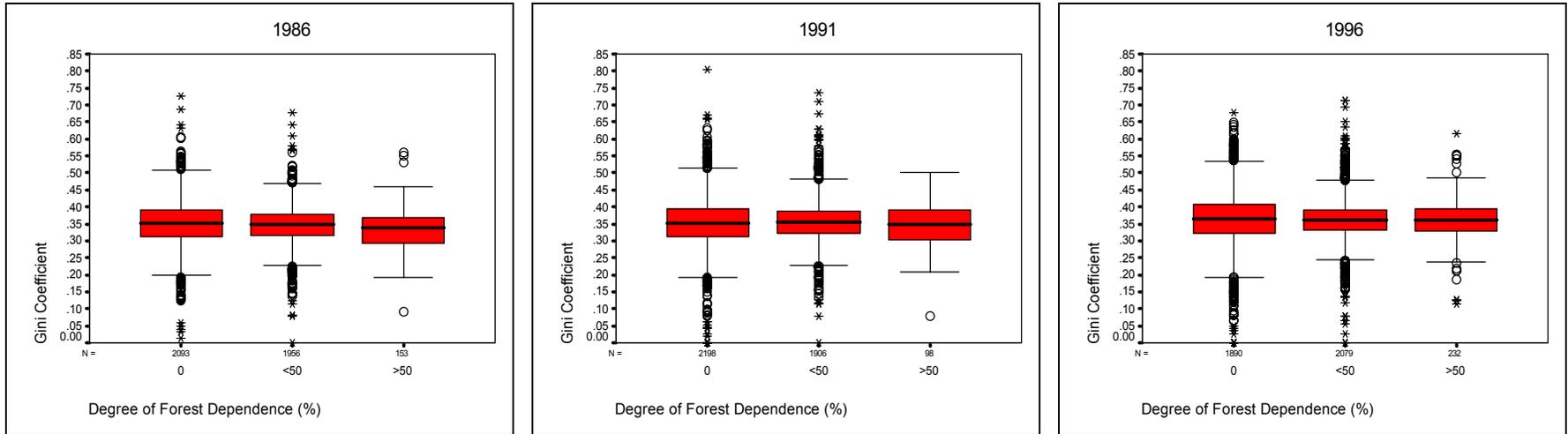


Figure 16: Boxplots of comparisons of Gini coefficient values across forest and non-forest dependent CSDs.



Incidence of low income among people living in private households

Figure 17 shows the incidence of low income among people living in private households and forest dependence across time. A decrease in the overall variance of this indicator as forest dependence increases across all years is observed. Between the two forest dependence groups the distribution of the incidence of low income is very similar across all years. However, the addition of the non-forest dependence group shows more clearly the result seen in the correlation analysis that increases in forest dependence are met with increases in incidence of low income for people living in private households.

Unemployment rate

The results of the correlation analysis of forest dependence and the unemployment rate are confirmed in Figure 18. This series of graphs compares the distributions of the unemployment rate across forest and non-forest dependent groups of CSDs across all three years. It is indisputable that as forest dependence increases, so does the unemployment rate. Also, the variance within the middle 50% of the values (as represented by the height of the boxes) increases as forest dependence increases in 1986, 1991, and 1996.

Figure 17: Boxplots of comparisons of incidence of low income among people living in private households across forest and non-forest dependent CSDs.

