AGRICULTURE TO FORESTRY IN WESTERN CANADA'S NORTHERN GRAIN BELT: IMPACTS ON RURAL COMMUNITIES

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ABSTRACT

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Agriculture to Forestry in Western Canada's Northern Grain Belt: Impacts on Rural Communities.

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This study investigates impacts on Western Canada's rural communities that may result from land usage change from conventional agriculture to that of forestry, in part or in whole. Many of Western Canada's rural communities in the agriculture regions near the tree line have developed around cash crops (cereal/oilseeds) and livestock production. Through the Government of Canada's commitments to achieve targeted greenhouse gas emission levels, a market may develop where landowners will be adequately compensated to initiate a switch from conventional agriculture to that of forestry. This study finds that forestry and agricultural regions have over time developed different business structures to support local industry demands. Because of this, converting land use to forestry from agriculture will likely have a significant impact on the rural communities that serve the local economy. Results also showed that population change is significantly influenced by the percentage of people employed in agricultural and by proximity to larger urban centres.

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CHAPTER 1: INTRODUCTION

1.1 Introduction

There is accumulating scientific evidence that pollution and specifically greenhouse gases are negatively affecting the earth's climate. Earth's temperature is rising dramatically compared to historical fluctuations (Government of Canada, 2004). Global temperatures have increased approximately one degree Fahrenheit over the last century; ten of the 20th century's warmest years were after 1984. Melting polar ice and glaciers caused sea levels to rise 4-8 inches last century (U.S. Environmental Protection Agency, 2000). One response to rising temperatures is the Kyoto Protocol which came into effect February 16, 2005 in Canada.[1] The Kyoto protocol is a plan to reduce the acceleration of greenhouse gas emissions. A major storage device of these greenhouse gases is plant biomass. Plants sequester carbon and reduce its build-up in the atmosphere, which has the effect of reducing greenhouse gases.

Forests are a large carbon sink, biomass is large compared to other ground cover and carbon is sequestered for decades. Forests throughout the world, and in particular rainforests, are being eliminated to make room for agriculture and human growth. One region that could undergo afforestation, or the growth of new forest, is the northern grain belt of Canada's Prairie Provinces where previously forested land has been cleared for agriculture. In this region marginal agricultural land could be converted to forests significantly contributing to carbon sequestration (Government of Canada, 2005).

[1] The federal minority Conservative government has said it will opt out of Kyoto and implement a new "Made in Canada" environmental plan.

To implement Kyoto commitments, policies to achieve carbon sequestration through afforestation initiatives will potentially be developed.[2] The land use and economic base of the communities in the affected regions could be substantially changed. Understanding the nature of the required changes and their potential impacts on communities is a crucial component of designing appropriate and successful policies. The purpose of this research is to examine the potential impacts of afforestation on rural regions/communities of the northern forest fringe of the Canadian Prairies.

1.2 Background - Greenhouse Gases

There are a variety of greenhouse gases throughout the atmosphere, carbon dioxide being the largest followed by methane and nitrous oxide. Some occur naturally while others are a result of industrial growth. Each gas varies in the amount and in the heat absorbency ratio that enables it to trap heat. Carbon dioxide is the largest contributor; it is man-made in large amounts through fossil fuel burning and can be sequestered by plants. Each year hundreds of billions of tons of carbon are sequestered by plants, thereby reducing the amount of carbon dioxide in the atmosphere (United States Environmental Protection Agency, 2005).

The Kyoto Protocol is now in effect in over 141 countries that have signed on. Every industrialized country except Australia, Monaco and the United States is part of the agreement. Developing countries are outside the protocol's framework but include large polluters like India and China. In Canada Kyoto commitment were to reduce emissions to 5.2% below 1990 levels by 2012 or face penalties (CBC News Online, 2005).

[2] If the Conservative Government exits Canada's Kyoto requirements and implements its own environmental plan carbon sequestration programs are still valid options.

At the turn of the century the Canadian Council of Forest Ministers created a vision of the future of Canada's forests. Their vision resulted in the creation of the Forest 2020 initiative statement. With funding from the Federal Government, a plantation demonstration and assessment is being conducted where non-forested rural lands that have been clear of trees since 1990 are being seeded to plantation trees.[3] This is important for the Kyoto Protocol as any new lands planted to trees since 1990 are available for credits if increases in carbon sequestration are achieved.

The Government of Canada announced its plan for honoring its Kyoto commitments on April 13, 2005, called Moving Forward on Climate Change. The document's contents were announced in the 2004 speech from the throne and the 2005 budget. This plan entailed a commitment of $10 billion over seven years to meet Canada's emission reduction goals. Most of this money was to go to The Climate Fund, the Greenhouse Technology Investment Fund and the Partnership fund (CBC News, 2005A). Canada intended to meet its emission level commitments through mostly domestic actions but provisions are available to invest in environmentally friendly projects in other countries to earn credits and to buy and sell credits in an open market. Carbon sequestering sinks are going to be one of the domestic actions under the protocol, leading to possible afforestation activities in the prairies (Government of Canada, 2005).[4]

1.3 Background – Rural Communities

The northern forest fringe of Canada is an area where afforestation can likely be achieved. When European settlers first came to Canada the forest fringe extended south

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[3] These plantations are a test of the optimal procedure to plant large scale forest plantations in the prairie provinces. Approximately 400 hectares are planted in each province (Alberta/ Saskatchewan/ Manitoba).
[4] If the current Conservative Government is successful in opting out of Kyoto these plans will most likely be eliminated and possibly replaced with new environmental policy initiatives.

of its current location. Over time, regions of trees have been cleared to make way for agriculture. These areas are prime locations for afforestation, or shifting from agriculture to a forestry base.

Communities in the northern grain belt have economies developed around the agricultural industry. Many people work in agriculture directly and indirectly. Entire regions have developed around agriculture, and as a result the business community has grown to serve this industry. Farm implement dealers, seed plants, fertilizer distributors and many other agriculture-specific businesses are there to serve the agriculture industry. Public and private services have likewise developed to serve the population, some directly related to agriculture and others that are needed to support any population (gasoline stations, grocers, mail service etc).

The agriculture industry and structure of rural prairie areas has been an ever changing entity. Originally farms were very small by today's standards and the land was worked with horse and plow. As technology advanced, mechanization enabled a single farmer to work more land. This advancement of technology has continued and it is not uncommon now to see a single farm consisting of upwards of ten thousand acres. The general outcome of these technological advancements has been a decrease in the demand for labour, as the changes have been labour-saving in nature. Because new local economic activity has not been sufficient to take up the surplus labour, this has over time brought about a decline in the rural population in regions of Canada's agricultural based economy, particularly Saskatchewan (Olfert, and Stabler, 2002).

Declining rural population has led to a decrease in viability of rural businesses through a decrease in local demand for private goods and services (Olfert, and Stabler, 2002). The rural economy in the northern agriculture fringe was, and is still, agriculturally fueled to a significant extent. Employment in rural areas is often a result of agricultural activity or reliant upon it. Communities that serve the rural population and the agricultural industry have a business structure and infrastructure suitable for this agricultural economic base. Many businesses in rural communities, faced with a declining population, have closed or re-located. This has led the system of trade centers to consolidate through the decline of many small communities leaving a small number of regionally strong centers (Olfert, and Stabler, 2002).

Given that a region's economic base is agricultural in nature, the question becomes what will transpire if the economic base is shifted to partial or complete forestry? How will the type and number of local businesses change and evolve? What are the implications for the local population and labour force? How will the required public services and infrastructure be affected? If the northern Saskatchewan grain belt is converted into a forestry-based region and rural communities undergo major adaptations, what policies are needed to support these changes in rural communities? No literature is currently available on this exact type of change in resource base in Canada at any large scale and many questions have yet to be answered.

1.4 Objectives

What will happen to Canada's agricultural based rural communities in the northern grain belt if a shift to forestry is undertaken? Depending on how the Kyoto Protocol is implemented in Canada, or its sequel, a potentially major economic transformation may take place in rural prairie forest fringe areas. If afforestation is chosen as one of the ways to reduce Canada's emissions back to 1990 levels major changes will happen to the economic base of the chosen regions. The private and public infrastructure and local economy will no doubt have to adapt to the new economic base. This shift may also take place through other influences, a carbon market may emerge where emitters from any country can purchase carbon offsets in Canada.

In this study the following questions regarding changing a rural area from an agricultural to forestry region will be investigated.

1. If afforestry is undertaken in the northern grain belt to what extent could this result in changes in the economic business structure and export dependency of the rural communities in those areas?

2. How does a forestry base, as opposed to an agriculture base influence population growth in these regions?

1.5 Incentives to Achieve Conversion to Forestry

This paper will investigate the repercussions for rural communities of converting marginal agriculture land to forestry in Canada. The scope does not encompass an economic analysis of revenue from forestry versus agriculture and when this switch will take place. That analysis will be different for each individual land owner due to existing conditions, type of land, crops grown, climate, soil type, tree type etc. The variability is quite large and the type of forestry that is implemented is still unknown. It may be an alley cropping or shelter belt scenario where strips of trees are planted in rows in a conventional agriculture crop. It may take the form of woody crops where willow trees are planted on a field and cut periodically for harvest and growth promotion or the form of hybrid poplar fields. Another scenario could be silvopastures where trees are planted on pasture land for future harvest while at the same time offering shelter to livestock.[5] For any of these planting scenarios to take place a market must be available for the end products. The pulp and paper industry in Saskatchewan has seen some tough times and new markets must develop to handle afforested products and offer income to producers. Some potential markets that may develop or expand are the prefab wood built buildings (mobile, modular, panelized) for hardwoods. For hybrid poplars or willows laminated veneer lumber, plywood, oriented strand board and energy production are possible value added markets.

This is a diverse mixture of variables that makes any kind of forecasting over a large region nearly impossible. This paper assumes that afforestation objectives will entail some sort of financial incentive that will be large enough to entice land owners to undergo this switch. Of note here is that Canada, under the previous Liberal Government, had in part agreed to a tentative compensation plan. In January 2006 the Liberals were defeated by the Conservative party and the status of the Kyoto commitment is currently unclear. This does not, however, reduce the need for a study of this nature. Climate change is real and carbon sequestration, if put on the backburner now, may appear in the future as a greenhouse gas storage device. Rural communities will undergo a transformation whenever land use change is pursued.

Even if Canada chooses to reverse its intention of using forestry as a carbon sequestration medium, a new emerging use of trees may become viable in the near future. Gasoline prices as of summer 2006 were at record highs, reaching well over a dollar per

[5] Statistics Canada census data does not distinguish between forestry and agriculture, or agro-forestry which makes analysis of mixed farming (agro-forestry) operations not an option in this paper, even though it is quite possible many farmers will adapt to some form of agro-forestry. Forest 2020's Plantation Demonstration and Assessment for the prairie provinces is using a plantation or solid tree cover approach.

liter. Ethanol or alcohol fuel is a possible alternative energy source and wood fibers may be one option. Enzymes break down the cellulose in the tree or it is fermented, in both cases creating the final product of fuel and once again creating an environment where land owners may have incentives to convert land to forestry.

1.6 Organization of Thesis

The following chapters are organized as follows. Chapter Two provides a literature review of studies and previous work addressing rural community impacts and responses to a range of changes similar in nature to the problem in this paper. Community responses to structural change are examined along with a wide array of case study examples, some looking at similar land usage switches. The determinants of population change are also reviewed in this chapter. Chapter Three presents the economic framework and concepts for the analysis in this study. The development and components of the economic base are discussed, followed by a description of the regional income determination model. This model is then adapted to extrapolate a series of regionally descriptive multipliers. Location quotients are then explained along with a community population change model. Chapter Four goes on to explain the data sources used and the methodology of the research. Basic and non-basic employment is explained along with how location quotients will be used. A comparison of the business structure for agriculture and forestry communities is discussed. Finally an econometric model of population change is presented. Chapter Five shows results obtained from the analyses including a discussion and interpretation of the results, and Chapter Six offers conclusions and a discussion of policy implications.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of the literature in three main areas. The first is a review of studies relating to the impact on rural communities of a long-term structural change to local economic bases. The second part will be a review of research dealing with an explicit economic base change like agriculture to forestry. Existing agriculture to forestry scenarios are examined from regions outside North America, areas that have already experience this land base switch. Canadian prairie towns where a major economic shock has altered their economic bases are also examined to see how a land use base affects the local economic and demographic conditions. The third section will be looking at the more general determinants of population change in rural communities.

2.2 Community Response to Long Term Structural Change

Olfert and Stabler (2002) examined how the trade center system of communities throughout Saskatchewan has, and continues, to develop. A clustering process was used to classify communities into six categories; primary wholesale-retail (PWR), secondary wholesale-retail (SWR), complete shopping center (CSC), partial shopping center (PSC), full convenience center (FCC) all the way down to minimum convenience centers (MCC). This classification was taken to represent a hierarchical system in the context of central place theory, that which explains the number, size and spacing of communities.

Central place theory describes the role of a community as being a service and distribution center for both the community itself and its hinterland. It relies on the notion of the range of a good or service as the maximum geographic area over which it can be economically distributed, limited by transportation costs. The second important concept is that of a demand threshold, defined by the minimum market size (population and income) required to be able to economically provide the good or service from that location. This population size and density, as well as its purchasing power will be influenced by the nature of the economic base in the region.

Different functions of rural communities will have different demand thresholds. A small population can support a gasoline station; it has a low demand threshold. However an automobile sales center will need a larger population to sustain it, due to a higher demand threshold. Also the distance over which goods and services can be economically distributed from a center will vary by the type of function. People need gasoline often and do not want to travel great distances to purchase it while automobiles are rarely purchased and people will travel greater distances to purchase them. The classification system approximates the hierarchical nature of communities, reflecting the nested types of functions performed at each level. A very large number of small communities will meet the threshold requirements for only the most basic functions with their geographic range extending relatively short distances. Only a few communities will meet the requirements for the full range of goods and services.

At the top of the trade center hierarchy, the primary wholesale-retail centers are large urban areas with the greatest selection of a complete set of both consumer and producer goods and services along with the full range of health, education and infrastructure services. Going down through the six levels in the classifications, at the lowest level of the hierarchy are the minimum convenience centers which are small communities with only the most basic goods and services. The four other classifications get progressively larger and offer more services as you move from the MCC through FCC, PSC, CSC and SWR up to PWR centers.

In the Olfert and Stabler study (2002) all communities in Saskatchewan were classified according to their role in the trade center system in 1961 and tracked through to 2001. The pattern throughout the study period was one of consolidation of the system of communities. Technological changes reduced labour requirements in primary agriculture. In the absence of new economic activity to offset these declines, rural population declined reducing the market size of many centers. With surrounding population declining, demand thresholds were met for fewer and fewer functions. In this long term structural change process, small communities declined and both commercial and public services moved to larger and fewer rural centers. The rural population shopping patterns were increasingly characterized by by-passing of the intermediate size centres to access the higher level centres with a more complete complement of goods and services with greater variety. Consolidation of the system of trade centers was facilitated by improved transportation as intercity highways between communities expanded.

This was a broad and landmark study for Saskatchewan and highlights the decline of many rural communities that developed to serve the agriculture industry due to structural changes in that industry. Following early settlement, a large number of rural communities had a fairly complete array of goods and services in the context of the early 20^{th} century. The range of these goods and services was small as transportation infrastructure consisted mainly of dirt roads or rail lines, and the mode of transportation was horse, foot or early model often unreliable vehicles. The population density was initially larger as farming was labour intensive. Demand thresholds were not very high for the set of basic goods and services. This created a business structure in support of the agriculture industry and the mostly immobile local population. Virtually all goods and services were purchased at the nearest center.

Over time as new technologies developed farming became more capital intensive and the amount of land farmed by individuals steadily increased. Populations fell creating a smaller market size for goods while transportation became faster, easier and cheaper. This decline in population and improved ability to travel to acquire goods and services caused consolidation in rural regions. At the same time the nature of many business functions changed, raising demand thresholds. In most communities a large employer or vital community business may have closed and moved down the road to a larger center. In many cases this was an agriculture dependent business, an implement dealer or parts and service center, for example. Farmers would now travel to the new location of this vital business and while there save time and money by buying more and more goods while “in town.”   This caused new growth and demand for goods in a few higher level communities while in others the loss of the “vital business” was too much to sustain and a ripple effect of decreasing demand caused more and more business to close creating in many cases ghost towns. These towns could no longer attract or retain the important farm or other businesses. This caused the town to further decline as demand decreased for the existing goods and services, which eventually closed with farmers and consumers shopping at the higher levels in the hierarchy. These studies (Stabler and Olfert, 1992, 1996, and 2002) document the impacts on the system of rural communities of a long term structural change in the underlying economy.

The economic base model has also been used to describe existing conditions and factors inducing change in a community (Fik and Amey, 1991, Kendall and Pigozzi, 1994, Nelson and Beyers, 1998, Sirkin, 1959, Tiebout, 1956). Nelson and Beyers (1998) applied an economic base model to explain new trends in rural incomes and examined how this affects the economy and growth of rural regions. Traditional sources of income in rural areas were land-based (farming, logging, mining) and were basic or exporting in nature. This income dependency explained the boom-bust growth of rural communities as commodity prices rose and fell. The belief was that in many regions current growth was not explained by these traditional or basic sources of income. They extended the export base model and included other sources of income in a regional income framework model. Additions were income sources in the form of dividends, pensions, royalties, rents and non-farm incomes generated through proximity to urban regions. They found that these types of incomes have come to play a major part in the growth of many regions and not just in basic or exporting industry (Nelson and Beyers, 1998).

Fik and Amey (1991) looked at the causes of population and employment growth in Florida counties. They found that in some counties growth could be explained through proximity to metropolitan centers and their economic spillovers, yet other regions did not have this access, and growth was due to other factors. Florida is mainly a service-oriented employment area or non-basic in nature. They found that although new growth is mainly in the service sector, it is stimulated by new basic industries and transfer payments and grows in support of these stimuli. They conclude that the economic base model is a good starting point for explaining regional growth and that the economic base of Florida has evolved to incorporate many types of income. Basic industry, mainly manufacturing, along with transfer payments to retired population were both a significant cause of new employment growth which showed up in the service sector (Fik and Amey, 1991). Of note in this study is that the "service sector" does not distinguish between basic and non basic, all services were classified as non basic or local serving. Florida has a significant tourist industry which is an export industry and thus some services should also be classified as basic or exporting in nature.

Henry, Barkley and Bao (1997) extended the Carlino and Mills (1987) and Boarnet (1994) development models and tested for linkages of rural to urban areas in a Functional Economic Area (FEA) framework to examine rural area population and employment growth. The early Carlino and Mills work examined the jobs versus people causality in a county setting, while the Boarnet extension recognized that "city labour market areas are larger than the municipality of residence of the labour force." Henry et al. found that in an FEA framework, surrounding rural areas grew faster with a slow growing urban core and a fast growing urban fringe. Rural areas are able to capitalize on added employment growth in fringe areas and new developing opportunities. The importance of this study is that rather than a sector-specific economic base profile, community growth can also be understood in the context of the broader regional economy. For rural communities it implies interdependence with urban areas. These interdependencies may change over time as economic growth concentrates in urban centers and the rural labour force accesses this growth through commuting.

An extensive complement of literature exists on urban influences on rural areas in the U.S. However for Canada, a rural area may be less likely to be proximate to a center of any great size or influence. Therefore this study focuses on rural communities, in many cases remote, and although urban influence will always play a role to some extent, a nearby urban centre as a potential source of economic growth for nearby rural communities may not always exist.

2.3 Land Use Change

The primary focus in this research is centered on the impacts on a rural community of a change in its economic base that is due to a land use change, i.e., a change from agriculture to forestry. Much of the world is still experiencing deforestation and afforestation has not been conducted on a large scale let alone in Canada with its own distinct economic and environmental conditions. Afforestation may become more prevalent in years to come due to environmental concerns and/or agriculture income problems but this change is just beginning and potential outcomes have yet to develop.

One area where research on a shift from agriculture to forestry has been conducted is Ireland (Leary and McCarthy, 2006). Compared to the rest of the European Union with an average of 31 percent cover, Ireland has only 9 percent forest cover. Ireland's goal is to raise forest cover percent due to environmental concerns and to encourage land cover diversity. Government incentives to achieve this objective and the resulting repercussions on affected areas were examined by Leary and McCarthy (2006). The initial problems with converting the land was that existing farmers with conventional livestock and grain operations viewed forestry with a sense of antipathy; it was something new and different. To overcome this, financial compensation plans were tried and the results examined.

From a regression analysis the optimal payment plan was determined to be a Forest Planting Grant that is an up-front payment incentive (Leary and McCarthy, 2006).

A close second was a plan where funding was provided over a number of years. The third option was payments made at the end of the "forest cycle." The latter had almost no influence on farmer decisions to convert primarily pasture land and some grain land to forest cover.

Based on the "optimal" plan the resulting impacts on communities was overall land owner revenue rose, yet since forestry demanded less labour per acre than agriculture there were surplus agricultural workers available for other employment. The implication of this creation of surplus of labour was that the economic base had to be strong and diversified enough to retain these workers and the overall population. Some areas were successful in achieving this while others were found to need more investment and entrepreneurship in order to employ the surplus labour. A big factor in retaining these workers in a region or community was the proximity to a major center with ample employment opportunities. If the region was proximate to an urban center, people were found to remain resident in their original communities and commute to work instead of moving away.

In the Leary and McCarthy (2006) paper, farmers were compensated to totally or partially convert agricultural land to forestry. Marginal agriculture land was the type of land converted, much like the region in question in this study. The Irish example, in most cases, resulted in areas of cattle grazing interspersed with trees, or agro-forestry which very well may be the case in Canada. This paper is a good reference point for examining Canada yet many differences have to be accounted for. The region under study in Canada is significantly larger than that of Ireland, farm sizes are larger, distances are greater and the type of farming itself is different. A large difference also exists in employment conditions. When converting to some type of forestry the supply of surplus labour, *ceteris paribus*, rises and the economic base must be able to absorb and grow with these people or face rising unemployment or out-migration. Ireland was capable of successfully retaining the population in most cases, possibly due to the closer proximity of towns and major centers compared with Canada. It is unclear if this surplus of labour will or will not be generated in Canada. Farm sizes are considerably larger in Canada and the Irish example did not include linked industry responses, just the effects in the primary industry change.

The Wairoa District in New Zealand commissioned a study to evaluate possible socio-economic impacts of a land use change to forestry from pasture land (Ministry of Agriculture and Forestry, New Zealand, 1997). The area under study was mainly pasture land with steep hills susceptible to erosion. Forestry became attractive in the early 1990s due to natural market conditions, and in doing so began displacing pastoral land and threatening social infrastructure. Employment was previously based upon farming as the major contributor to the region's economic base. Government in the region wanted to plan for short and long term changes by facilitating new opportunities, while simultaneously mitigating possible problems associated with change in the economic base, from primarily agriculture, to one mixed with forestry.

Existing pre-forestry conditions in the area of 10,000 people was half urban and half rural with a large percentage of the labour force employed in cattle/sheep industry, and only one percent employed in forestry. The land use change was seen to be a danger to historic traditions, way of life and rural services by the local community (Ministry of Agriculture and Forestry, New Zealand, 1997). Leading up to this change the population was declining due to large increases in overall farm size, labour saving technology, and an overabundance of meat processors which resulted in them cutting back employment.

The outcome of the impacts in the region are underway and yet to be determined. Preliminary forecasts offered in the paper were that "regional health" will depend upon the region's ability to adapt to this change and develop new local opportunities. At the initial stage of the land use change, a population decrease was expected as the growing trees require relatively little attention until maturity. From maturity on (approximately fifteen to twenty years) constant harvesting, planting, logging and processing opportunities will exist as new growth matures and can then be coupled with the next and ongoing planting phases.

In the initial transition period the businesses to see the first impacts are those directly related to agriculture. A few will be displaced (veterinary etc.) but in some cases are able to diversify and support both agriculture and forestry. The government's goal was to retain and support new business through training and economic incentives instead of outside contractors taking jobs and income flowing outside the region. This is to be done through educating the workforce in forestry technologies and providing incentives for harvesting and processing to take place within the region.

Social and economic impacts are expected to be minor but once again this depends on the region's ability to diversify (Ministry of Agriculture and Forestry, New Zealand, 1997). If the region is able to diversify through local business expansion or retooling then populations and incomes are expected to rise in the long term and remain relatively stable in the short term. If this does take place then existing infrastructure like schools and hospitals are expected to remain open even with a small population drop in the short term. An interesting outcome of this study suggested the need for reliable infrastructure in transportation to support heavy machinery needed in the forestry industry, another example of how the region has to diversify to support and grow with the emerging forestry industry.

The two studies above are similar in that marginal agriculture land is being converted to forest cover. The reason why the land use change occurred is not identical in each country; however, the bottom line to land owners anywhere is the question of whether it will increase profits, although at times this is tempered with the affinity for the "old" way of life and the heritage of the family farm. That is not to say that government policy has not played a significant role in influencing this land use change. In New Zealand the change occurred through natural market conditions while in Ireland, and presumably Canada, government influence and compensation is, and will be, a major factor in the change. In any afforestation case existing conditions will change and government will have a role in steering a community or region into growth and diversification to capture the new economic base employment and income opportunities. The locations and existing conditions of these two studies are very different from those in Canada's prairie provinces but the process should be similar.

2.3.1 Economics of Land Use Change

Ward (2005) modeled a "typical" or average producer from northern Saskatchewan's black soil zone, an area that is part of this paper's study region, using 1,200 acres as an average farm size. Profitability on this "farm" was then simulated for agricultural and forestry use. Detailed data from the Saskatchewan provincial government's crop planning guide was used to find the economic gains of twenty years of farming a crop rotation of canola and hard red spring wheat, with no summer fallow breaks. The crop planning guide breaks down all of the costs associated with certain crops by soil zone on a per acre basis along with average yields. After twenty years of farming this “average” producer was expected to realize an aggregate loss of $653,052 assuming no off-farm income.

This “typical” producer was then assumed to switch out of agriculture completely and plant the entire 1,200 acres to hybrid poplar trees. After the twenty year growing cycle the profits were calculated for two cases; case one where the trees are owned by the producer and the cost of logging, loading and hauling are undertaken by the land owner. Case two where the land is leased to a large firm, planting and maintenance is done by the land owner while logging, loading and hauling costs are undertaken by the firm. In the first case the loss after twenty years was $884,550 and in the leasing arrangement a loss of $1,012,050 was realized; both cases are assumed to have no off-farm income.

Many assumptions were made in this paper about how to model this land usage switch. In each forestry case a percentage of machinery was assumed to be sold; insurance, depreciation and investment costs also had to be adjusted for each individual case. The assumptions were made in consultation with current agricultural land owners and the Prairie Farm Rehabilitation Administration (PFRA). One of the main factors for studying this land usage change was climate control and carbon sequestration. For the calculations an estimated price of $5 per tonne carbon factor was used, market trading had not established a set price. The author concluded that a producer today can expect to lose around $650,000 farming for twenty years; this in many cases is reduced by off farm income. It appears that this is better than switching to forestry where even higher losses were incurred, under the assumptions employed here. The main reasons for this large loss in forestry is the under developed industry. As more and more acres are seeded value added industry and larger markets could help to raise the price and technological advances from pest management to harvesting and cloning techniques could decrease costs. Other factors to make forestry more inviting would be a larger carbon payout; in some cases more ability to work off farm and again reduced costs as infrastructure for forestry improves with increasing forestry acreage (Ward, 2005). For some producers off farm income has become a stabilizing force that subsidies farming losses in certain years.

2.4 One Industry Towns

The following sections outline case studies of primarily Western Canadian economic base changes in one-industry towns. They highlight conditions before and after a resource base change and examine how the community as a whole tried to adapt and survive (Western Economic Diversification Canada, 2005).

The life cycle of these towns closely follows the Canadian theory of staples idea developed by Harold Innis in the 1930s. In this theory Canada developed around three staple exports that were initially shipped to European markets. The east coast staple was cod, Central Canada was fur and Western Canada's staple was agriculture. In each case the three separate regions either developed or diversified into other industry or just grew around the initial staple. Central Canada has since diversified as the fur trade collapsed while certain areas in the east and west are still dependent on the initial staple. The Innis theory explains how a region that relied solely on the initial staple can either grow with the staple or decline. In other words the region is trapped by the plight of the staple and if the staple collapses the region can see job losses and population decline if the economy could not diversify or adapt (Innis 1970).

2.4.1 Grand Cache, Alberta

The original resource base in Grand Cache Alberta was coal. The mining industry in the region downsized in 1982 before virtual elimination in 2000. From 1996 to 2001 employment in mining went from 29 to 9 percent of the total labour force, as the mine employed almost 30 percent of all local jobs. Population dropped 4,441 to 3,828, where losses were primarily of young families with children, similarly incomes dropped nearly 7 percent. Unemployment in the community rose to 12.3 percent compared to Alberta's provincial rate of only 5.2 percent at the time. Local, provincial and federal government support encouraged expansion in forestry, inmate correction facilities and tourism. This, coupled with new oil and gas exploration in the region, has stabilized the town's population. Much of the original business structure that supported the mining industry has since closed. Diversification into other industry has led to new growth that supports the region's activities. Numerous tourist and service business now serve the region along with contracting, trucking and consulting firms that support the forestry and oil and gas industry (Western Economic Diversification Canada, 2005).

2.4.2 Logan Lake, British Columbia

Logan Lake, B.C. is located near both the Fraser and Okanagan Valleys. The town developed around the mining industry (molybdenum and copper) and grew with the mines. Population in the early 1980's doubled to almost 3,000 and the community was growing quickly. In the mid eighties the mines began closing due to adverse market conditions and by 1986 the population was down to 2,000. The town is still heavily reliant on mining but has grown to a present population of 2,300 through promoting its natural resources and tourism, facilitated by its proximity to densely populated areas. The region has become a hotbed of outdoor activity and is now a tourist destination. Golf courses, nordic and alpine skiing, fishing, kayaking and camping are all available in the region and the community has transformed from almost solely a mining town into a diverse community with a much more diverse economic base (Western Economic Diversification Canada, 2005).

2.4.3 Ogema, Saskatchewan

Ogema is a rural mixed farming and ranching area south of Regina. The town originally developed in support of the agriculture community. In 1996 the CPR (Canadian Pacific Railway) closed rail service to the town isolating it and resulting in the closure of the town's grain elevator and numerous other agriculture-serving businesses. Population fell from 441 in 1981 to 292 in 2001 and the school, a vital community service, almost closed. The town has since grown to 325 by expanding into hog farming, building a railcar upgrade facility and promoting tourism. The community now has a restored train station and original water tower, museum, trade shows and summer fairs to attract tourists and has since purchased the local rail line and grain elevator. New service oriented business has developed to support the town and in 2005 Ogema was awarded a trophy for the best sustainable development across Canada in the national edition of Communities in Bloom (Western Economic Diversification Canada, 2005).

2.4.4 Pinawa, Manitoba

Pinawa, Manitoba was established as a planned community for nuclear research in the 1960's. In 1996 the Federal Government who initiated the community announced it was closing its laboratory. Employment at the lab, through progressively being lowered, dropped from 1,100 to 30. The population of the town only dropped by 130 to 1,500 due to favorable early retirement and home buyout packages and the continuation of municipal tax payments by the federal government. The privatization of the lab failed, yet some new high-tech companies have moved into the region to capitalize on existing scientific facilities, background and infrastructure and the highly trained workforce. This has been largely due to active recruitment and advertising from the town. The proximity of the town to Winnipeg and reliable transportation infrastructure has facilitated new development yet the town still relies heavily on government support and has continuing unemployment problems due to a lack of adequate high paying jobs for its highly skilled workforce (Western Economic Diversification Canada, 2005).

2.4.5 Uranium City, Saskatchewan

Uranium City grew from a series of uranium mines located in remote northern Saskatchewan; the town is only accessible year round by air. It originated in 1952 as a planned community and by 1959 the town had 3 mills and 12 mines. Instead of numerous small communities spread throughout the remote region, Uranium City was developed to be a larger community with good amenities and services that could support the entire region. In the late 1970s heavy investment was still taking place but the last Eldorado Mining facility was unexpectedly closed in 1981. This surprise closing dropped the population from 2,000 to only 400 almost immediately and today Uranium City has a population of 175 as the mines have been decommissioned. Isolation of the town and limited transportation routes has made diversification into other economic activity almost impossible. Minimal health, education and overall services are still available but may shut down completely when salvage operations at the mines cease (Western Economic Diversification Canada, 2005).

2.4.6 Military Base Closures

After the cold war military build up in the United States many military bases were being closed or downsized. A paper by Herzog and Poppert (2003) examined what happened to the region surrounding these bases and how they coped with a major employer leaving the area. Findings were conducted by using a panel data set and an econometric model using data from 3,092 counties over 20 years and looking specifically at local non-military employment at the county level. A total of 97 major installations were examined with the civilian and military personnel lost averaging 4,109. California had 19 bases while the remaining was distributed among 28 other states. The United States Defense Department estimated the ratio of permanent indirect jobs lost directly to base personal job losses at 1.51, i.e. for every ten jobs lost at the base five are lost in the community. Herzog and Poppert investigated the linkages between military base employment and local communities and at how this closure affected the community in the short and long term.

Results showed that initially the region will usually experience indirect job losses. The long term picture for these communities did improve, however. After a couple years many regions started to show employment growth as the communities diversified into other industry and services. The recovery was facilitated by help from the federal government as monetary assistance was given to these towns for investment and restructuring along with base infrastructure used to entice new industries to locate there. It was found that both gains and losses of base employees cause positive indirect employment growth in the local community in the long term. Personnel losses cause community gains by the "self-sufficient nature of military installations, the composition of the federal civilian workforce, and other mitigating factors" (Herzog, and Poppert, 2003 pg 479). Military bases were deemed to be self sufficient so personnel losses did not greatly affect the community and in many cases the people found private employment within the community itself. These losses were found to cause less hardship to the local community than labour losses at bases with continuing operations. The total direct, indirect and induced employment reductions resulting from closing bases was in the end a positive influence as the community responded and utilized military structures along with federal monetary assistance. This utilization of resources was a positive indirect effect with the magnitude being dependent on the timing of the release (Herzog, and Poppert, 2003).

2.4.7 Case Study Summary

The case studies highlighted above describe the adjustment process for communities that are generally dependent on one major employer initially. The economic base of the region is composed of one major type of "commodity" and the town follows the boom and bust of that product be it agriculture outputs, minerals or specialized labour. These cases show what can happen to a community if this major player leaves, or if the economic base significantly changes. They highlight how the community attempted to diversify into other business and industry in order to increase employment and retain population.

In some cases a community cannot recover, largely due to location. If a community is remote with limited transportation opportunities the ability to attract new industry and jobs is limited because of limited urban access. Proximity to urban regions can reduce many types of costs, transportation for all goods being key. Without additional new jobs, as the older retired population who may have stayed start passing on, new younger people in the workforce are not taking their place, and populations decline.

On the positive side many communities have been able to recover to an extent. Either the town can diversify into another economic base and create new jobs and attract people or wither away. Thus, finding a new economic base is the key. For example, tourism can play a major role. If diversification takes place the town has a greater chance of survival and growth. Government support can play a major role, investment at the right time and in the right areas can spur on this new growth and new ideas.

2.5 Rural Population Change Determinants

Another area of research relevant to this thesis is that of more general factors affecting rural community population change. Rather than a major employer leaving the region, the focus here is on more gradual and continuing adjustments, through population change resulting from ongoing exogenous shocks. A change in the economic base is one potential source of an exogenous shock.

Roback (1982) in her landmark paper modeled population change as a function of both the location decisions of firms and those of households. She found that local amenities affect wages that firms offer and rents people are willing to pay where the difference is the implicit price of local amenities. All three (wages, rents and the implicit price of amenities) are simultaneously determined in the labour and land markets. The conceptual model was one where employees move to maximize utility, while employers locate to maximize profits. The underlying meaning of this is that people will move to a community where they can achieve the highest degree of "happiness" and firms will locate to have the lowest cost of production.

Roback (1982) used two regression models alternating land prices and wages as the dependent variables. Amenities were composed of population density, snowfall amounts, heating degree days, crime rates, cloudy days and pollution rates. The unemployment rate was used as an economic indicator for the "region" in the model. Although not all expected variables had significant coefficients, correct signs of the variables were achieved. Roback's model was influential in that it did not focus solely on either utility maximization or profit maximization. Roback accounted for adjustments in economic conditions and overall utility given increases in population which affect labour and land markets. This paper resulted in a wide array of new research using both land rental rates and wage rates as a proxy for amenities instead of the original hypotheses that land prices alone were a sufficient measure. Most of the literature on regional development and the role of amenities and social capital are done using U.S. data, which suggests some caution must be used in applying the model directly to rural Canada's northern prairies.

Ferguson et al. (2006) looked at rural and urban community population change in Canada from 1991-2001 at a fairly disaggregated geographic level and for specific age cohorts. A unique decomposition approach was developed to gauge contributions of variable groupings for different age groups. As in the Roback model, individuals were assumed to be utility maximizing and to weigh the costs versus benefits of relocating through preference ranking of competing locations. This utility for individuals was derived from either favourable economic or amenity conditions.

In the Ferguson et al. (2006) paper, the location of firms was dictated by maximizing the production function composed of land availability and population size of the community while at the same time minimizing costs. Costs were composed of the price paid in wages for employees and the price of land. These two community population change drivers are in an equilibrium state when all firms have equal production costs and all households have equal utility levels. This equilibrium state is reached by adjustments of the wage rate and land price fluctuating constantly through relocation of firms and residents. The final wage rate and land price that cause equilibrium to be reached are determined in the labour market for wages and the demand for land.