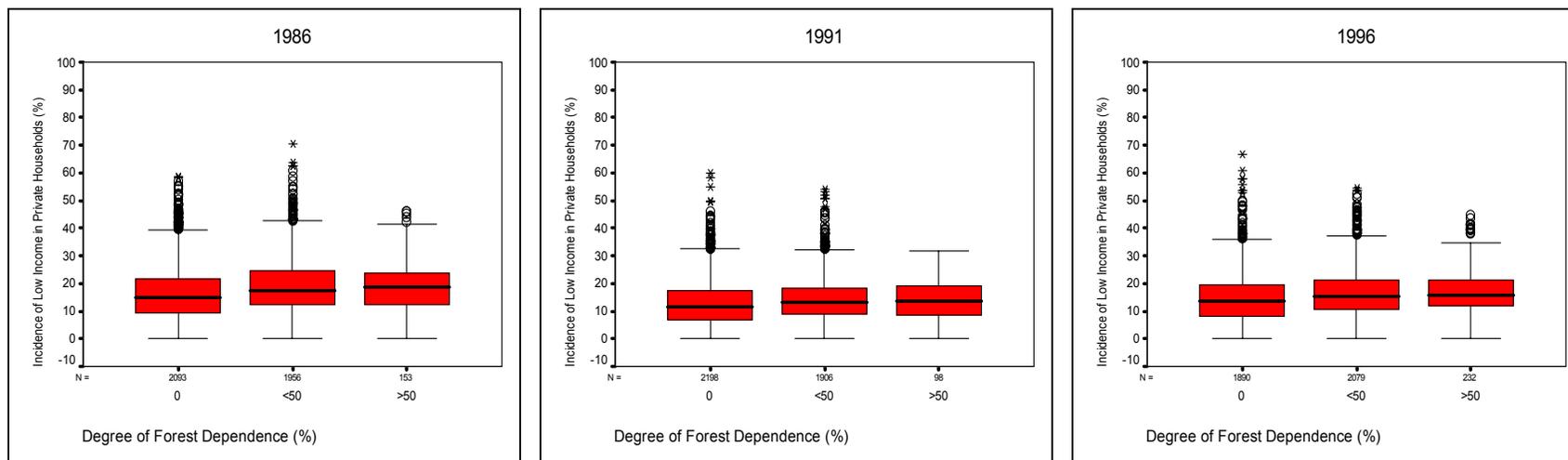
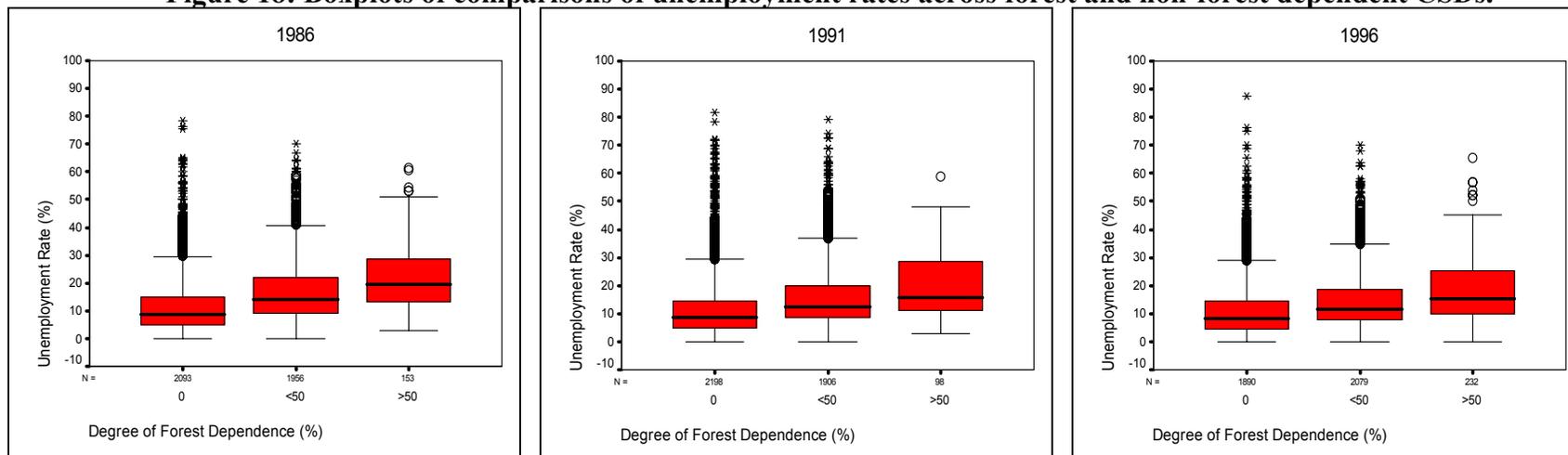


Figure 18: Boxplots of comparisons of unemployment rates across forest and non-forest dependent CSDs.