The study (Ferguson et al. 2006) found that in rural census consolidated subdivisions (CCSs) economic factors dominated population growth, while in urban areas economic and amenity factors are almost equal, yet in rural areas amenities were more important for elderly demographics. Results implied that "for rural communities, especially those concerned with retaining/attracting rural youth, supporting/facilitating economic activity would have greatest payoff" (Ferguson et al., 2006, pg. 19). The study also found that in some cases, remote communities may benefit from a focus on developing a higher quality of life through both economic and amenity factors in order to retain population. Each region is its own special case yet diversification from solely agriculture and proximity to urban centers helps in the retention of population (Ferguson et al., 2006).

A Canadian population growth study looked at population growth (loss) in Canada with comparisons made to the United States where regional population growth has been strongly influenced by amenities (Partridge et al., 2005). A utility maximizing model was developed where households would locate in an area with the best mixture of economic conditions and amenities while firms located to areas with the lowest cost of production. Results showed that in contrast to the U.S., Canada's population growth is strongly influenced by proximity to large urban areas of more than 500,000 people. Unlike previous findings these centers were found to positively influence population growth beyond the normal "spillover" distance. Conclusions were that in Canada, rural areas would benefit from more large urban centers. Proximity to (large) urban centres was paramount, while amenity-driven growth was not evident. Possible reasons for the relative lack of amenity-driven growth in Canada was that unlike the U.S., the majority of people in Canada reside in a long east-west "line" close to the U.S. border and climate conditions are relatively constant along this line. In other words moving south in Canada to a warmer climate is not an option. Access to urban centres representing access to both urban employment and urban amenities was found to be more important in Canada (Partridge et al., 2005).

Monchuk (2005) examined forces that cause overall growth at the U.S. county level by using an OLS regression model incorporating economic conditions, amenities and state effects. Findings were that counties with strong agricultural presence do not do as well as diversified counties or counties with value added agriculture. Recreational amenities were found to be important for enticing new industry and business to locate in the community. Distance to urban centers also helped, while high local taxes were a negative impact on growth (Monchuk et al., 2005).

Although rural population in the U.S. rose from 1900-90, increases were seen mostly in non agriculture regions (Huang et al., 2002). Concerns exist that if rural populations in agricultural-dependent regions decline further, then erosion of services for citizens may eventually cause towns to disappear as they become too small for self sustenance. Findings here were that rural areas suffer from the brain drain syndrome and young educated people can not find good high paying jobs in order to stay in rural areas. Greater diversification of community promotes these types of jobs and population growth is stronger in these areas. The study did not find that investment in public services was a good attraction for population growth in rural areas, but government investment and a good transportation infrastructure does help growth.

2.6 Summary

Populations in the rural areas of the agriculture belt of the Great Plains are falling. This long term structural change has been underway for decades as farm technology has been successively labour saving and farm sizes increased over time. The rural community structure has adjusted to this and over time has become more consolidated. The economic base model is a way to show how a region develops around certain types of industry or resources and relies upon that as a major employer, and causes ripple effects of growth needed to support that main industry.

The case studies highlight certain instances where communities have not been able to adapt to a change in industry and eventually cease to exist, whereas diversification has rejuvenated some rural regions. Two regions, Ireland and New Zealand, which underwent the same type of resource change being examined in this paper, were showcased for possible outcomes that could be similar to that of Canada.

Another factor revealed as important in rural community health and vitality is proximity to urban centers and transportation infrastructure. If a community is close to urban or densely populated areas and has good access, this provides yet further opportunities. Amenities also play a role in rural development, these amenities may be health care in many instances, but scenery/services etc. also come into play. These amenities do help in retaining younger people and in enticing new business to the area but without jobs amenities are secondary to younger people and long term population growth will not be achieved.

CHAPTER 3: THEORETICAL MODEL

3.1 Introduction

This chapter presents the economic framework and concepts for this study. This framework provides the context for the development of the methodology that will be used for analysis. The export base model is presented to show how export activity can stimulate growth in a regional economy and how the structure of the regional economy will reflect the nature of the export base. Employment and income multipliers show the relationship between basic industry growth and growth in both employment and income in non-basic, or residentiary, activities. Location quotients are a means of identifying the export base of a region through measuring the strength of each industry in that region relative to some reference area. Finally a model of population change determinants is presented showing the relationship between community population growth and industrial, geographic and amenity variables.

3.2 The Export Base Model

The export base model is a particular type of economic base model explaining how exports cause a region to change over time. One of the more thorough definitions of a region's economic base was done by Tang (2003). The check list below shows a system for defining a region's economic base.

1) The aspects of the economic base:

-Demographic: population and household forecast, demographic trends, age distribution.

-Employment: employment forecast, income levels, and employment characteristics.

-Industry: types of industry present, number of firms, top firms in a community, population/employment ratio by industrial sector and entire community.

2) Physical features of region relating to economic base

-Agriculture – Farm numbers and types, soils, topography, ground & surface water, environmentally sensitive areas.

-Mineral resources – types, quantity, and quality of non metallic and metallic resources.

-Forest resources – types, quantity, and quality of private and public forest resources.

-Recreational/tourism – types, quantity, and quality of parks, recreational areas, and navigable waters.

3) Land use inventories

-Industrial land availability – size and quantity of available industrial zones and re-developable brown fields.

4) Other supporting infrastructure inventories

-Transportation corridors.

-Capacity and service of telecommunications facilities.

A region's economic base includes all the activity taking place in the unit of analysis (the region or community) and shows how the region derives its income within a bounded area, and how it can be expected to grow with time and system shocks. Economic base theory includes the concepts of the export base, basic and non-basic activities. The export base refers to the regional output that is sold outside the region; this is the basic activity or export of the region. The export base is vitally important in the economic base of any region and the smaller the region the more prominent the export base is likely to be. According to the export base theory, exports are the primary determinants of growth, decline or stagnation of the local community (North, 1956). While a nation may grow due to endogenous factors, a region will not thrive without exporting goods and, in exchange, receiving income from outside sources. An increase in export sales is the cause of income and employment growth in the region. Multiplier effects will stimulate linked activities as well as residentiary activity, thus supporting population growth. The local-serving activities are still an important part of an economic base. These are called non-basic activities as they serve people and businesses within the region of analysis and are indirectly dependent on the export base or basic activity. A change in the export base of a region is likely to have a significant impact on the regional economy, both basic and non basic components (Sirkin, 1959). This is because different export bases have different types and number of linkages, with different multipliers.

Export base theory has not been the only development model used for explaining growth in a region. Hoover (1937, 1948) and Hoover and Fisher (1949) proposed a competing explanation for regional development; the "stages" theory of growth. In this theory a region is hypothesized to develop by passing through a series of stages, listed below.

1) Largely self-sufficient, low investment and trade. The population locates according to the geographical distribution of resources.

2) The transportation sector improves, small scale local manufacturing emerges.

3) Inter-regional transportation improves; regions begin to have external trade or exports. Specialization begins; farming goes from grain and cattle to dairy and specialty crops.

4) Population growth and diminishing marginal returns cause region to begin industrialization. Activities in mining and manufacturing increase, manufacturing begin "value adding" to the regions resource.

5) Region specializes in service activities and greater proportion of labour force is employed in this. Region exports capital, skilled labour, finished products and specialized services to less-developed regions. Outflows of capital exceed inflows.

North (1955) and Stabler (1968) agreed that the stages theory may not be sufficient to explain regional development. It more adequately described pre-twentieth-century development in Europe, and specifically closed economies. Exports and interregional relationships were thus largely absent as a cause for regional growth (North, 1955, Stabler, 1968).

The export base theory is appropriate for the area of study in that it was developed for explaining economic growth in North America where development was initiated though natural resource extraction (Stabler, 1968). The region develops as a result of external demand. In this theory exportable commodities are extracted and exported to other regions, reflecting a comparative advantage in production costs. Growth of the region over time is then greatly influenced by growth in exports, both directly and indirectly. Direct effects are those consisting of change in export production and indirect effects are captured by industry and services linked to the export base that originally developed in support of the economic base. Certain export bases have the capacity to generate more of these linked activities, leading to larger multiplier effects meaning they stimulate the local economy to create more jobs and income than would another export base. An export base where the export is refined, value added, in the region or uses large amounts of local goods and services in production, will have more linked services and larger multipliers than an export requiring few inputs or one that is shipped elsewhere for value added production.   Linkages can be either “forward” or “backward” depending on the sequence of production of a final good. A “forward” linkage would be a flour mill for agricultural regions or, for forestry, a pulp and paper plant, in both cases the export undergoes further refining. A “backward” linkage would be an equipment manufacturer building implements to be used in the primary export activity. Coupled with these linked industries will be the service industries supporting the export base and resulting population. The size and type of population will depend upon both the labour intensity of the export production and the type of labour requirements. Similarly population size implications for the region also depend on the quantity and type of labour needed in the linked and service industries that develop around the export base (Hirschman, 1989).

The export base theory is then a means of understanding how a regional economy develops; historic growth can be used to infer future growth based on relationships within the region and projection of export demand. Exports are the prime cause of economic growth, or exports are key in the economic base of a region. In this paper the export bases will be agriculture, and forestry. Each type of region will have its own types of indirectly generated economic activity. Linked industries and tertiary or community serving activities will develop in each type of region depending on the exports from the region, and may be different for agriculture and forestry export bases of primary interest in this paper.

Export base theory provides a reasonable explanation of how North American regions have developed and growth was initiated. Some of the limitations of this model are that it does not encompass local growth, or non-basic growth as a stimulus for further regional growth. Perloff et al. (1960) point out that non basic industry and business does not grow and adapt passively or naturally to basic industry or export income entering a region, but can be an important autonomous factor in regional growth. Stabler (1968) stated that: “While interregional trade is not ruled out, it arises as a result of change generated within the region and is not the vehicle by which the impetus for development is provided…” (Stabler, 1968, 13). Tiebout (1956), who is commonly acknowledged to be one of the founders of regional export growth theory, pointed out that all growth must be considered including both the demand and supply side of a regional economy. On the supply side the initial resource endowment may change over time due to depletion of volume, reduction of quality and technological changes. On the demand side government expenditures, consumption and investment rates or shifts can all be factors of growth in addition to exports (Tiebout, 1956).

Export base theory is a way of highlighting the importance of exports in determining the equilibrium income as well as the effects of a change in exports from a region. Export base theory focuses on the exogenously determined demand for exports of a region that are a part of the larger income determination model. This model is shown below and explains how regional income determination can be represented in terms of all sectors and how exports are incorporated and multipliers can be derived.

3.2.1 Regional Income Determination Framework and Model

Export base theory focuses on the exogenously determined exports in a regional income determination model. The regional income determination framework with the importance of exports highlighted is shown as:

$$E = D + X + I \quad (1)$$

$$Y = C + S \quad (2)$$

$$C = D + M \quad (3)$$

where: E = total regional expenditures;
D = production for regional consumption;
X = exports;
I = investment;
M = imports;
Y = income;
C = consumption; and
S = savings.

Total expenditures in the region (E) are composed of domestic production (D), exports (X) and investment (I). Income (Y) is used for consumption (C) and savings (S) and consumption is composed of domestically produced and imported goods (M), as represented by equations 1, 2 and 3. This basic model focuses on the demand side of the regional economy and has not incorporated the government sector, which would mean adding government expenditures and taxation to the equations. It is a much simpler model without government influence but this omission does not hinder the goal of isolating the role of exports in regional growth.

The following equations are technical or behavioral assumptions of the income determination model. The consumption and import functions are represented by equations 4 and 5 and show consumption and imports as a function of income based on the marginal propensities to import (m) and consume (c). These first two specifications mean that for every dollar of income earned, a certain portion will be spent on consumption, and of this consumption some will be spend on imports. Exports and investment are determined exogenously as shown in 6 and 7, meaning that their value is determined outside the region.

$$C = cY \tag{4}$$

$$M = mY \tag{5}$$

$$X = X'' \tag{6}$$

$$I = I'' \tag{7}$$

where: c = marginal propensity to consume ;
m = marginal propensity to import;
X" = exports (determined exogenously); and
I" = investment (determined exogenously).

Equilibrium conditions are shown below by equations 8 and 9. In equilibrium the income has to be equal to the total expenditures and the leakages must equal injections to the regional economy. Or as equation 9 shows, the imports and savings which are leakages from an economy because the dollars leave the region, must equal the outside sources of expenditures, or injections. These outside sources of income are exports sold outside the region and investment in the region. The latter two are seen as injections to the regional economy as the income originates from outside the region and stimulates growth.

$$Y = E \tag{8}$$

$$M + S = X + I \tag{9}$$

In this equilibrium, income will equal total regional expenditures, or savings plus imports will equal planned investment plus exports. When these are not equal adjustment forces will take place to eventually restore equilibrium. If expenditures exceed income then inventories will drop and firms will increase production resulting in income rising. If income is larger than expenditures then inventories will build up causing firms to cut back production and incomes will fall. These adjustments represent times of economic expansions or recessions. In this simple framework the marginal propensity to consume/save and import play a key role in determining the effects of an external shock. In the larger picture, interest rates, inventories and labour market conditions will also influence the size and direction of adjustments en route to a new equilibrium.

3.2.2 Income and Export Base Multipliers

The export base and investment multipliers are shown by the solution equations 10 and 11, derived from manipulating equations 1 through 9. The rate of change in income with respect to either exports or investment yields the multipliers for the region. Multipliers are based on the amount of domestic expenditure induced once the marginal propensity to import is subtracted from the marginal propensity to consume. The remaining local expenditures will have a direct effect on the region's growth through spending and re-spending of income brought into the region from the exogenously determined export and investment dollars.

$$\frac{dy}{dx} = \frac{1}{1-(c-m)} \tag{10}$$

$$\frac{dy}{di} = \frac{1}{1-(c-m)} \tag{11}$$

where: dy/dx = the export base multiplier; and
dy/di = the income investment multiplier.

These multipliers show how regional income responds to changes in exogenous variables. Exogenous demand shocks will impact regional income according to the size of the multiplier (Schaffer 1999). Problems with calculating the multipliers are: tourist spending in the region is hard to distinguish from local spending, commuter spending outside the base is hard to measure and transfer payments or outside income is difficult to determine. Due to these difficulties this data is often neglected, as in this case. Furthermore it assumes that every region can be divided into basic and non basic sectors (Gibson and Worden 1981).

The export base multiplier is a very quick and easy tool to assess the impact of a change in exports. Depending upon how the model is set up, many types of multipliers can be obtained for analyzing changes in the region. An example will highlight the export base multipliers importance. If marginal propensity to consume is 0.8 and all of this consumption is spent on local or domestic goods and services, zero spent on imports, the multiplier value will be five. One extra dollar of export expenditure causes regional income to rise by five dollars. Initially this export dollar cause's income to increase by one dollar, eighty cents of this dollar is then spent locally, then this portion is re-spent once again but only sixty four cents is spent, etc. etc. until this dollar has circulated or until leakages (savings in this example) have exhausted it.

Leakages typically are in the form of savings or imports in this model; however they could also be in the form of taxes or goods and services purchased outside the region (Olfert, and Stabler, 1994). One of the main problems with income determination models is that structural parameters are held constant or static which is a limitation of the model purporting to represent growth and development. For example, with export dollars creating new growth and industries to develop in the region the previously imported goods may now be produced locally which would cause a decrease in the marginal propensity to import. A degree of caution must be used when applying these models to regions of various sizes. For example, the marginal propensity to consume and the export base multiplier become smaller as the region shrinks. As the region becomes smaller less consumption goes to local producers while consumption of imports becomes larger. This is a precaution that must be exercised when comparing regions of varying sizes. Further the import propensities will change over time in response to more or less import-replacing activity. The results of this study should be interpreted as applying to the average region as represented in the study period. .

3.2.3 Employment Multiplier

An adaptation of the income determination model can also be used to develop an employment multiplier, which can be used in conjunction with the export base multiplier shown above to highlight and analyze regional growth. The employment multiplier, by the definition outlined below, is a ratio and does not reflect the impact of marginal changes. Total employment is considered to consist of both basic and non-basic employment. An example of basic employment would be a car plant that produces cars for export; while non-basic would be a grocery store that sells its products to local residents. An employment multiplier can be used to suggest, assuming the structure of the economy remains unchanged, how new basic employment in a region can stimulate local or non-basic employment. Below is a model to show how the employment multiplier is calculated (Krumme 2002).

Total employment in a region is composed of basic (B) and non basic (N) employment. The multiplier becomes the ratio of the total employment (T) and the basic employment. The multiplier (M) shows how employment in a region will rise with a known rise in the basic employment.

$$T = B + N \quad (12)$$

$$T = \frac{B(B+N)}{B} \quad (13)$$

$$T = B * \frac{B}{N} \quad (14)$$

$$K * B = T \quad (15)$$

where: T = total employment in region;
B = basic employment in region;
N = non basic employment in region; and
K = employment multiplier.

The (K) value shown above is the multiplier. It shows, for the region, how many new (in total) jobs will be created as the result of a new basic job in the region. As equation 15 shows, when a new basic job is multiplied by K the multiplier effect the new total jobs (basic and non basic) are calculated. This total includes both the basic and non-basic employment. If the multiplier has a value of two, total employment would increase by two, as a result of an increase of one basic employee; the original employee and the second a new non-basic employee that serves that basic industry. This multiplier includes induced effects or ripple effects that occur over time. The induced increase in employment in non-basic employment captures non-basic sector growth as populations grows to fill these jobs and the economy expands.

To estimate an employment multiplier, determination must be made about whether each type of industry is basic (exporting) or non-basic (local serving) in nature. The sales pattern is the main determinant in choosing how to make these classifications. An industry such as agriculture, forestry or mining selling its output primarily outside the region is therefore basic while retail trade, construction and local government are non-basic as they serve the local residents in the region even though employment is in the region. The bottom line in the determination is where the majority of the dollars that support the industry come from (Isserman, 1980; Alexander, 1954; Kiel and Mack, 1986).

The location of the population is both a function of the costs associated with getting to the place of work, and personal preferences. Where commuting across regional boundaries exists it is complicated to count employment correctly as the primary residence lye outside the region. This can lead to incorrectly counting the employment in the region and as a result will lead to errors in the value of the multiplier ratio.

The model does not take into account technological progress or changes in production that can alter the relationship over time. Basic and non-basic activities may not be affected similarly as technology changes. For example the technology may affect the basic industry in the region which could result in a decrease in the demand for labour, while at the same time leaving labour requirements in the non-basic activities unchanged and therefore altering the multiplier value (Klosterman, 1990; Mulligan, 1987).

3.3 Location Quotient

The export base of a region may be determined by numerous methods, including the assignment and survey methods. Surveys are the most thorough and complete though they are time consuming, expensive and data can be difficult to obtain. The assignment method is a way to designate a basic or non-basic industry based on knowledge of the local economy. This may be adequate in some areas; however knowledge of the region is subjective. A quick and simple way to approximate the export base industries in a region is to use location quotients. This is a ratio that shows the amount of employment in a given industry in a region as a share of total employment in the region, divided by the same industry share employment in a reference region, usually the national economy. Location quotients show the relative concentration of industries in a region, and show the relative strength/weaknesses of the particular industry in the region of investigation. A location quotient greater than one shows a greater proportion of the labour force is employed in that industry regionally than at the national level. This is commonly inferred to indicate that it is an export producing industry. A residentiary industry will have low location quotients close to one, showing that the industry in the region has the same relative importance as at the national level. For example, the ratio of employment in grocery stores, retail services and local government is dependent on the population size everywhere, at the regional as well as at the national level. A location quotient of less than one is indicative of an industry that is under-represented in the region and thus an importing sector.

Location quotients are evaluated as:

$$L_{ir} = \frac{E_{ir} / T_r}{E_{in} / T_n} \qquad (16)$$

where: L_{ir} = location quotient for industry i in region r;
E_{ir} = share of industry i employment in region r;
T_r = total employment in region r;
E_{in} = share of industry i employment in nation n; and
T_n = total employment in nation n.

The value of the location quotient is an important tool for understanding the relative importance of industries in a region. Knowledge about the current and future growth in demand for the export sectors can then yield information on the potential future growth of the broader regional economy and its population.

Location quotients will change over time and by type of export base, both because of changing industry composition but also if labour-to-output ratios change differently in a region than at the national level. If, for example, agriculture is capital intensive in the nation and more labour intensive in a region, possibly through low labour wages then the location quotient will be larger in that labour intensive area. An example of this would be immigrant labour in the southern United States. Location quotients can also change over time due to changing industry structures, if the region discovers a new resource that creates new employment. An example of this would be the oil sands in Alberta and Saskatchewan. Oil and gas location quotients have risen over time as this industry has exploded in the region.

Location quotients are not multipliers and do not reflect marginal changes, limitations must be noted when using them for any analysis. One limitations of location quotient analysis are that it assumes consumption patterns in a region and at the national or benchmark level are the same. In reality consumption of a specific good or service may be much larger per capita nationally than regionally or visa versa. The assumption that labour productivity is constant across all regions is also made. If the region's productivity is higher than nationally the number of the region's export oriented jobs will be underestimated. Another assumption is that local demand will be met by local production whenever possible. This is not true in reality; local producers do not have a monopoly on that specific good. Location quotient analysis also assumes a nationally "closed" economy. Another problem with using location quotients is the aggregation of the data. Different studies will have different groupings of industry making comparisons difficult.

3.4 Community Population Change

A more comprehensive way of representing regional or community growth is to focus on population change, rather than income or employment directly. Regardless of the "chicken-and-egg" question of what comes first people or jobs, the resulting population change in a region/community will reflect the household and firm location decisions as they respond to economic and other variables. As the literature section showed, numerous studies have examined population growth and change.

The underlying reason for why people live where they live is to maximize utility. Utility maximization models are driven by people responding to economic effects, while obtaining the best amenity package. Population change is then driven by this utility ranking. If more utility can be obtained by moving to a different community then people will move, affecting population in the original and new community. A simple model highlighting this revealed preference approach to utility maximization and community preference is shown below (Goetz, 1999).

$$D = U_2(w_2, h_2, a_2, m) - U_1(w_1, h_1, a_1) \tag{17}$$

where: D = decision variable;
U = utility;
w = employment wages;
h = housing costs;
a = amenity package; and
m = cost of migration.

In the above equation (D) is the decision variable consisting of weighing variables, determining the location of residence. Utility is influenced by three variables; (w) denotes employment wages, (h) is the housing costs and (a) is the amenity "package" the region offers. If D>0 then a utility maximizing individual will move to the new location, labeled with the subscript 2. In this case the total package of employment wages, housing costs and amenities is better in region 2 than region 1 so the individual will move to region 2 even with the added costs of moving, it is still decided to be a better community than the original (Goetz, 1999).

The problem with this simple model is that it does not explain why everyone doesn't end up moving to that "special place" with the highest level of utility. This model does not take into account utility and economic changes as people migrate over time. This initial level of utility and economic conditions will change as increasingly more people move to that maximum utility center thus impacting the labour and land markets and creating an increasingly greater strain on the existing amenities as populations increase.

To account for these dynamics adaptations to this simple model have to be made. Residents access local amenities by renting land at a given rental rate. Residents then sell their labour to firms in their community at a given wage rate and then purchase this land and a numeraire consumptions good produced by firms in the region. In the short term the supply of land is assumed to be fixed. Every individual in the community is then assumed to achieve the same level of utility due to a homogeneity assumption.[6] This level of utility that individuals have living in a given community, n, is then defined by an indirect utility function shown below.

$$V_n = V_n(w_n, r_n : a_n) \tag{18}$$

where: V_n = indirect utility function;
w_n = wage rate;
r_n = rental rate of land; and
a_n = amenity vector.

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[6] Implies $\partial V_n/\partial w_n>0$, $\partial V_n/\partial a_n>0$, $\partial V_n/\partial r_n<0$. V is derived through maximizing utility subject to a budget constraint.

When expected utility varies across regions individuals increase utility by moving to communities with greater expected utility. In the long run, after land rental rates and wage rates have adjusted no resident will have an incentive to relocate and move to a different community. In the long run, shown in equation 19 below, no additional outsiders have incentives to locate to that community nor do current residents have any incentive to leave (Roback, 1988; Beeson and Eberts, 1989).

$$U_n(w_n, r_n, a_n) = U_o \qquad (19)$$

where: U_n = utility in region n; and
U_o = utility in current community.

The second part of this population change utility model incorporates the actions of firms that employ residents in the production of a numeraire consumption good X, numeraire meaning the price is equal to 1. In the short run costs are allowed to vary across locations but in the long run the costs of producing X are equal to its price of 1 making it a perfectly competitive good in all firms across the country. This behavior is represented in equations 20 and 21, the unit production function and the cost minimization function for firms.

$$X = f(L_n, P) \qquad (20)$$

$$C(r_n, w_n) = 1 \qquad (21)$$

where: X = numeraire consumption good;
Ln = available land in community n;
P = population of community; and
C = cost to firms of producing X.

In the short run firms will relocate to communities that will minimize the cost of production, left hand side of equation 21. In the long run wages offered to employees and rental rate of land will adjust to ensure equation 21 holds. This will ensure that in the long run firms have no incentive to relocate because the cost of production will be identical in every community (Bloomquist et al., 1988).

A population change model can now be developed that takes into effect the actions of firms and individuals in the adjustment process described above. The dependent variable in the model is population change.

$$POPCHNG = f\{ECON, AMENITIES\} \tag{22}$$

where: POPCHNG = population change in region;
ECON = economic conditions in region; and
AMENITIES = quality and quantity of amenities in region.

The population change in a region is then a function of two broad sets of variables or conditions. The first is economic conditions which relates to how the employment, incomes and property values affect people's decisions to stay in a region or re-locate. The more employment opportunities and higher the income available the more people will want to stay in that region, or conversely move to an area that has more economic opportunity. The second condition is amenities available in the region. This set of variables covers both the quality of amenities that are offered, as well as the amounts. Amenities can cover an almost endless number of variables; the ones chosen will normally relate to what will have the most effect on the dependent variable. Amenities can be composed of weather conditions, school and hospital availability, crime rates, recreation activities, transportation infrastructure etc. Some of these are "natural" amenities, others built amenities and still others are more general urban amenities.

In this study a number of economic conditions will be investigated to examine effects on community population change. The area of this study is fairly homogeneous with respect to amenities. Rural regions across the prairies have similar weather, crime, education and health care facilities. In many cases people will have to travel to larger centers to use these and many other "amenities" so distance to an urban center will be a proxy for access to urban amenities.

3.5 Summary

This chapter provides a theoretical framework of how agriculture to forestry land usage change can be studied. Export base theory provides a means to examine how regions have developed around the export or basic industry. This framework also represents how secondary and tertiary-linked businesses evolve in support of this export base. It articulates how the income of the region it determined, the amount and varying types of business that develop. These relationships are represented by an income determination model.

Export base theory can be seen as a special case of the more general income determination model, focusing on the role of the exogenously determined exports. A number of multipliers can then be formulated from this model and used to indicate how exogenous changes can alter incomes and employment. The export base and employment multipliers both highlight the influence that exports have on regional growth.

Location quotients show regional strengths in terms of specific industries, including exports. Location quotients can be used to indicate an export industry and will provide a means for classifying either a forestry or agriculture-dominated area in this study. Population change models are the most comprehensive way of examining the role of export employment, as well as other determinants, in community or regional growth and vitality.

CHAPTER 4: DATA SOURCES AND METHODOLOGY

4.1 Introduction

The methodology and data sources for this study are outlined in this chapter. The methodology was selected to identify the communities that are primarily dependent on agriculture/forestry, to measure the strength of that relationship, and to examine differences between them. Determinants of population change, including dependence on forestry and agriculture are econometrically estimated.

4.2 Data Sources

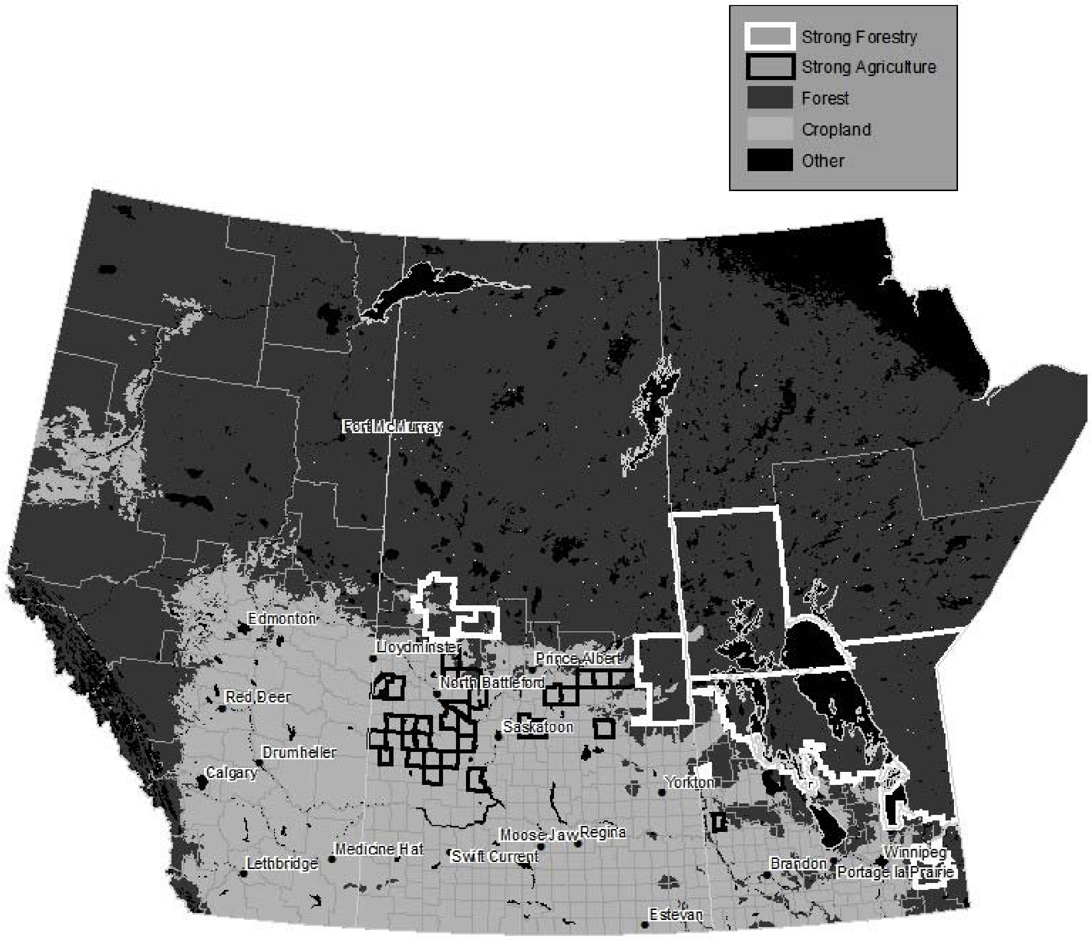
Employment by industry at the Census Consolidated Subdivision (CCS) level is obtained from the 1991 and 2001 Censuses of Population, Statistics Canada. The detailed disaggregation to the 3-digit level to discern agriculture and forestry specifically was obtained through a special tabulation by Statistics Canada (2005a). Population, income, and other socio-economic characteristics at the CCS level are also obtained from Statistics Canada (2005b). Since CCS boundaries change from census to census, 1996 constant boundaries were used for both 1991 and 2001 (C-RERL, 2006). The CCS is a grouping of adjacent CSDs that form the building blocks for census regions in Canada. CCSs are composed of town, villages and unorganized rural areas within a rural municipality (RM) or county. A CCS is considered a reasonable approximation to a "community" in that it includes both the centers and their immediate rural surroundings.

All demographic, employment and income data were obtained for these CCS regions using the census data. Distances from a CCS or "community" to another CCS of 10,000 or more people were obtained from Canada Rural Research Lab (C-RERL) configured using ArcGIS mapping software. Data for the detailed description of the business and public service composition of individual communities is available from an existing C-RERL database constructed using Dun and Bradstreet credit data. This database was used for describing existing businesses in forestry and agricultural communities and testing for differences in the composition or types of business.

The region under study in this paper is shown below in Figures 1 and 2; the area is the forest fringe or transition zone from agriculture or cropland in the south to forestry in the north throughout Manitoba, Saskatchewan and Alberta. This region was chosen because it is most likely the region in which afforestation would take place in Canada's Prairies. Some areas in this region were once under forest cover but were cleared for agricultural purposes. The climate and soil conditions support tree growth and the region is closer to existing forestry infrastructure, processing and refining, than that of the southern prairies grasslands where tree cover is sparse at best and no secondary processing is available. North of this transition zone between agriculture and forestry the land is already covered mainly by trees so this is not an area where afforestation would occur. Figure 1 shows the existing land cover designated by cropland in agriculture regions and forest in forestry areas (C-RERL, 2006). Strong forestry and strong agriculture regions are outlined in bold and all CCSs are outlined with a thin line.

Figure 2 on page 56 shows the CCSs that form the communities investigated in the study. Of the 201 CCSs in the geographic study area, 45 were lost leaving a total of 156 CCSs which were used in all calculations throughout the study. A total of 27 CCSs were excluded from the study because of their urban status, since this thesis is focusing

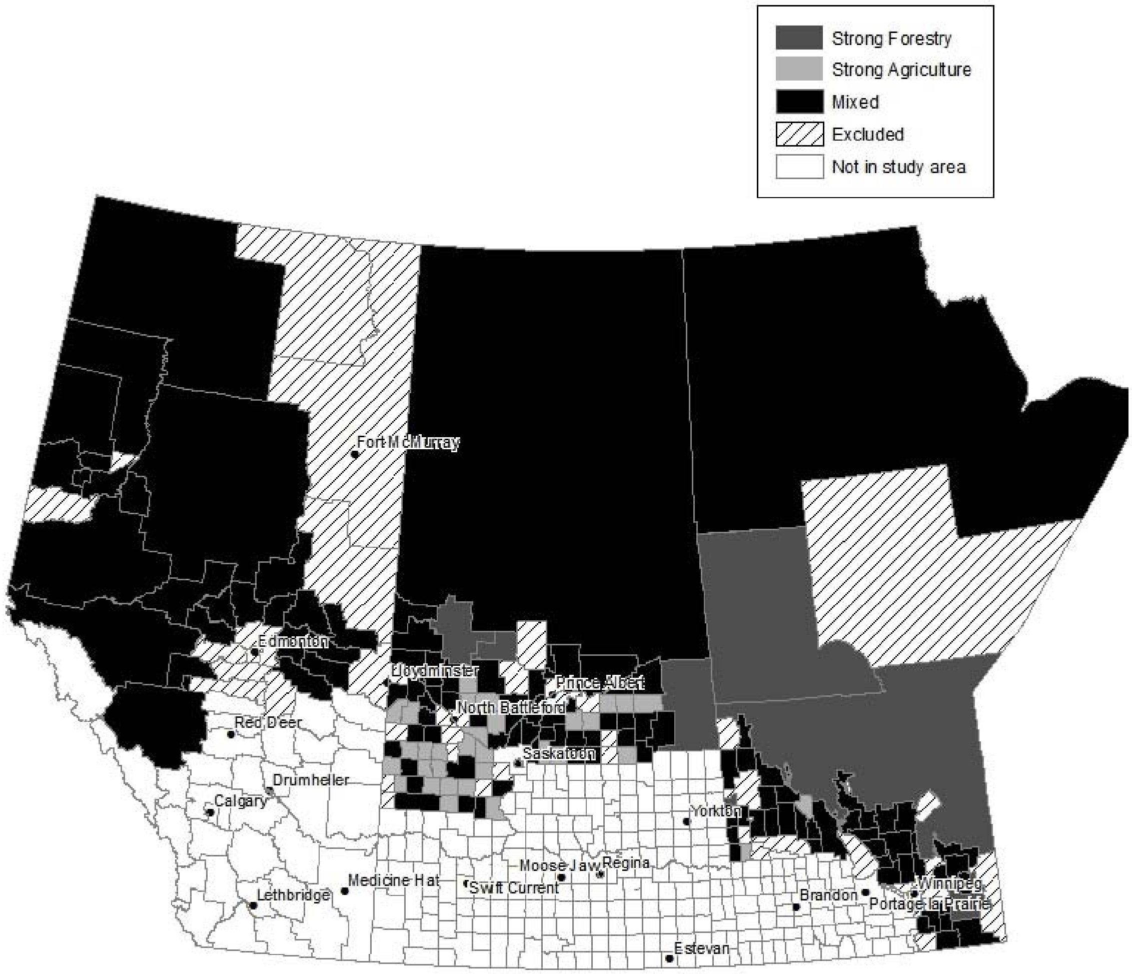
Figure 1. Existing Land Cover and Strong Forestry and Strong Agriculture CCSs, 2001.



Source: C-RERL Lab, 2006.

on rural regions and these 27 CCSs are centered on larger centers (Edmonton, Prince Albert). The reason some CCSs were omitted is because some of the calculations and models use total population throughout the entire study zone as the base line and a large population such as Edmonton and its surrounding area would overwhelm smaller rural regions with small populations. In other words, the relationships characterizing smaller population CCSs which the paper attempts to model would be dwarfed by those in the large urban communities. A further 18 CCSs were omitted because statistics Canada excludes CCSs with populations less than 250 people due to accuracy issues and privacy concerns.

Figure 2. Location and Type of CCS, 2001.



Source: C-RERL Lab, 2006.

Figure 2 shows all CCSs in the three provinces. They are broken down into regions classified as mixed, strong agriculture and strong forestry. It also includes CCSs excluded from the study and then CCSs that were not part of the study or not in the study area.

4.3 Methodology

The methodology section shows how the analysis of the forestry and agriculture communities will be done along with the comparisons that will be made between these respective regions. The different methods used in this thesis are explained in detail in the following sections.