Economic diversity

Figure 19 compares the distribution of economic diversity to forest dependence across the three census years. Compared to the non-forest dependent groups of CSDs, diversity increased in all three years for the second group with less than 50% forest dependence. This could probably be explained by the addition of activity in Division C (logging and forestry) and/or part of Division E (forestry related manufacturing), both of which are absent in the non-forest dependence group. The addition of this activity increases the diversity of the CSDs in this group that is less than 50% forest dependence. However, in the third group that is more than 50% dependent on forestry or forest-related activity, there is a definite decline in diversity in all three years. This confirms the correlation result that increased forest dependence is related to decreased diversity.

Trade exposure to exports

Figure 20 compares the distribution of trade exposure to exports to forest dependence across the time series for the three groups of CSDs. Trade exposure to exports definitely increased from the non-forest dependent group to the two forest dependent groups. However, in 1986 and 1991 we see same trend as in Figure 13; trade exposure increases for the group that is less than 50% dependent upon forestry or forest-related activity, but decreases in the third, more forest dependent group. Examining 1996, again we see the same trends as seen in Figure 13, but the results differ greatly from the other two years. As CSDs become increasingly forest dependent, their trade exposure to exports increases as well. This is the same relationship exemplified in the correlation analysis.

Figure 19: Boxplots of comparisons of economic diversity across forest and non-forest dependent CSDs.

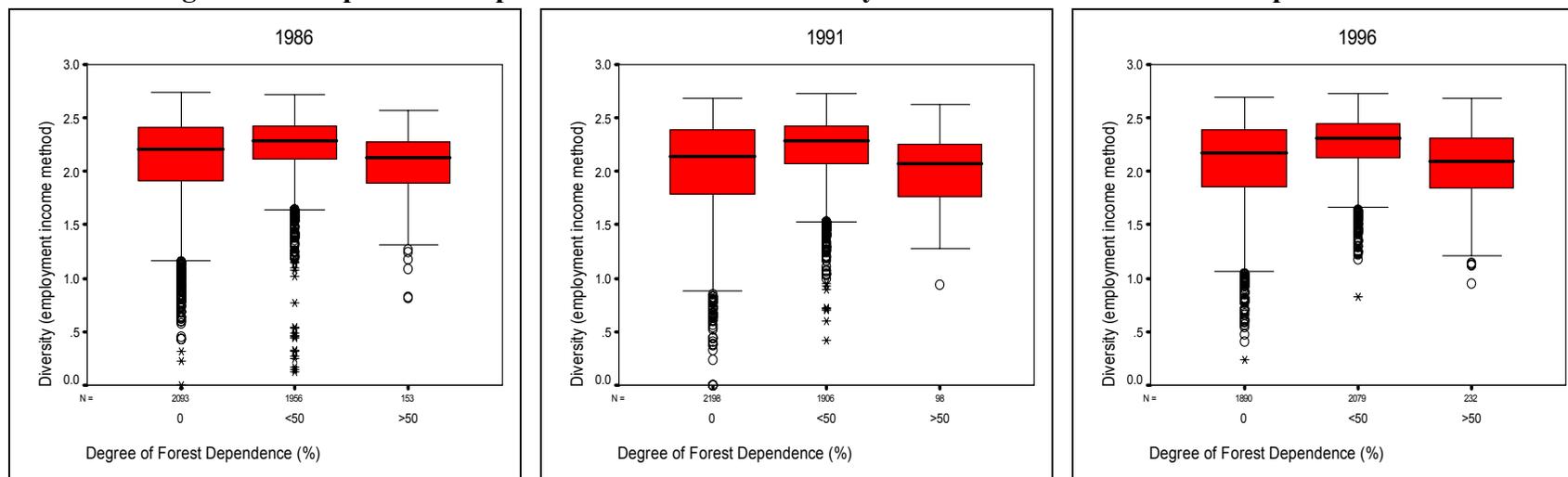
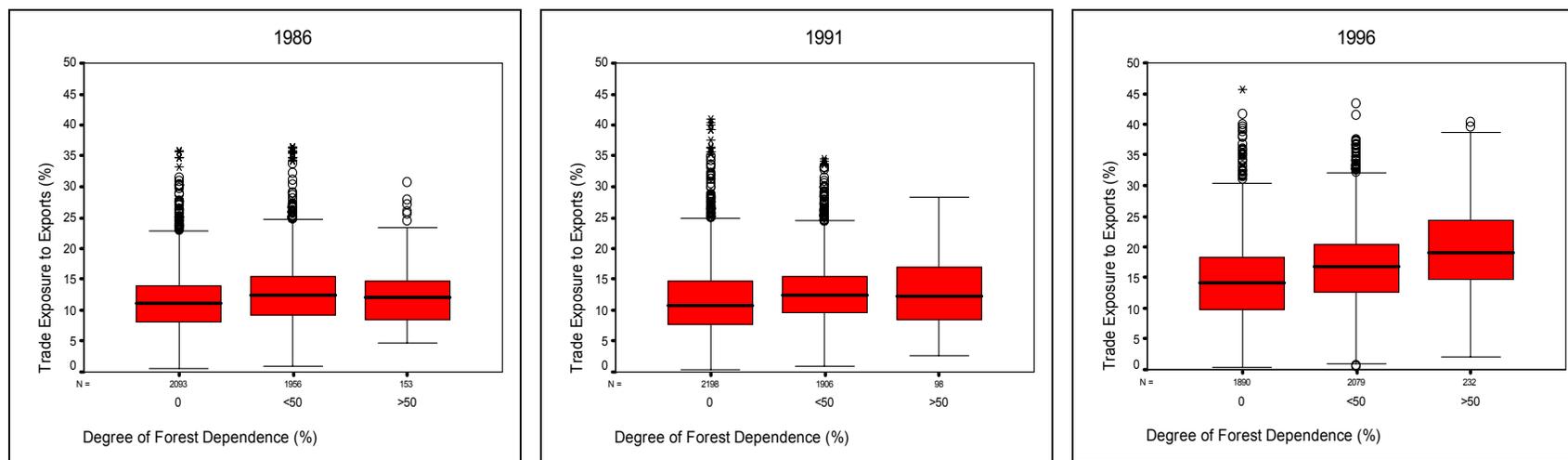