4.3.1 Location Quotients

Location quotients were calculated for each of the CCSs being used in the study for both 1991 and 2001 for agriculture, forestry, oil and gas and mining. The latter groups are included because in some CCSs the oil and gas and mining industries employ a significant portion of the labour force and are a major exporter from the region. The numerator of the location quotients formula, $L_{ir} = \frac{E_{ir} / T_r}{E_{in} / T_n}$, shows the share of employment in an industry at the regional level. This is divided by this same industry share at the national or standardized level which is the denominator.[7]

A ranking system was developed to facilitate the identification of the two types of regions, strong agriculture or strong forestry. Having a location quotient greater than one does mean that the region is stronger in that industry than at the national level. However, the study area is predominantly an agriculture area and most CCSs have agriculture location quotients greater than one. For this reason a quartile ranking system was used that ranks each region from high to low for both forestry and agriculture. CCSs with the highest quarter of location quotients, for each of forestry and agriculture, were given a

[7] For the calculation of location quotients, total of all industries was based on 1980 Standard Industries Classification. Total all forestry workers is sum of logging industry, forestry services industry and wood industry. Total all agriculture workers is sum of agriculture industries and service industries incidental to agriculture.

ranking of one and the bottom or lowest quarter of location quotients for each industry were given a value of four with the middle being ranked two and three sequentially. Each CCS thus has a ranking for both forestry and agriculture. Communities with a forestry ranking of one (top quartile of forestry location quotients) and an agriculture region with a ranking of four (lowest quartile of agriculture location quotients) was then classified as “strong forestry”, or vice versa for “strong agriculture” communities. All other communities were then designated regions of mixed forestry and agriculture. This process produced categories of “strong forestry” and “strong agriculture” that each had location quotients in their designation greater than in the other specialization, in absolute terms. For example, “strong forestry” regions have forestry location quotients that are larger than their agriculture locations. This ranking then gave regions that were relatively specialized in agriculture and relatively specialized in forestry, leaving a mixture of both. A complication was introduced by the fact that there are CCSs in the study area that are specialized not only in agriculture and forestry but also in oil and gas and mining.

Oil and gas and mining location quotients were thus also calculated to see which CCSs are strong in these industries. These are the other two major economic base exports in the study area. If the mining location quotient or oil and gas location quotient is larger than, or equal to, that of agriculture or forestry in the respective “strong” regions then these regions would be influenced more by the mining/oil and gas industry and should not be classified as either forestry or agriculture dependent. Subsequent business structure and multiplier analysis rely on the classification of a CCS as either forestry or agriculture to compare the consequences of the different economic bases. In many specific regions oil and gas or mining could play a major part in regional employment and overall development so it is important to determine whether their oil/gas/mining specialization disqualifies them for classification as either a forestry or agriculture region.[8] If a CCS has an oil and gas or a mining location quotient larger than the forestry location quotient in a "strong forestry" zone or larger than the agriculture location quotient in a "strong agriculture" zone then these CCSs lose their classifications as either strong forestry or agriculture.

Knowing, through the location quotient analysis, if a region is specialized in either forestry or agriculture or a mixture of both is the basis for a number of comparisons. The community-level employment multipliers and the business structure are compared for those communities that are specialized to varying degrees in forestry and agriculture. This will show the extent to which communities with different economic bases have developed a different quantity and type of linked industry and supportive services.

4.3.2 Basic and Non-Basic Employment

In the context of the export base model, it is important to separate the basic and non-basic components of the economic base of a region in assessing the role of the export base, and from this make inference about the impact of external demand shocks. Basic industries consist of businesses that primarily export goods from the region, non-basic industries serve the local community. Industry is defined here to be the grouping at the three digit SIC code. Employment in each community is available by industry group. A

[8] Oil and gas and mining location quotients were calculated using 1980 Standard Industrial Classification. Oil and gas is composed of crude petroleum and natural gas, refined petroleum and coal products industries and pipeline transport industries. Mining location quotients are composed of mining industries, service industries incidental to mineral extraction, primary metal industries and non-metallic mineral products industries.

detailed description in Appendix A shows how each Statistics Canada classification was allocated to either basic or non-basic employment. The assignment of an industry as basic or non-basic was based on considerations of the nature of both the region and the industry. The area of study is composed of rural areas with relatively small populations. The assumption was made that the agriculture, forestry, oil and gas, and mining produce, for example, was primarily not consumed by the small local population making them basic or exporting industry. Similarly, the products of fishing and trapping or other exporting industries like the beverage industry were also classified as basic. It is the case that some of the output of these export industries is consumed locally, either as final demand or by processors. However, given the nature of the output and the size of the communities this is assumed to be a minor portion. Further, the presence of these industries is undoubtedly due to external, rather than local, demand.

This ratio of total to basic employment is used to indicate whether agricultural or forestry regions have a larger multiplier, or stimulate more non-basic employment in their respective communities. The basic employment is composed of all exporting industries in the region, not just forestry and agriculture. The observed multipliers will also be due, in part, to all exporting industries in the community.

The comparison between the multipliers associated with agriculture versus forestry communities is complicated by the fact that most communities have both forestry and agriculture employment. Therefore the non-basic employment will be generated in part, by both agriculture and forestry. The classification into “strong” agriculture and “strong” forestry will allow a comparison of those communities that are *relatively* more specialized. The definition of what constitutes an agriculture community or a forestry community was described above in section 4.3.1.

In addition it is necessary to recognize that some communities have basic activity that is composed of other industry not just forestry and agriculture. The largest of this other basic industry is oil and gas and mining. Section 4.3.1 describes the decision rule that deals with CCSs having a strong influence in these other industries.

The ratio of total employment in all industries to the basic industries: $\frac{T}{B}$ is indicative of the employment multiplier in the region. This ratio was calculated for each community in the study area. A complete list of CCSs is shown in Appendix B. The numerator of the ratio is composed of all employment while the denominator is composed of only basic employment as defined above. This ratio was calculated for strong forestry regions, strong agriculture and a mixture of both. CCSs having location quotients in oil and gas or mining larger than forestry location quotients in the strong forestry zone, and larger than agriculture location quotients in strong agriculture zones, being relegated to the mixed classification zone. These three groupings were formed from the location quotient analysis and a ranking of those quotients as discussed in section 4.3.1 above.

4.3.3 Agriculture and Forestry Communities Business Structure

For a subset of the regions/communities a detailed investigation of the composition of businesses is examined. Communities classified as strong forestry and strong agriculture are selected to investigate differences in business structure. Based on χ^2 tests statistically significant differences will be used to infer whether the linkages and residentiary (tertiary) activities generated in a community with an agriculture base are different from those generated in a community with a forestry base.

Dun & Bradstreet (Dun & Bradstreet, 2001) data were used to examine the business structure in forestry and agriculture regions for 2001. These data show the types of business by Standard Industrial Classification (SIC) code and the quantity in each community. Unfortunately due to data restrictions this could only be done for Saskatchewan CCSs that are within the study zone. The location quotients have been used to identify communities that are "strong forestry" or "strong agriculture". Export base theory tells us that the business structures of these regions have developed over time around the export, agriculture or forestry, and the type of linked business will develop due to the type of export. This theory suggests that an agriculture community may have a different set of businesses from a forestry community.

A total of 59 business groups are used ranging from service to recreation and manufacturing. The distribution of individual businesses (firms) over types of businesses (classification) is then compared for agriculture and forestry communities to determine whether there are differences. The 59 businesses are aggregated into a smaller subset of 8 groupings which are shown in Appendix C. A chi squared (χ^2) statistical test was used to determine whether the industrial distributions are statistically significantly different in agriculture and forestry dependent communities. The null hypothesis is that business structures in agriculture and forestry communities are not significantly different. Forestry and agriculture communities are first compared to all communities in the study area in Saskatchewan (forestry, agriculture and mixed) to see if they have a significantly different business structure from the "average" study area community in Saskatchewan.

For these tests the Saskatchewan business distribution is the expected distribution and forestry or agriculture regions are the observed. The industrial structure of forestry and agriculture communities are then compared to each other with forestry being the expected distribution and agriculture the observed.

4.3.4 Econometric Model of Population Change

An econometric estimation of the determinants of population growth in the study area communities, including the forestry and agriculture employment shares is shown below. The variables chosen for the model were assumed to have an influence on population change and are discussed in the following paragraphs.

$$Pop\,\Delta_{91-01} = \beta_1 + \beta_2 Ag_{91} + \beta_3 For_{91} + \beta_4 Pop_{91} + \beta_5 D_c + \beta_6 Edu_{91} + \beta_7 Abpop_{91} + \beta_8 \Delta emp_{86-91} + \beta_9 Inc_{91} + \beta_{10} D_{Mb} + \beta_{11} D_{Ab} + e \tag{20}$$

The econometric model employed is a cross sectional analysis of individual communities and does not recognize the potential spillover effects from neighbouring communities. A given CCS may benefit from positive spillovers from conditions in neighboring communities, or be negatively affected by negative spillovers. Spillover effects could include entrepreneurship or regional history for example. These omitted fixed effects between CCSs could cause a correlation of the error term with the explanatory variables and may cause biased results; this is one of the standard weaknesses of cross sectional analysis.

$Pop\Delta_{91-01}$ is the percentage change in population from 1991-2001 and includes natural and migratory changes. Community population change reflects the health and vitality of the community through its ability to retain/attract population. The 1991-2001 interval is considered long enough to accommodate migration decisions in response to inter-community variations in migration determinants.

The selection of the explanatory variables is based on initial conditions as represented (mostly) by 1991 data. This was chosen because they are data at the beginning of the analysis period and are thus the initial or starting point for each of the communities and using it will avoid endogeneity problems.

Ag_{91} is the percentage of workers in a community that is employed in agriculture in 1991, showing the relative strength of agriculture in that region. Represented by coefficient $\beta_{2,}$ agriculture employment share is expected to have a negative influence on population growth. Agriculture has become progressively labour saving over time due to labour saving technological change. The arable land acres have not changed significantly and it now requires fewer hours to farm the same land area as machinery has become larger, quicker and more efficient. Farms have also found it harder to make a viable income as commodity prices stay low and costs rise. This may lead to strong agricultural areas seeing a fall in population and employment over time.

For_{91} is the 1991 percentage of total community employment in forestry in the community. As this is also a primary sector experiencing labour-saving technological change, its influence on population as shown by β_3 is also expected to be negative. Most rural regions with large forestry employment shares are remote with relatively low populations and limited capacity for major increases. In the absence of a rapid increase in the external demand for forestry products these communities may not have enough opportunity for young people to find adequate employment which may result in migrating to find employment elsewhere. The pulp and paper industry has been consolidating and down sizing worldwide.

Pop_{91} is the initial level of population and β_4 is expected to exhibit a positive influence because of threshold requirements relating to the sustainability of local businesses and public services. Also the presence of agglomeration economies would lead to a positive influence of initial period population size.

D_c is the distance of the CCS centroid to the closest CCS centroid with a population size above 10,000. β_5 captures the influence of proximity to regions with a relatively large population. Its sign will indicate the dominance of spillover effects versus the effect of protection from competitors. CCSs with population of 3,000 and 5,000 were also tested to see which population size exerted the most influence on neighboring CCSs. Positive influence is expected through access to jobs through commuting as well as markets for local production. People can live in the “rural” CCS and achieve a “rural” lifestyle and commute to the CCS with population over 10,000 for the greater number of employment opportunities. At the same time this rural CCS can sell local production to the larger markets in the 10,000 population CCS. In some instances business may choose to locate in the rural CCS to capitalize on lower land prices and still capture business opportunities from the neighboring CCS with this larger population. On the other hand, closer proximity to an urban centre will expose the CCS to more competition from the urban centre. Which of these two effects is stronger will determine the sign of the coefficient.

EDU_{91} is the percentage of the population in the 25-54 age group that have some post secondary education in 1991. β_6 could have a positive effect on population change reflecting the importance of human capital in supporting economic activity and population. On the other hand, higher education levels without local opportunities may lead to out-migration, and a negative β_6 value, as education will increase the mobility and opportunity cost of the local labour force. Out-migration may happen if there are no local jobs for educated young people. Factors influencing the role of this variable will be the ability to work from home and the proximity to larger populous centers where commuting may be a possibility and they could stay in the CCS of their choosing. Due to these offsetting influences of this variable, there are no *a priori* expectations as to the sign of the coefficient.

$Abpop_{91}$ is the percentage of the population that is of aboriginal origin residing in the community. The coefficient of this variable, $\beta_{7,}$ is expected to have a positive influence on population growth in that region. The aboriginal population has high birth rates and a large proportion of its population in the younger age cohorts (Government of Saskatchewan 2003). Very little out migration for employment is also shown in this demographic further influencing the positive influence on population change.

$Emp\Delta_{86\text{-}91}$ is the lagged percentage change in employment from 1986-1991. This is a measure of the recent strength of the local economy in terms of employment growth. This variable is expected to have a positive influence on population growth represented by the sign of β_8. If a region has experienced strong employment growth this trend may continue and the community would be better able to attract new people to find work and retain youth looking for work as people are attracted to areas with employment growth.

$Income_{91}$ is all sources per capita income in the region in 1991. Higher incomes are expected to lead to positive population growth as this would represent greater local purchasing power and effective demand. Increased regional incomes help to lower the demand threshold of firms or markets as more income is available per capita to spend on goods and services.

Two dummy variables were also added for the provinces of Alberta and Manitoba, D_{MB} and $D_{Ab,}$ with Saskatchewan being the omitted province. They take the value of one if the CCS is in that province and zero otherwise. These dummy variables account for any fundamental differences between the three provinces in the study. They take into account differing determinants of population change that cannot be explained by the other variables in the model, such as crime rates, weather patterns, entertainment amenities, public policies etc.

4.4 Summary

This chapter specified the data sources used throughout the thesis. The methodology was then discussed outlining the various techniques and application of these techniques in analyzing the impacts to communities of a switch from agriculture to forestry. Communities are classified into strong forestry, strong agriculture or mixed zones through location quotient analysis, based on decision rules discussed above. The methods used to describe industry as basic or non-basic were discussed, along with their use in multiplier analysis. The method used to compare the business structures in forestry and agriculture communities is the χ^2 test. An econometric model of population change to be estimated is described. The following chapter will present the results of the analysis.

CHAPTER 5: RESULTS

5.1 Introduction

This chapter presents the results of the analysis of potential community-level impacts of a change in the economic base from agriculture to forestry in the study area. The location quotient analysis is used to classify communities by their type of economic base (strong forestry, strong agriculture, mixed). Some descriptive statistics highlight current economic and demographic conditions in these areas. The employment multiplier results are then discussed showing how an increase in the region's basic employment could stimulate the local economy. Results for the chi square testing of whether the business structure is different in forestry or agriculture communities is then presented. Finally the results of the econometric estimation of the population change model are discussed, followed by a brief chapter summary.

5.2 Location Quotients

Location quotients show the relative concentration of industries in a region, and the relative strength/weaknesses of particular industries in a community. A summary of location quotients for the three provinces is shown below in tables 5.1 and 5.2. Table 5.1 presents a summary of the forestry location quotients for Manitoba, Saskatchewan and Alberta and table 5.2 shows agriculture location quotients. The tables show location quotients by province and for each of the two analysis periods of 1991 and 2001. The total number of CCSs being used in this study is 156; the tables show the number of CCSs in each of the provinces under investigation.

Minimum and maximum location quotients are shown along with the mean for all the CCSs in each province. In the interpretation of location quotients, a value of one is a critical value. Location quotients less than one and greater than one show the breaking point between "importers" and "exporters". A location quotient greater than one is usually taken to mean that this is an exporting region of the output of the industry, based on the assumption of a closed national economy. Location quotients less than one show an industry under-represented in the region relative to the national economy and this implies that the region is importing these goods and services from the rest of the country. A location quotient equal to one indicates relative self sufficiency, again relative to the national level, with the region not being an importer nor exporter. Thus the location quotients show the degree to which a region is specialized in a particular industry, relative to the nation.

Table 5.1. Summary of Forestry Location Quotients, by Province, 1991 and 2001.

	Manitoba		Saskatchewan		Alberta	
Year	1991	2001	1991	2001	1991	2001
Number of CCSs	46	46	85	85	25	25
Minimum LQ value	0.0	0.0	0.0	0.0	0.0	0.0
Maximum LQ value	16.5	11.8	14.1	17.7	8.9	7.2
Mean LQ value	1.8	1.9	1.0	1.0	2.6	2.4
Number of CCSs > 1	17	23	18	23	17	16
Number of CCSs < 1	29	23	67	62	8	9

Source: Calculations by Author.

The location quotients for the forestry industry have a minimum of zero for each of the provinces. This is not surprising because the region of analysis is the forest fringe and along this fringe there are communities composed solely of agriculture, typically in the southern part of this fringe where all timber has been previously cleared for agriculture or areas where timber was never dominant. Moving north, a region of mixed agriculture and forestry will be seen, and farther north primarily forestry as the maximum location quotient values demonstrate areas of significant forestry concentrations. The maximum location quotient of 17.7 in Saskatchewan shows that there is a CCS with almost eighteen times more forestry employment share compared to the national level.

The average forestry location quotients are largest in Alberta for 1991 and 2001 yet the maximum is the lowest in this province for both years. Saskatchewan has an average of one in both years and the majority of CCSs have location quotients less than one. Manitoba has roughly half of its CCSs being forestry exporters (location quotient greater than one) and some regions with a dominant forestry industry as the maximum location quotients show in this province. Thus Saskatchewan appears to have a wider distribution among its CCSs in terms of their specialization in forestry. Even though Alberta has a narrower distribution, less variation between the maximum and minimum, it has an overall degree of specialization in forestry greater than the other two provinces, as shown by the average over all CCSs in that province. It should be noted, however, that Alberta also has the smallest number of CCSs in the study, only 25 out of 156.

The number of CCSs with forestry location quotients greater or less than one show how specialized the CCS is relative to that of the nation. Saskatchewan has about one third of its CCSs specialized in forestry and again some regions with a dominant forestry industry. Alberta has about two thirds of its CCSs specialized in forestry, this is reflected in the large average. Manitoba has over half of its CCSs with forestry location quotients less than one in 1991 but in 2001 the CCSs are split between those with forestry location quotients greater and less than one. Alberta does not show any major differences between 1991 and 2001. Saskatchewan has slightly more CCSs specialized in forestry in 2001 yet the average value for the location quotient in that province did not change. Manitoba also showed an increase in the number of CCSs with location quotients greater than one from 1991 to 2001. This means that, relative to the nation, a significant number of CCSs in Manitoba increased their specialization in forestry over the ten year period yet the average degree of specialization for the entire province did not change significantly, this result was also seen in Saskatchewan.