Figure 20: Boxplots of comparisons of trade exposure to exports across forest and non-forest dependent CSDs.



MANAGEMENT IMPLICATIONS AND CONCLUSIONS

The Canadian National Census provided a good basis for studying the behavior of economic sustainability indicators across a subset of CSDs over the period of 1986-1996. The indicators were examined over the context of the whole CSD, rather than in one sector of the economy. This proves a vital facet in the proper assessment of sustainability. The subtle interactions between the various sectors all contribute to an indicator's behaviour; thus, an economy-wide perspective is important.

Although the three years of census data provided a preliminary glimpse at indicator trends through time, it would be ideal to continue the same analysis as new years of census data become available. With the same attention to detail as found in this study, new data can be manipulated to add to the original comprehensive, standardized database. By continually updating the database and monitoring for changes in sustainability and indicator definitions, it may be possible to examine economic sustainability for most CSDs in Canada over long periods of time. Another future endeavor that would enhance this database would be to work with Statistics Canada to fill in the information gaps that prevent some CSDs from being included in the final database, for example many small communities. This could create a more complete picture of economic sustainability in CSDs of all sizes. It would also be valuable if this database could be expanded to include some measures of "augmented income" that would include values of non-market goods and services. This modification may be especially useful for aboriginal communities where subsistence hunting and other non-market activities may comprise a large portion of their income and employment. With no way to capture these values in the present database, the reported indicators may not give an accurate picture of the sustainability in these aboriginal communities. Although this data may not exist at the CSD level, perhaps procedures in the future would permit this inclusion at the regional level.

Our examination of these community level economic sustainability indicators in 1986, 1991, and 1996 did provide valuable information as to how various social and economic factors are related to forest dependence. Although some of the graphs did not depict clear trends, the correlation analysis defined the relationships that existed between the indicators and forest dependence. An increase in a CSD's forest dependence is negatively related to its median household income, incidence of low income for people living in private households, and the unemployment rate. The Gini coefficient values were not related to the degree of forest dependence. Increased forest dependence was related to decreases in the CSDs' diversity and increases in its trade exposure to the export market. When non-forest dependent CSDs were added to examine their differences, especially in relation to the group of CSDs that were more than 50% forest dependent, there were some interesting results. The non-forest dependent CSDs had slightly lower median household incomes, lower unemployment, lower poverty (incidence of low income), lower dependence on trade exposure to exports and higher diversity. Increases in forest dependence may be inevitable or natural in CSDs that have the necessary resources and technology. However, the result may leave the CSD's economy vulnerable to outside economic shocks and slow to rebound from sudden sectoral changes in employment. This might prove

detrimental to the residents of those communities who must deal with the income, employment and poverty changes that can ensue. Areas with lower levels of forest dependence fared better enough to hint at an economic plan of diversification for CSDs in the high forest dependence categories.

The descriptive graphs in this report have built a good foundation for the characterization of how economic sustainability indicators perform in forest dependent communities over time. However, the interpretation of causal factors associated with these indicators is a topic of ongoing research. Structural economic models are being developed to help explain the relationships between community economic indicators and factors like global market dynamics. These models will also attempt to uncover interactions between the indicators in forest and non-forest dependent regions. Hopefully these efforts will lead to the ability to forecast the behaviour of the indicators in the future under different economic scenarios.

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APPENDIX A: DATA ISSUES

Point 1

Although this study examines only the 1986, 1991, and 1996 censuses, it would have been ideal to have a fourth year in the database to allow for lags in the models. Since the 2001 census data were not yet available, the 1981 census was explored as a possible addition to the database. However, after selecting our desired variables for examination from the other three census years, it was discovered that 1981 was missing some of the same key variables. Also, the available data source for the 1981 data used the enumeration area as its geographic area. Thus, any data extracted would have to be amalgamated up to the Census Subdivision (CSD) level. There would most certainly be rounding errors in the aggregation due to data suppression at this level of geography. Thus, only the three remaining census years were used for data analysis.

Point 2

The main level of geography examined in this study is the census subdivision (CSD). A CSD is either a municipality (as determined by provincial legislation), or its equivalent (unorganized territories, Indian settlement or reserves). In Newfoundland, Nova Scotia, and British Columbia, a CSD can also be a geographic area created by Statistics Canada (also equivalent to a municipality) for the purpose of census data collection (Statistics Canada 1999).

Point 3

The census data is gathered under two profiles: 2A which is data collected from 100% of the population, and 2B (20% of the population). However, remote areas and Indian reserves have data collected from 100% of the population. The data from Profile 2B in other areas is weighted up to provide estimates for the whole population (Statistics Canada 1999). When aggregating the 2A and 2B profiles for each year, it was discovered that for 1991 there were 21 CSDs that were not common to both profiles. Thus, these CSDs had to be removed from the datasets for 1986, 1991, and 1996. Below is a table detailing these CSDs.

Appendix A, Table 1: Missing CSDs

<i>List of CSDs found in 1991 2A, but not 2B</i>	<i>List of CSDs found in 1991 2B, but not 2A</i>
Sally's Cove (1009037) COM 00000	Terra Nova (1007040) COM 00000
Queens, Royalty (1102018) LOT 00010	Goodwater (4702036) VL 00000
Manitoulin, Unorganized, Mainland (3551091) UNO 01020	Carmichael (4704056) VL 00000
Fife Lake (4703008) VL 00000	Waldron (4705061) VL 00000
St. Victor (4703027) VL 00000	Evesham (4713052) VL 00000
Meyronne (4703049) VL 00010	Lakeview (4811042) SV 00010
Netherhill (4713004) VL 00000	Willowbrook (4709018) VL 00000
Birchcliff (4808023) SV 01000	

Parkland Beach (4808042) SV 01000	
Grandview (4811004) SV 00000	
Mewatha Beach (4813045) SV 00040	
Telegraph Creek 6 (5949826) R 01020	
Duff (4705068) VL 00000	
Success (4708036) VL 00010	

Point 4

When standardizing the three census years of data, it was necessary to adjust each monetary variable to constant dollars using the Consumer Price Index (CPI). Provincial CPI's for 1986, 1991, and 1996 were used to adjust each group of CSDs in each year. Below is the table of provincial CPI's by year, with a base year of 1992.