Table 5.2 below shows the location quotients for agriculture in 1991 and 2001. The mean is much larger than for forestry and the number of CCSs with location quotients greater than one is higher in agriculture for all provinces in both years. This shows that the area of study is overall more specialized in agriculture. That is, there is more agriculture specialization on average and the degree of specialization is greater. Within the forest fringe in the study area virtually all communities have some agriculture employment relative to the national economy. Agriculture is typically present even in those communities that also have a forestry base. In the northern part of the forest fringe, where agriculture is largely absent, are isolated communities with low populations. Statistics Canada has designated very few CCSs in this area. For Saskatchewan only one CCSs composes the entire northern half of the province. This is also reflected by the number of CCSs with location quotients less than one, almost every CCS in each province has more specialization in agriculture than the nation. The only noticeable difference in any province from 1991 to 2001 is the small decrease with CCSs in Manitoba that have CCSs with values greater than one, falling from 44 to 41. This

Table 5.2. Summary of Agriculture Location Quotients by Province, 1991 and 2001.

	Manitoba		Saskatchewan		Alberta	
Year	1991	2001	1991	2001	1991	2001
Number of CCSs	46	46	85	85	25	25
Minimum LQ value	0.0	0.0	0.2	0.1	0.4	0.1
Maximum LQ value	19.5	17.9	24.4	26.5	15.1	19.0
Mean LQ value	7.6	7.4	12.5	12.6	6.1	7.1
Number of CCSs > 1	44	41	84	83	24	24
Number of CCSs < 1	2	5	1	2	1	1

Source: Calculations by Author.

means that 3 communities in Manitoba went from being on exporter in agriculture to an importer, relative to the nation.

The above tables show descriptive information on the CCSs' location quotients and highlight some of the existing conditions by province. The information is further broken into quartiles in the following section to gain a more precise view of the extent to which forestry and agriculture form the economic base of the study area. The comparison of the business structure in agriculture and forestry communities relies on the location quotient groups described below. Similarly employment multipliers are also calculated for groups of CCSs, classified as forestry or agriculture based on location quotients.

5.2.1 Location Quotients by Quartile

To facilitate the classification of CCSs into "forestry" and "agriculture" communities the CCSs are ranked by their location quotients and then divided into quartiles. This is necessary because there are not enough observations that are either only forestry (with no agriculture) or only agriculture (with no forestry). A detailed description of the quartile ranking process is discussed in section 4.3.1. Table 5.3 below shows the quartile ranking breakdown by province and by the total data set, the latter containing all 156 CCSs. A ranking of one for forestry means that the CCS falls into the top quartile of location quotient region's economic base is heavily reliant on forestry compared to the nation. This means that a larger percentage of people work in forestry and that the local economy and the infrastructure will have developed to support that. A low ranking, four, means that the region is in the bottom quartile. The same ranking system was used for agriculture.

Summary of the rankings and the resulting groups is shown below in table 5.3 for both forestry and agriculture location quotients. Forestry regions are shown as (For) and agriculture regions are shown as (Ag). In Saskatchewan, for example, of the 52 CCSs that were in the lowest quartile of forestry location quotients, 33 were in the top quartile of agriculture location quotients in 1991. Alberta only has 3 CCSs with the lowest quartile ranking in forestry for either year and of these three none were a high agriculture location quotient CCS. In 1991 Manitoba had 16 CCSs ranked as low forestry with 5 being a high agriculture CCSs and 2 as a low agriculture CCS.

From this ranking system, CCSs can be grouped into those that have high forestry and low agriculture (For 1 and Ag 4) at one extreme, and low forestry and high agriculture (For 4 and Ag 1) at the other. This ranking system is used to identify CCSs that are primarily forestry and those that are primarily agriculture communities. That is, CCSs in the top quartile in forestry and in the lowest quartile in agriculture are classified as "strong forestry" communities. Similarly CCSs in the top quartile for agriculture and

Table 5.3. CCS Rankings According to Location Quotient Quartiles.

Quartile		Manitoba		Saskatchewan		Alberta		Total	
Year		1991	2001	1991	2001	1991	2001	1991	2001
For 1	Ag 4	3	4	3	4	6	5	12	13
For 1	Ag 3	5	6	3	1	2	4	10	11
For 1	Ag 2	3	3	6	4	1	0	10	7
For 1	Ag 1	1	2	3	2	0	1	4	5
For 2	Ag 4	2	2	1	1	2	1	5	4
For 2	Ag 3	4	3	1	3	6	2	11	8
For 2	Ag 2	3	3	6	5	0	3	9	11
For 2	Ag 1	1	3	1	3	2	2	4	8
For 3	Ag 4	5	5	0	0	0	0	5	5
For 3	Ag 3	3	0	6	6	3	3	12	9
For 3	Ag 2	0	1	3	6	0	1	3	8
For 3	Ag 1	0	1	0	0	0	0	0	1
For 4	Ag 4	2	3	0	0	0	0	2	3
For 4	Ag 3	4	3	4	9	1	1	9	13
For 4	Ag 2	5	5	15	11	2	2	22	18
For 4	Ag 1	5	2	33	30	0	0	38	32
Sum		46	46	85	85	25	25	156	156

Source: Calculations by Author.

the lowest quartile for forestry is classified as “strong agriculture” communities. In between, or all other combination of rankings, it is harder to assign CCSs unambiguously to either forestry or agriculture. The rest of these CCSs are a mixture of forestry and agriculture but not at the extremes which were classified as strong forestry and strong agriculture. These CCSs will be called “mixed” communities.

Although the ranking was done to discern “strong forestry” and “strong agriculture” communities, the absolute value of the location quotients for both forestry and agriculture show the degree of specialization compared to the nation.

As shown in table 5.3 above there were 13 CCSs that were classified as strong forestry (and minimal agriculture) in 2001 and 12 CCSs in 1991. Alberta has the most strong forestry communities and the fewest number of CCSs. For all three provinces combined, there were 38 CCSs in 1991 that were strong agriculture (and minimal forestry) and 32 CCSs in 2001. Saskatchewan has majority of strong agriculture regions while Alberta has no strong agriculture regions. The decrease in strong agriculture CCSs, going from 1991 to 2001, shows that the number of communities specializing in strong agriculture decreased over the ten year period. This is expected as agriculture had continuingly low commodity prices and increases in costs.

These communities (strong forestry and strong agriculture) form the basis for many of the comparisons throughout this thesis. The classification into strong agriculture and strong forestry communities can be used to address a number of questions. What are the population, incomes, employment and education levels in regions with developed agriculture and no forestry or vice versa? If Kyoto implementation results in policy changes or financial incentives that induce land owners to shift their land from agriculture to forestry what will be the impact on rural communities? What are the implications for population growth or incomes, for example?

5.2.2 Other Industry Influence

Making comparisons between agricultural and forestry regions is a vital part of forecasting how an agricultural region may transform to a forestry region. Defining the region on the basic of the agriculture and forestry location quotients assumes that the economic base is composed of one or both of these two sectors. A strong forestry region is assumed to have a business structure, infrastructure and demographic profile that have developed in support of forestry industry. However oil and gas and mining industries are two prevalent industries in the northern prairie regions that may have significantly influenced the development of regions over time. The Alberta and Saskatchewan oil sands are a large developing industry along with numerous mining operations in this resource rich region.

For strong agriculture regions the oil and gas or mining location quotient was never larger than the agriculture location quotient so the designation of these communities as strong agriculture is retained. In the strong forestry zone there were cases when oil/gas or mining had a larger location quotient than that of forestry's location quotient so these CCSs were deleted from the strong forestry category. The comparison of the location quotients of forestry, oil and gas and mining is shown in Appendix D. In 1991 there were 5 communities that had a larger location quotient in oil and gas or mining and 6 communities in 2001. These CCSs were deleted from the strong forestry category.

These CCSs originally classified as strong forestry regions but have location quotients in either oil/gas or mining larger than the forestry location quotient will now be labelled as forestry/oil and gas/mining. The communities could be added to the existing mixed economic base zone that is all communities that don't specialize in either forestry or agriculture. The reason these communities are not grouped into this mixed zone is that it is interesting to note the differences that forestry with oil/gas or mining influence have compared to just a strong forestry region. Tables 5.4 through 5.8 in the following sections will highlight some of these differences.

5.2.3 Descriptive Statistics of Agricultural and Forestry Regions

In tables 5.4 and 5.5 below some descriptive demographic characteristics are shown to compare types of communities. Location quotients, population, income, employment and education are shown for strong forestry regions (forestry quartile 1 and agriculture quartile 4), strong agriculture regions (forestry quartile 4 and agriculture quartile 1), forestry/oil and gas/mining regions (forestry quartile 1, agriculture quartile 4 and oil and gas or mining location quotient larger than forestry location quotient) and mixed which is composed of all other quartile combinations. Average income is income from all sources of people fifteen and older averaged over population in all CCSs, employment is percentage employed over fifteen, and education is the percentage of people fifteen years and older with a completed university degree.

In order to obtain a more accurate comparison of the data the information in table 5.4 and 5.5 is weighted by population within each economic base type. An example of income illustrates the weighting process. First assume that strong forestry has within it ten different CCSs or communities, each community has its own income that has already been averaged by Statistics Canada. Now from these ten communities in strong forestry, one may have a very large population and a very large income, while the other nine have very little population and small incomes. A simple average will just add the income of all ten communities, and divide by ten. The one community with the large population does not have an adequate representation here; it only has ten percent representation when in fact in might have half the population in strong forestry so its importance or representation should be half. To compensate for this, the income is multiplied by the population in each community. This is done for each of the ten communities and this number is then added up to form aggregate income and divided by the total population of all communities in strong forestry. This is then called the "weighted average income" of strong forestry. This is then done for each of the four representative zones and is also done for the location quotients, employment rate and university degrees in the following two tables. Percentage of sample income is the percent of the total income in each of the four zones; this was done as percentage of the weighted income and is shown in brackets under the average income values.

Table 5.4. Descriptive Characteristics by Region by Economic Base Type, 1991

Land Usage Type	Total Pop. (% of Total)	Pop. Weightd avg LQ Forestry	Pop. Weighted avg LQ Agric.	Avg Weighted Inc. 1990$ 15+ (% Tot)	Average Weighted Emp. Rate 15+(%)	Weighted University Degree 15 + (%)
Strong Forestry	46,595 (7.5)	4.7	2.7	15,125 (6.5)	55.7	3.1
Strong Agric.	30,160 (4.9)	0.0	17.0	15,371 (4.3)	73.2	3.2
Forestry (Oil/Gas/ Mining)	98,780 (15.9)	4.5	2.3	20,919 (19.1)	65.1	4.0
Mixed	444,585 (71.7)	1.4	6.2	17,031 (70.1)	61.0	3.9

Source: Calculations by Author.

Table 5.5. Descriptive Characteristics by Region by Economic Base Type, 2001

Land Usage Type	Total Pop. (% of Total)	Pop. Weightd avg LQ Forestry	Population Weighted avg LQ Agric.	Avg Weighted Inc. 1990$ 15+ (% Tot)	Average Weighted Emp. Rate 15+(%)	Weighted University Degree 15 + (%)
Strong Forestry	54,810 (8.3)	4.5	1.5	18,229 (7.7)	50.8	4.7
Strong Agric.	21,088 (3.2)	0.00	18.8	18,255 (3.0)	72.4	4.4
Forestry (Oil/Gas/ Mining)	134,381 (20.4)	5.3	1.7	20,657 (21.5)	59.7	4.1
Mixed	447,041 (68.0)	1.3	6.4	19,612 (67.8)	63.0	5.2

Source: Calculations by Author.

It is evident from tables 5.4 and 5.5 that the majority of the population resides in the mixed CCS zone which contains the majority of the CCSs. Strong agriculture accounts for a small population, even though it has more CCSs or communities than either strong forestry or forestry with oil and gas or mining. This is due to the location of these zones. Strong agriculture CCSs are primarily from Saskatchewan where population is composed of farm inhabitants and very small towns. Strong forestry has about eight percent of the population but forestry with oil and gas or mining has almost twenty two percent of the population. This is once again due to location, forestry with oil and gas and mining is virtually all in northern Alberta, areas around Edmonton and northeast into the oil sands. Strong forestry on the other hand is located almost solely in northern Saskatchewan and Manitoba.

The forestry location quotients are large in strong forestry, falling in the mixed zone and becoming zero in the agriculture region for both 1991 and 2001. The forestry zone with oil/gas and mining has a similar location quotient value to the strong forestry zone in 1991 but a larger value than strong forestry in 2001. Agriculture displays a similar pattern, though even the forestry regions still have a significant agriculture presence in both years. Some differences are that location quotient values for agriculture are larger in both forestry zones in 1991 than in 2001. Weighted average income is highest in the forestry zone with oil and gas or mining, followed by the mixed zone. Strong agriculture and strong forestry zones have the lowest income rates in both years, where they are almost identical. Strong agriculture regions have the highest employment rates while strong forestry has the lowest employment levels in both years. The percentage of people over fifteen with university degrees rose in all zones from 1991 to 2001. In 1991 forestry with oil and gas or mining has the largest percentage while in 2001 the mixed zone had the largest percentage of people with a university degree.

The population in each of the four classification zones show some interesting patterns. Comparing 1991 with 2001 strong agriculture communities account for a lower percentage of the total population (shown in parenthesis underneath the total population values). The mixed zone has also fallen in percentage terms while the forestry and forestry with oil/gas and mining zones have both risen. Forestry oil/gas and mining zone showed an increase of 4.5% between 1991 and 2001. Of note here is that the number of CCSs classified in each zone will affect the population changes. For example agriculture had 38 CCSs being classified as strong agriculture in 1991 and only 32 CCSs met this criteria in 2001. It is also important to remember that the 32 CCSs in 2001 are not necessarily the same 32 CCSs classified as strong forestry in 1991. The quartile rankings were done separately for both years. This means that CCSs can have a different quartile ranking if their location quotient values changed from 1991 to 2001 and the examination zone they fall into may change.

To account for the changing composition of the strong forestry and strong agriculture groups over time, another comparison was done explicitly between 1991 and 2001. The CCSs quartile rankings were held constant into 2001. This means that every CCSs in strong forestry (strong agriculture, mixed, forestry oil/gas and mining) is the same in 2001 as it was in 1991. The data for this comparison is shown below in table 5.6, 2001 data is shown in quotation marks below the 1991 data in each cell. Population and income are both percentage of total in the respective year. Average weighted employment is percent employed and weighted university is percent of people with a completed degree.

Table 5.6. Descriptive Characteristics by Economic Base Type, 2001, for 1991 Economic Base Type Design.

Land Usage Type	Pop. (%) of Total 1991 (2001)	Pop. Weighted avg LQ Forestry (2001)	Population Weighted avg LQ Agric. (2001)	Avg Weighted Income (% total) 1990$ 15+ (2001)	Average Weighted Emp. Rate 15+ (2001)	Weightd Univ. Degree 15+ (%) (2001)
Strong Forestry	7.5 (8.1)	7.5 (4.8)	2.7 (3.3)	6.5 (7.0)	55.7 (57.1)	3.1 (4.2)
Strong Agriculture	4.9 (4.1)	0.0 (0.45)	17.0 (16.8)	4.3 (3.6)	73.2 (70.2)	3.2 (4.4)
Forestry (Oil/Gas/ Mining)	15.9 (16.3)	4.5 (5.0)	2.3 (1.6)	19.1 (19.3)	65.1 (66.0)	4.0 (5.0)
Mixed	71.7 (71.5)	1.4 (1.6)	6.2 (5.7)	70.1 (70.1)	61.0 (60.6)	3.9 (5.0)

Table 5.6 tracks the differences in demographic characteristics from 1991 to 2001 using the same CCSs in each land usage type zone. The percentage of the population has risen for both types of forestry zones and has fallen for the strong agriculture zone. This further highlights the decline in rural agricultural regions populations. Forestry regions are showing growth, probably through aboriginal population increases and expansion in the oil and gas labour force. The forestry location quotient has fallen significantly in the strong forestry zone and climbed higher in the forestry oil/gas and mining zone. It is also interesting to note that the strong agriculture zone had zero forestry activity in 1991 but in 2001 some CCSs have developed a forestry presence. This might be due to some existing Government incentives to switch to forestry or a diversification in the attempt to exit the agriculture industry and its shrinking profit margins. The agriculture location quotient has climbed in the strong forestry zone and fallen in the oil/gas region. This could be due to closure of some key mills in the strong forestry areas and expansion in the forestry oil/gas areas at agricultures expense. The percentage of total incomes

accounted for by both forestry zones has increased while the strong agriculture zone income proportion has declined from 4.3 to 3.6 percent of the total income in all study area CCSs again highlighting the decline in agricultural incomes. Employment rates have climbed in the strong forestry zone and fallen in the strong agriculture zone narrowing the gap between the two. The mixed zone remains almost unchanged over the ten year period, except for percentage of people over fifteen years of age with a completed university degree. This is the same for each zone; more people are obtaining university degrees.

5.3 Basic and Non-Basic Employment

Employment multipliers show total jobs in a region relative to basic industry job. Employment multipliers are shown below in table 5.7 for 1991 and table 5.8 for 2001. These tables are once again broken down into a strong forestry region, a mixed agriculture and forestry region, a strong agriculture region and then a strong forestry region with oil and gas or mining influence. The employment multiplier shows the ratio between total employment and basic employment, an indication of the extent to which basic employment in these regions stimulates non-basic employment.[9]

In both 1991 and 2001 strong agriculture had the lowest multiplier value compared to the other three land usage types which were all nearly double that of strong agriculture. Strong forestry showed the smallest increase while strong forestry with oil and gas or mining showed the largest increase in the non-basic component of the workforce. The multiplier values over the ten year period reflect this change in employment structure. The multipliers have increased in all zones from 1991 to 2001

[9] Basic employment is defined by an industry that produces primarily exports. The major basic industries in this paper are agriculture, forestry, mining and oil/gas. A complete list of all basic industry is shown in Appendix B.

reflecting the change in industrial structure which has more and more employment concentrating in the service industries as opposed to goods providing industries. In this

Table 5.7. Employment Multipliers by Economic Base Type, 1991.

Land Usage Type	Total Emp.	Basic Emp. (%)	Non-Basic Emp. (%)	Avg Weighted Mult. Value (Std Dev)	Max. Multi-plier	Min. Multi-plier
Strong Forestry	18,735	4,860 (25.9)	13,905 (74.2)	3.9 (2.8)	10.7	2.6
Strong Agriculture	15,520	8,955 (57.7)	6,385 (41.1)	1.7 (0.3)	2.3	1.3
Forestry (Oil/Gas/Mining)	52,450	16,440 (31.3)	36,080 (68.8)	3.2 (0.4)	3.7	2.8
Mixed	202,245	60,400 (29.9)	142,225 (70.3)	3.4 (1.2)	6.9	1.6

Source: Calculations by Author.
*Note: Percentages may not add up to 100 due to Statistics Canada rounding of data. Basic employment is defined by an industry that produces primarily exports. The major basic industries in this paper are agriculture, forestry, mining and oil/gas. A complete list of all basic industry is shown in Appendix B.

Table 5.8. Employment Multipliers by Economic Base Type, 2001.