Appendix A, Table 2: CPI numbers by province and year

Geography	1986	1991	1996
Canada	78.1	98.5	105.9
Newfoundland	81.9	99.0	106.0
P.E.I.	78.8	99.2	105.2
Nova Scotia	79.7	99.3	105.6
New Brunswick	80.0	99.3	104.9
Quebec	77.7	98.2	103.4
Ontario	77.5	99.0	105.9
Manitoba	78.9	98.6	109.2
Saskatchewan	78.8	99.0	108.9
Alberta	79.1	98.5	107.3
British Columbia	78.6	97.4	108.9
Yukon	81.2	99.1	107.5
N.W.T.	80.3	99.0	108.2

- Statistics Canada (2001)

Point 5

When evaluating statistics in the Canadian census, it is important to keep in mind Statistics Canada's procedure of random rounding and area suppression. Although the practices listed here can be applied generally to the data, each year's suppression rules may slightly vary. The practice of random rounding is applied to all census variables, except population counts. Thus, any number in tabulation, including totals are rounded up or down to a multiple of five, and in some cases ten. Random rounding protects the confidentiality of survey respondents (so that none of the data can be traced to a specific individual), yet does not add significant error to the census data. Area suppression also exists for the purpose of protecting confidentiality. Statistics Canada removes all characteristic data for geographic areas with populations below a particular size. Thus, all data in CSDs with less than 40 people is suppressed, and if the data

contains income distribution and related statistics, this is suppressed in CSDs with less than 250 people. Anytime area suppression is used, the suppressed data is always included in higher, aggregated totals for the variables (Statistics Canada 1999). Since random rounding and area suppression are in effect in small communities, the census data, including employment numbers are affected. Statistics Canada (1999) warns that small cell counts may suffer a considerable distortion from random rounding. Given that the employment numbers are the basis for the forest dependence calculations, these procedures can affect the level of forest dependence in these small communities. One way to minimize distortions from random rounding is to use custom tabulation numbers, rather than census data. These tabulations aggregate data from individual census records, where rounding does not occur until aggregation is complete. However, due to budget and time constraints, the Canadian census was the source for most of the variables used in this study. Statistics Canada also warns that the resulting estimates are subject to various errors that can occur while compiling the census data. These errors include coverage errors, non-response and response errors, processing errors, and sampling errors. For information on these errors, the Statistics Canada Census Dictionary for any year in question can be consulted (Statistics Canada 1999).

Point 6

The following is a list of the industry categories at the “S” level according to Statistics Canada. All of the employment and average income data were standardized to coincide with this list:

Appendix A, Table 3: Industry categories at the “S” level according to 1980 Standard Industrial Classification

Division A	Agricultural and related service industries
Division B	Fishing and trapping industries
Division C	Logging and forestry industries
Division D	Mining (incl. milling), quarrying, & oil well industries
Division E	Manufacturing industries
Division F	Construction industries
Division G	Transportation and storage industries
Division H	Communication and other utility industries
Division I	Wholesale trade industries
Division J	Retail trade industries
Division K	Finance and insurance industries
Division L	Real estate operator and insurance agent industries
Division M	Business service industries
Division N	Government service industries
Division O	Educational service industries

Division P	Health and social service industries
Division Q	Accommodation, food and beverage service industries
Division R	Other service industries

- Statistics Canada (2000)

Point 7

As noted earlier, the particular source for the 1986 and 1991 average incomes was missing 787 CSDs and their incomes for 1991. There are three possible reasons for the missing CSDs. First, the source reported income data, which is collected from census profile 2B (a 20% sample). Therefore, a CSD’s income data were suppressed if the non-institutional population was below 250 people. Thus, it is possible for a CSD to have a population over 250, with suppressed income data. This is due to the fact that when the census reports a CSD’s population, it usually is reported from the 100% sample showing the total population of the CSD. Secondly, some of the missing CSDs could have been Incompletely Enumerated Indian Reserves, which would suppress their data. Last of all, suppression of CSDs can occur if the data tabulations show a global non-response rate of 25% or more. The global non-response rate refers to the percentage of required responses left unanswered by respondents (L. Sather, Statistics Canada, Regina, Saskatchewan, pers. comm).

Point 8

In the forest dependence calculations, the province’s share of employment income in each industry is weighted by the proportion of national output minus net exports to show the amount of output needed to meet domestic consumption. While national output tables were readily available, the national import and export data were difficult to find. Statistics Canada categorizes industry data by 3 levels: “L” which is the link level, “M” which is the medium level, and “S” which is the small level, with increasing aggregation of industry categories in each. All of these levels are created from an even more disaggregated set of categories than “L” which is “W” the worksheet level. Although Statistics Canada publishes documents that list national imports and exports at the “L” level, then cannot be easily collapsed into the “S” level format (the 18 industries that we have been using in this study). This is because “S”, “M”, and “L” are not linked to each other, but they are separately linked to the “W” level of categorization. Thus, the national import and export data at the “L” level had to be linked back to the “L” level, from which the national imports and exports at the “S” level could then be derived (Statistics Canada 1998). This process required a custom tabulation from Statistics Canada (2002).

Point 9

It was necessary to take a few steps to ensure each CSD could be compared to itself across the three census years. The first set of necessary changes only applied to the province of

Quebec. After the 1986 census, Statistics Canada and Quebec agreed that the ‘municipalités régionales de comté’ (MRC) would be recognized as the census division level of the Standard Geographical Classification hierarchy in Quebec for 1991. The MRC geographic units are used as the current system of regional administration in the province. Since the MRC boundaries were vastly different than the 1986 census division boundaries, an entire revision of all Quebec SGC codes was necessary at the CSD level (Statistics Canada 1992). While changing the SGC codes, name changes were ignored for now, and it was discovered that some CSDs had been joined to make one new CSD. Between 1991 and 1996, there were 101 CSD dissolutions within Quebec. This high number was meant to reflect the provincial government move to combine some municipalities to be one regional municipality, which was an effort to cut costs (Statistics Canada 1999). Thus, in these cases, all of the variables from the two communities had to be combined. If the variables could not be simply added together, a weighted average was performed using the population in each CSD. In three separate instances, a CSD was missing some data so the weighting average for the variable was computed only from the other CSD(s). Also, 8 CSDs had to be entirely deleted, as they were not found in the Quebec SGC code changes file.

At the same point in time, Statistics Canada reorganized a few census divisions in British Columbia, which resulted in changes to a small number of CSDs. The SGC codes for these CSDs were revised to reflect these changes (Statistics Canada 1992).

In standardizing the initial data extracts from the Canadian census, it was recognized that there have been numerous changes to CSD boundaries, names, codes, and types across Canada from 1986-1996. Although these changes were not dealt with at the beginning of the compilation of the database, they must be addressed in order to compare the three years of census data. The CSD changes originate from three sources: provincial legislation, Indian and Northern Affairs Canada, and Statistics Canada. The changes are necessary either to make data collection more efficient, or because of change and growth in urban areas (Statistics Canada 1999). Recognition and application of these changes is important as it further standardizes the database and allows more CSDs to match up across all three years. Thus, it can prevent a CSD from being removed from the database due to missing data points. Across our ten years of study, there were two sets of changes: between 1986 and 1991, and between 1991 and 1996 (Statistics Canada 1992, 1997). The changes are grouped into 10 coded categories. Codes 1, 2, 4, and 7 represent the creation of a CSD, a name change, dissolution of a CSD, and a SGC code change respectively (Statistics Canada 1992). Changes to CSDs that fell under this set of codes were applied to the data. However, the creation of a new CSD (code 1) was only followed if all of the component CSDs were completely dissolved (code 4). Thus, if CSD was partially annexed (codes 5 and 6) to create a CSD, the change was ignored. If the component CSDs were completely dissolved, their variables had to be added together to create the new CSD. Thus, their respective populations could be cross-referenced against the new CSD’s population in the next census year. Most often the populations matched exactly. However, if they were different, the code changes were only implemented if the population difference was less than 200 people. The 6 codes outside of 1, 2, 4, and 7 represent the most numerous changes and characterize

partial annexations and boundary revisions. These latter changes could not be applied to the data as the changes were too numerous and detailed for a group of over 5000 CSDs. However, this exclusion should have little effect on the analysis as these annexations and revisions usually involve very small areas and populations (Statistics Canada 1992).