Land Usage Type	Total Emp.	Basic Emp. (%)	Non-Basic Emp. (%)	Avg Weighted Mult. Value (Std Dev)	Max. Multi-plier	Min. Multi-plier
Strong Forestry	22,210	5,530 (24.9)	16,770 (75.5)	4.0 (1.2)	6.2	2.4
Strong Agriculture	11,070	5,760 (52.0)	5,200 (47.0)	1.9 (0.4)	2.8	1.4
Forestry (Oil/Gas/Mining)	59,860	13,960 (23.3)	46,005 (76.9)	4.3 (0.8)	5.7	3.7
Mixed	213,790	54,845 (25.7)	158,805 (74.3)	3.9 (1.6)	13.8	1.7

Source: Calculations by Author.
*Note: Percentages may not add up to 100 due to Statistics Canada rounding of data. Basic employment is defined by an industry that produces primarily exports. The major basic industries in this paper are agriculture, forestry, mining and oil/gas. A complete list of all basic industry is shown in Appendix B.

study the basic industries are all “goods” producing. It is noteworthy that the increase in multiplier values was very small in agricultural regions, again showing this region is experiencing a population decline.

The forestry zones and mixed zone have very similar multiplier values, all hovering around 4 in 2001, and are more than double those of agriculture in each year. This suggests that both the forestry and mixed economic bases have a greater capacity to stimulate non-basic employment than does an agriculture base. Forestry with oil/gas/mining showed a large increase of 3.2 to 4.3 from 1991 to 2001, this is due to the large expansion of mining and oil/gas in the northern forest areas. On the flip side, agricultural zones do not do a great job in stimulating non-basic employment; the multiplier value is less than two in both 1991 and 2001. This suggests that agriculture regions to not stimulate a great deal of non-basic employment. This is highlighted by the decline in total businesses in many small towns. The agriculture areas no longer support a barber, bank or gas station in every small town; these businesses have become concentrated into a smaller number of service centres.

5.4 Forestry and Agriculture: Business Structure

This section looks at the business structure in forestry and agricultural zones for 2001 in Saskatchewan. Unfortunately data constraints precluded this analysis for Alberta and Manitoba. The strong forestry zone that has a strong oil and gas or mining influence does not exist in Saskatchewan, these communities are primarily in Alberta.[10]

In table 5.9 below the CCSs total is composed of all CCSs in Saskatchewan included in the study area, including the strong agriculture, strong forestry and the mixed

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[10] A chi squared analysis cannot be done with only one observation so this single forestry community in Saskatchewan with oil and gas or mining will be included as just a forestry community.

zones. The business types are based on SIC classification. The entire industry distribution is aggregated up to the 13 groups shown.

Some apparent major differences in the business structure between agriculture and forestry communities is the lack of personal services in the agricultural communities, the high manufacturing presence in forestry regions and the large number of real estate businesses seen in agriculture areas. Forestry regions have more transportation businesses which is probably reflective of the location of these CCSs, often remote northern regions where local air transportation services would be utilized more often. This would also be the case for the tourism industry and specifically "fly in" fishing camps. Another factor here could be the need to hire outside transport service to haul lumber while agriculture producers typically own their own transport equipment. The lack of personal services in agriculture communities is likely a reflection of the size of the communities. They are often very small communities offering the bare minimum services; these types of services would be located in larger centers offering a more diverse business structure. The high value for manufacturing in forestry communities would be due to the wood processing industries located in these regions, agriculture regions on the other hand have virtually no local processing. Real estate has a very large presence in agriculture communities, the reasons for which are unknown. One possibility could be a large amount of land being sold by older retiring farmers to younger start up farmers and real estate agents are needed to facilitate this transaction. Another major difference is the larger fuel sales in agricultural communities. This would be due to the large amount of farm equipment being used throughout the year.

Table 5.9. Strong Forestry and Strong Agriculture Community Business Structure, Saskatchewan, 2001.

Business Groupings	Forestry Total Business (%)	Agric. Total Business (%)	All CCSs Total Business (%)
Financial Business	13 (8.23)	20 (8.40)	455 (7.80)
Transportation	12 (7.59)	7 (2.94)	318 (5.45)
Automobiles Sales and Service	13 (8.23)	16 (6.72)	514 (8.81)
Miscellaneous Repair and Hardware Sales	7 (4.43)	14 (5.88)	331 (5.67)
Fuel Sales	4 (2.53)	14 (5.88)	237 (4.06)
Manufacturing	16 (10.13)	1 (0.42)	212 (3.63)
Business Services	7 (4.43)	18 (7.56)	483 (8.82)
Building Materials	30 (18.99)	46 (19.33)	1062 (18.20)
Food and Drug Stores	13 (8.23)	15 (6.30)	349 (5.98)
Miscellaneous Retail	14 (8.86)	14 (5.88)	508 (8.71)
Real Estate	5 (3.16)	50 (21.01)	576 (9.87)
Entertainment	15 (9.49)	23 (9.66)	560 (9.60)
Personal Services	9 (5.70)	0 (0.00)	230 (3.94)
Total	158 (100)	238 (100)	5835 (100)
Number of Communities	4	18	61

Note: The above sectors are composed of the following classification if not labelled in table: Financial business - banks/ATM's/credit agencies/security and commodity brokers/insurance. Transportation - machinery transportation/transportation/air transportation. Fuel sales – bulk fuel/service stations. Manufacturing – food/apparel/lumber and wood/printing/stone and concrete/primary metal and metal fabrication. Business services – professional business services/other business services/communication and utilities/ services to primary. Building materials – other wholesale/lumber and building materials/construction. Food and Drug Stores – grocery stores/other food stores/drug stores. Miscellaneous retail – general merchandise/furniture/computers and entertainment/miscellaneous retail. Entertainment – eating and drinking/recreation/hotels. Personal services – other personal services/beauty and barber shops/apparel.

The total businesses for all CCSs are the reference distribution against which the business distributions for sub-groups of communities are compared. A series of chi-squared tests were conducted to test for these statistically significant differences.

A series of three tests was conducted where the null hypothesis in each case is that the businesses are not significantly different. Using 12 degrees of freedom and 5 % significance gives a critical value of 19.68.

Test 1: Null - Forestry is not significantly different in business structure from all CCSs. In this test the distribution of business types in all CCSs is the expected value and the distribution of businesses in the forestry regions is the observed values, the chi squared statistics is then 21.4 with 12 degrees of freedom. For this test the observed χ^2 statistic (21.4) > χ_{cr} (19.68) so the null is rejected. Forestry business structure is significantly different than all CCSs at the 5 % level.

Test 2: Null – Agriculture is not significantly different in business structure from all CCSs. In this test all the distribution of business types in all CCSs is the expected values and the distribution of business in the agriculture regions is the observed values, the chi squared statistic is then 22.9 with 12 degrees of freedom. For this test the observed χ^2 statistic (22.9) > χ_{cr} (19.68) so the null is rejected. Agriculture regions do have a significantly different business structures than all CCSs.

Test 3: Null – Forestry and agriculture communities do not have significantly different business structures. Forestry is now the expected business structure distribution value and agriculture business structure distribution is the observed value. The chi squared statistic is 127.3 at the 12 degrees of freedom. For this test the observed χ^2 statistic (127.3) > χ_{cr} (19.68) so again the null is rejected. Forestry regions do have significantly different business structures from agricultural regions. Even at the 1 % or 0.5 % the null would still be rejected with this large chi squared statistic.

From the three chi-squared tests, business structures are significantly different depending on the economic base type. The business structure in forestry and agriculture regions both differ from the business structure in the entire region of study in Saskatchewan. Forestry and agriculture regions also have business structures significantly different from each other as the large test statistics shows. The types of business that developed around the main export of the region, in reflecting the services to support that economic base and the resident population, are significantly different.

If an agriculture region converts to one of forestry there is the possibility for a significant change in the types of businesses that serve the local community. For example, if the business structure for forestry presented in table 5.9 is reflective of what a new forestry region would require, some businesses could possibly close while other new business opportunities may be available. Fuel sales dealers for example would not be in such large demand without the steady gas needs of agriculture equipment. More manufacturing could be required to process the timber; transportation needs could also be in higher demand to haul the timber. In some cases businesses may be able to adapt and change to serve these forestry community needs, in other cases the business may not be able to adapt resulting in closure. This will heavily depend on the existing skills of the labour force and how labour requirements for agriculture and forestry differ. The possibility for new industry recruitment is also present. A void could be created where new upstart businesses could feed the needs of the forestry industry.

5.5 Econometric Results

The econometric analysis was conducted to see what factors have influenced population change in the CCSs in the prairie forest fringe. Percentage population change from 1991-2001 was used as the dependent variable with independent variables presented in section 4.3.4 above. The role of forestry and agriculture in the growth and vitality of the communities is represented by the percentage of agriculture and forestry workers in each CCS for 1991. These industries were chosen because they represent the two land use types of study in this paper, forestry and agriculture. The percentage of the labour force employed in these two industries will represent their importance in community population change. In order to avoid endogeneity, the initial values in 1991 were used for these independent variables. Both of these variables are expected to have a negative influence on population change as they have been labour saving in technological change over time.

Distance to an urban center of > 10,000 population was measured in km (using 1996 CCS boundaries). This variable is expected to have a negative influence on population change as proximity to urban centers offers more amenities and employment opportunities. Distance to communities of 3,000 and 5,000 people were also tested and were a negative influence, though significance increased with the size of the center. Education was measured by the percentage of people in the 25-54 age group with some post secondary education in 1991. This variable may be expected to be positively associated with population change reflecting the importance of human capital in support of economic potential. However the possibility does exist for this variable to have a negative influence on population growth if out-migration occurs from a lack of adequate jobs in a community to support these higher educated people, relative to opportunities elsewhere.

Lagged employment change was measured in percentage change from 1986 to 1991. This is expected to positively influence population growth as it reflects the lagged strength of the local economy allowing for inertia to sustain ongoing growth. Also controlling for growth/decline will allow subsequent-period population change to more accurately reflect responses to initial period (1991) values of the other variables. The income variable was per capita from all sources measured in 1991 dollars. It is expected to have a positive influence reflecting greater local purchasing power and effective demand. Population was the entire CCS population in 1991; its influence is expected to be positive because of threshold requirements related to sustainability of local businesses and public services. Percent aboriginal in the community is expected to positively influence population change due to both young age structure and higher birth rates. Dummy variables for Manitoba and Alberta take the value of 1 for CCSs if they are in that province and 0 if the are not.

Five models were estimated and are presented in table 5.10 below. In model 1 only the percentage of the labour force employed in agriculture was included and found to be highly significant with a very large negative influence on population growth. Rural agricultural areas have been experiencing this population decline for many decades due to the fact that agriculture has been progressively more labour saving in technology and very little other employment is available to help retain people, especially younger age groups. On top of this the prices for agricultural commodities have been chronically low while

Table 5.10. Dependent Variable: Percentage Change in CCS Population 1991-2001.

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
C	13.28 (7.30)**	16.56 (2.74)**	18.23 (3.36)**	10.48 (1.54)	18.56 (2.27)**
Agriculture in work force (%)	-0.47 (-9.29)**	-0.51 (-9.26)**	-0.46 (-8.76)**	-0.41 (-6.55)**	-0.47 (-6.93)**
Forestry in work force (%)	N/A	-0.25 (-1.27)	-0.12 (-0.71)	-0.26 (-1.30)	-0.31 (-1.57)
Employment Change 1986-1991 employed 15+ age group (%)	N/A	0.06 (0.74)	0.05 (0.68)	0.10 (1.25)	0.12 (1.61)
Inc in 1991 ($)	N/A	-1.24 E-04 (0.37)	-1.34 E-05 (-0.05)	5.10 E-04 (1.52)	4.4 E-04 (1.27)
Distance to Center >10,000 pop. (km)	N/A	N/A	-0.07 (-4.60)**	-0.08 (-4.80)**	-0.08 (-4.77)**
Education 25-54, people with some post secondary educ. (%)	N/A	N/A	N/A	-0.09 (-0.74)	-0.17 (1.30)
Percent Aboriginals of Community Population (%)	N/A	N/A	N/A	0.17 (2.82)**	0.15 (2.56)**
Population in 1991	N/A	N/A	N/A	-7.19 E-05 (-0.31)	-5.58 E-05 (-0.22)
Dummy Variable for Manitoba	N/A	N/A	N/A	N/A	-2.06 (-0.78)
Dummy Variable for Alberta	N/A	N/A	N/A	N/A	-4.00 (-1.89)*
R^2	0.42	0.43	0.49	0.52	0.53
Adjusted R^2	0.42	0.41	0.47	0.49	0.50
Number of CCSs	156	156	156	156	156

Note: All models using White heteroskedasticity-consistent standard errors and covariance. T-statistics are in parenthesis, ** and * indicate significance at ≤ 5% and ≤ 10% levels for a two tailed t test. N/A = not included.

the costs of inputs has steadily increased making it even more difficult for people to stay in thee regions. The coefficient of this variable is highly significant and of the expected sign. This model even with only one variable has an adjusted R^2 value of 0.42 which is large for a single variable model. This suggests the extent to which the agriculture industry dominates population growth in many of the CCSs of this study. Of course with only one independent variable this model will suffer from omitted variable bias.

In model 2 the percent of the labour force that comprises forestry workers, employment change and per capita income were added. The influence of percentage of forestry workers in a region was found to be negative as expected, though an insignificant influence on population growth. Employment change was also an insignificant influence on population growth, as was per capita income. The addition of these three variables in model 2 actually results in a reduced adjusted R^2.

In model 3 distance to urban center of >10,000 population was added. Distance from a center > 10,000 had a significantly negative impact on population change. This is expected as opportunities for employment and amenity benefits afforded by access to an urban center diminish with distance making a CCS less attractive as a place to live.[11] The R^2 value increased to 0.47 with the addition of distance reflecting the importance that it plays in population change.

In model 4 education rates, percentage aboriginal and initial population were all added. Percentage aboriginal had a significantly positive influence on population growth as expected, reflecting the growth of this demographic in overall populations of western Canada. Neither education nor initial population size were significantly related to

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[11] When model 3 is run with distance to urban center > 3,000 instead of 10,000 the coefficient on this variable is -0.06 with a t statistic of -1.80. When urban center of 5,000 is used the coefficient is -0.06 with a t statistic of -2.413.

population growth. In model 4 initial income now became a positive influence but is still insignificant.

For model 5 the dummy variables for Alberta and Manitoba were added to capture fixed effects that may be due to inter-provincial differences other than those variables already explicitly included. This model was taken to be the most complete both since it includes the variables considered theoretically important and also because it performs the best in terms of sign, significance and R^2. Percent agriculture employment and distance to an urban center >10,000 remained negative and significant. Percent aboriginal was still significant and positive and the dummy variable for Alberta was negative and significant at the 10 % level. This implies that relative to Saskatchewan, Alberta communities are *less* likely to experience population growth, after the other variables are controlled for. From this model it can be seen that the farther one gets from a town > 10,000 and the more agriculture workers in the area the faster the population will drop. The greater the portion of the population that is of aboriginal origin, the greater will be the offsetting positive influence. The R^2 value for model 5 is 0.53 and the adjusted R^2 is 0.50 which suggests that this is the most predictive model. By far the most important variable is the percentage of agriculture workers, reflected by the large R^2 value in model 1. Between model 1 and 5, nine explanatory variables are added and the adjusted R^2 increases by only 0.08 points. Furthermore the coefficient on percentage agriculture employment remains consistent. Insights are that communities with a high agriculture specialization can expect to see population declines.

The econometric results help to shed further light on possible outcomes of the proposed land usage change investigated in this thesis, by highlighting how certain factors influence population change. The greater the dependency on agriculture the faster the population will drop. While the results also show a negative coefficient on % of labour force employed in forestry, this variable is not significant. This negative population change influence is offset by a higher percentage of aboriginal population in the region and also by being located near larger communities. In the study region forestry communities have the larger shares of aboriginal populations, as well as being near larger communities. Overall, these results suggest that the consequences of changing the export base from agriculture to forestry would be stronger population growth or lesser population declines. Although the results suggest these changes, caution must be used when extrapolating these results into the future.

The population change model also assumes that technologies will remain constant. This implies that the mix of labour and capital will remain constant into the future, this is not necessarily true. New technologies may emerge that affect this labour capital mix and the costs associated with this mix. The model is also based on the existing economic structure. A limitless number of factors may come into play that can alter this structure and in the case of a large change or shock the existing structure may significantly alter over time. A forestry community that developed around such a base in the early 1950s may be very different from one that would develop around a forestry base in the 21st century. The other potential limitation is where forestry is occurring today. This thesis is based on climate change occurring and areas may see large shifts in rainfall and temperatures. Areas that today provide an environment for forestry may become either to dry or to hot to support the type of forestry seen today.

5.6 Summary

In this chapter the demographics and business structure of forestry and agricultural communities were compared through a location quotient analysis and a chi squared testing of differences in business structures. Results showed that there are significant differences between these two types of communities, both in the business structure and in the socio-economic characteristics of the regions. Sizable differences were also seen in the absolute values of the location quotients and in the multiplier values. Other industries, particularly oil and gas and mining, were found to be more prevalent in forestry than agricultural communities. A population change model was then estimated where variables were tested to see the significance they play in community population change. Percentage of agriculture workers had a negative influence on population change as did the distance from a community with a population greater than 10,000. Larger aboriginal communities exerted a positive influence on population. The next chapter concludes the thesis by briefly summarizing these results with further discussion and policy implications.

Chapter 6: Summary and Conclusions

6.1 Introduction

This chapter will present a summary of this thesis and the conclusions based upon the results and analysis. The results are summarized, followed by a discussion of how a land use switch from agriculture to forestry could affect rural communities in Western Canada's forest fringe area. Limitations of the study and likely outcomes for the region are discussed, as well as recommendations for further research offer concluding remarks.

6.2 Summary

Due to climate change concerns and initially the Kyoto Protocol commitments, afforestation has been identified as an option to increase carbon retention from the atmosphere. The land use and economic base of the communities in the regions affected by afforestation could be substantially changed. Understanding the nature of the required changes in, and by, communities and their impacts is a crucial component of designing appropriate and successful policies. The purpose of this research was to examine the potential impacts of afforestation on rural regions/communities in Alberta, Manitoba and Saskatchewan's forest fringe and the areas immediately north and south of this fringe.

6.2.1 Location Quotient Analysis

The location quotient analysis showed areas where forestry and agriculture has a strong presence. Agriculture was found to be present in almost every community studied and in many areas it was the dominant industry. Forestry was not as common and was totally absent in many communities. This is due to the geography of the area and location of communities. The area of study was the forestry fringe area itself plus a region immediately south that is predominantly agriculture and an area north that is mainly forest cover. The number of communities or CCSs in the study area was more concentrated in the grassland and fringe area in the Statistics Canada Census Divisions that were the basis for the study. North of the fringe where forest predominates there is very low population density and hence a small number of communities to study, as classified by Statistics Canada. This forest cover area also has a large proportion of the oil/gas and mining that in many cases eliminated communities from being labelled strong in forestry.

Communities were classified as "strong agriculture" or "strong forestry" based on the percentile rankings of the forestry and agriculture location quotients. Due to the dominance of agriculture and the large number of "mixed" forestry and agriculture communities, there were more communities classified as strong agriculture than strong forestry. In 2001 there were 32 communities classified as strong forestry and originally 13 as strong forestry. Taking other industry influence into effect, oil/gas and mining, the number of forestry communities dropped to 7 leaving the remaining communities classified as mixed.

6.2.2 Descriptive Statistics

The communities, now being classified into land usage type regions, were examined to see how factors such as population, income and employment varied. The strong agriculture region contained more communities than the strong forestry region but the population was smaller. This is due to the strong agriculture region having a smaller land area than strong forestry. Average incomes were almost identical in these two types of communities although lower than in the rest of the study area. Percent of people employed was highest in agriculture communities while the proportion of residents with a completed university degree did not differ greatly among any of the community types. The above description applies to both 1991 and 2001.

A comparison between 1991 and 2001 shows that in both strong forestry and strong agriculture regions, incomes and education levels have risen. Percentage of people employed on the other hand has fallen slightly in agriculture but is still above seventy percent while in strong forestry it fell to a very low rate of just over fifty percent. The large employment percentages in agriculture regions is likely due to the nature of the "family" farm institution. Older and younger people helping out at busy time of the year like seeding and harvest may report being employed year round even though their actual contributions are seasonal. In forestry regions the larger aboriginal population may also lead to the lower employment rates. The most striking change is the decline in population of strong agriculture regions. It has fallen from almost five percent of the study area population to just over three percent in 2001, this may be due to younger people finding employment in urban areas but also attributable to an aging population.

The comparison between 1991 and 2001 was also done by keeping communities in their 1991 classification. This comparison showed that once again agriculture regions are still experiencing population declines while forestry regions are seeing population growth. In this comparison strong forestry communities in 1991 have shown employment (percent people employed) growth over the ten years.

6.2.3 Basic and Non-Basic Employment

Total employment in each community was next classified into either basic or non-basic based on SIC classifications. This information yielded multiplier values for each of the land use zones. Strong forestry communities have multipliers almost twice the size of agriculture communities, implying that forestry communities stimulate almost two times as much non-basic employment as strong agriculture communities. This suggests that strong forestry regions may have the ability to stimulate new support jobs in the local area or community at higher rates than strong agriculture regions.

6.2.4 Forestry and Agriculture: Business Structure

The business structure was compared in areas classified as strong agriculture and strong forestry to see if they were significantly different. These were also compared to all other communities in the study area. Unfortunately this could only be done for Saskatchewan limiting the number of observations. The results showed that these three community types are all significantly different from each other. This is expected given that local business structure in these communities will have developed in support of the dominant industry. It also implies that a switch from agriculture to forestry land use will require restructuring of other businesses in the community.

6.2.5 Econometric Results

An econometric model was developed to see what factors have influenced community population change over a ten year period, 1991-2001. The results showed which of these factors significantly contributed to the population change throughout the study area. It was found that a strong dependence on agriculture is negatively related to population growth. Conversely it was found that proximity to a larger center (10,000+) is positively related to population growth. Population growth is also positively influenced by the percentage of aboriginal people in the community.

6.3 **Discussion**

Due to the Kyoto Protocol and other Government incentives to combat climate change, afforestation is an option to significantly increase carbon retention (carbon sinks) in Canada. The impacts and potential outcomes on these communities that may be affected by switching from agriculture to forestry are unknown. The goal of this research was to see how agricultural communities may change if the land use in their surrounding areas switched to forestry.

Forestry based communities were found to have lower employment rates, stimulate more non-basic employment and have stronger population growth compared to agriculture based communities. All of this is not due to just the region being specialized in forestry or agriculture. Forestry regions are in the north and have a higher aboriginal population per capita than the agriculture regions. This might play a large part in the population growth and lower employment rates. The non-basic employment differences can partially be explained through tourism. The forestry region has many lakes and scenic views that bring in tourism that agriculture areas don't currently have. Over time this may change, as more trees are planted a new tourist industry may be created further south in these once agriculture areas although the small number of lakes would be a limiting factor.

One characteristic of the communities affected by a change from agriculture to forestry land use that will likely change is the business structure. Forestry communities have more manufacturing and transportation industry than agriculture communities. They also have more personal service business but fewer real estate and fuel sales. Personal business services will depend on the population size served by the town and its surrounding area. The agriculture communities have fewer towns of larger than the smallest size while in the forestry area larger towns are present. Forestry may lead to more manufacturing and probably more transportation; although some of the transportation differences may be explained by the remote location of some forestry areas. Fuel services will definitely adjust due to the crop cycle. Machinery will not be run as often with forestry and the fuel demand will reflect this.

The econometric population growth model showed that the share of the labour force engaged in agriculture was a negative influence and the proportion of the population of aboriginal origin and proximity to larger centers were positively related. Following a switch to forestry, labour demands would be large for planting and harvesting the trees but the maintenance does not require much labour, keeping in mind that this is probably a 15 year cycle. If manufacturing and transport business develop, then the quantity of labour will increase in these fields. The people, however, may come from the diminished fuel sales, real estate or grain elevators businesses for example. In other words shifting from agriculture may not necessarily promote population growth. If no large towns are nearby or the aboriginal presence is not large then forestry may not stimulate population growth.

6.3.1 Likely outcome

The research findings did show some interesting outcomes of existing conditions and some possible outcomes of proposed changes. There is no doubt that changes will happen if this land transformation occurs. It is impossible to forecast exact changes but this section will discuss some likely outcomes.

The most likely outcome will be a mixture of agriculture and forestry or agro-forestry. Government wants to increase forest acres by offering economic incentives to agriculture farmers. A current farmer switching their entire land base to trees is unlikely without a huge economic incentive. If agro-forestry is what happens, this is a land use currently not seen in Canada to a great extent so there is no base line to compare with. Most probably there would be a decline in some agriculture serving business (machinery, fuel, fertilizer etc.). This will be offset by forestry serving business and an increase in manufacturing presence. In some cases the existing business may be able to diversify and begin offering equipment/service to both forestry and agriculture. In other cases this existing business may close and new entrepreneurs will capitalize on the new "forestry" needs.

Population change will probably not be significantly affected. Percent of people employed in agriculture is a strong negative influence on population change and percent forestry is also a negative influence on population change, but not as significant. Switching to forestry may improve the bottom line in producer's pockets but it will not bring droves of new people, it may only lessen the de-population or slow the population losses compared to agriculture regions. The size of towns will also not change significantly in the short term which means distance to centers > 10,000 which is a significant influence on population change will not change. The presence of aboriginal people, a strong positive influence on population change, will likely not change as well. Over time this may change but not in the short term. The location of these larger towns or aboriginal people will not "follow the trees" but will follow, along with other people, jobs. For example if a new lumber mill is initiated then the population may start to grow and the size of towns will increase but it would take at least one cycle of tree growth to begin this type of change. Those rural areas or small communities closer to larger centres, or with an aboriginal population, will continue to gain in relative if not absolute terms.

6.4 Limitations of the Study

There are some limitations of this study. One of these limitations is the small number of communities that were classified as strong forestry. This was due to the large size of CCSs in the northern regions where forestry is observed giving a limited number of overall communities, and also by the presence of other industry. Many areas with forestry also have a strong agriculture presence or a strong oil/gas or mining industry that disqualified naming communities as strong forestry.

Another limitation of the study was not having the data or resources to examine in detail the tourist industry. In strong agriculture regions there is almost zero tourist industry, the only scenery is crop land and the number of communities are limited in size and number. In the strong forestry regions this cropland gives way to trees and lakes that attract many tourists. This will influence both business structure and the multiplier values in forestry regions.

Probably the biggest limitation of the study was in the classification of forestry itself. This study examined what might happen to an agriculture community if it transformed to a forestry community, proxied by communities currently dominated by the forestry industry. These forestry communities are what exist today in the study area. They were defined using Statistics Canada employment data. If agriculture regions do transform to forestry it may not be exactly like existing forestry communities. Farm owners may only put some of their land into tree cover which would more closely approximate an "agro-forestry" region. This type of employment is not large in Canada and Statistics Canada does not have a classification for agro-forestry making comparisons with this type of region impossible.

6.5 Recommendations for Further Research

There is more opportunity for research in this area. Climate change is an urgent and emerging problem in Canada and the shift back to forestry is a new phenomena. This means that the outcome is really an unknown. This study focused on the impacts to rural communities with the assumption that the economic incentive offered by the government to producers would be sufficient to entice the planting of trees. A study looking at the economics or prices/costs that would be associated with this type of transformation would help to shed further light on the issue and possible outcomes. This study assigned business as either basic or non-basic which the multiplier information was based on. A study focusing on the survey method would provide information on the exact amount and location of input purchases and sale of goods and help to improve accuracy of results. Knowing where the community purchases its goods may give some insight into where supplies are purchased. If a strong agriculture community is close to a strong forestry community and frequently purchases goods and services in the forestry community then it may have the same purchasing pattern if the agriculture community diversifies into forestry. The following section provides further insight into this discussion.

6.6 Conclusions

The existing conditions in forestry regions and agricultural regions are different. The business structure, multiplier values, and average number of people employed are different in forestry based communities than in agriculture based communities. For all communities the percent aboriginals and proximity to towns over 10,000 exert positive influences while percentage employed in agriculture exerts a negative influence. If this land use switch does take place at one hundred percent, or all land is switched to forestry from agriculture, then there are likely to be substantial changes to the business structure. This may cause industry, especially lumber processing, to locate to some of these communities and cause population growth due to people needed to work in these mills and the non-basic industry that forestry regions stimulate. However, such a change is likely to happen over a long time period, greater than 15 years. A more likely scenario is not one hundred percent land use change. People will switch if it is economically productive to do so or if adequate incentives are provided. Given the current conditions in forestry and agriculture a partial land use change is most likely where agriculture regions will not change to a complete forest regions but a new type of industry labelled as agro-forestry where more modest community changes will occur gradually.

This assumption that areas will become more agro-forestry oriented is further supported by section 2.4 analysing the life cycle of one industry towns. Communities were able to adapt and survive if they diversified, so an agricultural area switching to a forestry area is not necessarily diversification. They would still be reliant on that one industry and survival would still hinge on that industry, without diversification it would just shift from reliance on agriculture to reliance on forestry. This is important information for any policy initiatives, promoting diversification into agro-forestry may better serve the community in the long term than policy initiatives to shift mixed communities into primarily forested areas.

Another factor to consider by policy makers would be the spatial location of these communities. If policy is going to promote diversification then the location of affected communities must be examined. A strong agriculture region located adjacent to a mixed or strong forestry region may not adapt or diversify into an agro-forestry business structure at all. The actual land use may diversify into agro-forestry but without a similar diversification in the business structure the community has not really undergone any diversification. If a strong agriculture community is adjacent to a strong forestry community then the emerging forestry industry may be served by the businesses in the the adjacent strong forestry community. A historically strong agriculture community whose economic base switches to forestry and is spatially removed from any forestry infrastructure is most likely to develop this diversified agro-forestry business structure. This increases the chance the community can survive exogenous shocks to either the agriculture or forestry industry.

This, on the surface, does not give any assurance to policy makers that the proposed changes would occur. Targeting policy to communities on just a spatial location analysis is the first step but there is still a degree of guess work. A deeper analysis of the existing businesses could be employed and would give policy makers further insight into communities that may be targeted with agro-forestry diversification. One would have to assume that a community with an existing degree of diversification, not necessarily just forestry, would be a better target. These communities may be more apt and able to develop an agro-forestry business structure. A location quotient analysis would give a degree of confidence to policy makers into the regions existing business structure and some insight of whether the community has the pattern of diversification.

The age structure may also be used to determine if the community may be apt to diversify. An aging population may be content and not want to diversify into a new and unknown business. A community with a younger population may be more acceptable of change and willing to take the challenge of starting new business ventures.

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APPENDIX A

Table A-1: Basic Industries

01 - Agricultural industries
03 - Fishing and trapping industries
04 - Logging industry
05 - Forestry services industry
06 - Mining industries
07 - Crude petroleum and natural gas industries
10 - Food industries
11 - Beverage industries
12 - Tobacco products industries
15 - Rubber products industries
16 - Plastic products industries
17 - Leather and allied products industries
18 - Primary textile industries
19 - Textile products industries
24 - Clothing industries
25 - Wood industries
26 - Furniture and fixture industries
27 - Paper and allied products industries
28 - Printing, publishing and allied industries
29 - Primary metal industries
30 - Fabricated metal products industries (except machinery and transportation equipment industries)
31 - Machinery industries (except electrical machinery)
32 - Transportation equipment industries
33 - Electrical and electronic products industries
35 - Non-metallic mineral products industries
36 - Refined petroleum and coal products industries
37 - Chemical and chemical products industries
39 - Other manufacturing industries
46 - Pipeline transport industries

Table A-2: Non-Basic Industries

02 - Service industries incidental to agriculture
08 - Quarry and sand pit industries
09 - Service industries incidental to mineral extraction
40 - Building, developing and general contracting industries
41 - Industrial and heavy (engineering) construction industries
42 - Trade contracting industries
44 - Service industries incidental to construction
45 - Transportation industries
47 - Storage and warehousing industries
48 - Communication industries
49 - Other utility industries
50 - Farm products industries, wholesale

51 - Petroleum products industries, wholesale
52 - Food, beverage, drug and tobacco industries, wholesale
53 - Apparel and dry goods industries, wholesale
54 - Household goods industries, wholesale
55 - Motor vehicle, parts and accessories industries, wholesale
56 - Metals, hardware, plumbing, heating and building materials industries, wholesale
57 - Machinery, equipment and supplies industries, wholesale
59 - Other products industries, wholesale
60 - Food, beverage and drug industries, retail
61 - Shoe, apparel, fabric and yarn industries, retail
62 - Household furniture, appliances and furnishings industries, retail
63 - Automotive vehicles, parts and accessories industries, sales and service
64 - General retail merchandising industries
65 - Other retail store industries
69 - Non-store retail industries
70 - Deposit accepting intermediary industries
71 - Consumer and business financing intermediary industries
72 - Investment intermediary industries
73 - Insurance industries(3)
74 - Other financial intermediary industries
75 - Real estate operator industries (except developers)
76 - Insurance and real estate agent industries(3)
77 - Business service industries
81 - Federal government service industries
82 - Provincial and territorial government service industries
83 - Local government service industries
84 - International and other extra-territorial government service industries
85 - Educational service industries
86 - Health and social service industries(3)
91 - Accommodation service industries
92 - Food and beverage service industries
96 - Amusement and recreational service industries
97 - Personal and household service industries(3)
98 - Membership organization industries
99 - Other service industries

Appendix B

Table B-1: CCS Name and Largest Community in CCS if Any

CCS Number Code	CCS Name	Largest Community in CCS
4601035	Stuartburn	
4601039	Piney	
4601043	Reynolds	
4601046	Whitemouth	
4601057	Lac du Bonnet	Pinawa
4601071	Alexander	Powerview
4602032	De Salaberry	St.-Pierre-Jolys
4602041	Hanover	Steinbach
4602053	La Broquerie	
4602057	Ste. Anne	Ste. Anne
4612052	Brokenhead	Beausejour
4613043	St. Andrews	Selkirk
4614031	Woodlands	
4614036	Rockwood	Stonewall
4616019	Silver Creek	
4616024	Russell	Russell
4616040	Shellmouth	
4616045	Hillsburg	
4616049	Shell River	Roblin
4616063	Park (North)	
4617026	Alonsa	
4617034	McCreary	McCreary
4617040	Ste. Rose	ST. Rose du Lac
4617045	Ochre River	
4617048	Dauphin	Dauphin
4617053	Gilbert Plains	Gilbert Plains
4617057	Grandview	Grandview
4617063	Ethelbert	Ethelbert
4617071	Mossey River	Winnipegosis
4617076	Lawrence	
4618031	Gimli	Gimili
4618037	Armstrong	
4618040	St. Laurent	
4618044	Coldwell	
4618052	Eriksdale	
4618057	Siglunes	
4618060	Grahamdale	
4618068	Fisher	
4618071	Bifrost	Arborg
4619045	Division No. 19, Unorganized	
4620032	Mountain (South)	
4620037	Minitonas	Minitonas
4620041	Swan River	Swan River

4620055	Mountain (North)	
4621078	Division No. 21, Unorganized	Flin Flon
4623062	Division No. 23, Unorganized	Gillam
4712001	Pleasant Valley No. 288	
4712004	St. Andrews No. 287	Rosetown
4712011	Milden No. 286	Dinsmore
4712020	Fertile Valley No. 285	Conquest
4712026	Montrose No. 315	
4712034	Marriott No. 317	
4712038	Mountain View No. 318	
4712042	Biggar No. 347	Biggar
4712050	Perdue No. 346	Perdue
4712064	Eagle Creek No. 376	
4712069	Glenside No. 377	
4713006	Kindersley No. 290	Kindersley
4713019	Prairiedale No. 321	Major
4713024	Oakdale No. 320	Coleville
4713028	Winslow No. 319	Dodsland
4713032	Grandview No. 349	
4713038	Mariposa No. 350	Tramping Lake
4713041	Progress No. 351	
4713046	Heart's Hill No. 352	
4713049	Eye Hill No. 382	Macklin
4713056	Grass Lake No. 381	
4713059	Tramping Lake No. 380	Scott
4713064	Reford No. 379	Landis
4713068	Buffalo No. 409	Wilkie
4713072	Round Valley No. 410	Unity
4713079	Manitou Lake No. 442	Marsden
4713092	Hillsdale No. 440	Neilburg
4713096	Cut Knife No. 439	Cut Knife
4714001	Hudson Bay No. 394	Hudson Bay
4714006	Porcupine No. 395	Porcupine Plain
4714021	Kelvington No. 366	Kelvington
4714023	Ponass Lake No. 367	Rose Valley
4714034	Barrier Valley No. 397	Pleasantdale
4714038	Bjorkdale No. 426	Bjorkdale
4714043	Tisdale No. 427	Tisdale
4714047	Star City No. 428	Melfort
4714053	Willow Creek No. 458	
4714056	Connaught No. 457	Ridgedale
4714059	Arborfield No. 456	Arborfield
4714067	Moose Range No. 486	Carrot River
4714072	Nipawin No. 487	Nipawin
4714077	Torch River No. 488	Choicland
4715001	St. Peter No. 369	Muenster
4715007	Humboldt No. 370	Humbolt
4715011	Bayne No. 371	Bruno

4715014	Grant No. 372	Vonda
4715018	Aberdeen No. 373	Aberdeen
4715026	Laird No. 404	Waldheim
4715031	Rosthern No. 403	Rosthern
4715036	Fish Creek No. 402	Alvena
4715039	Hoodoo No. 401	Wakaw
4715044	Three Lakes No. 400	Middle Lake
4715048	Lake Lenore No. 399	St. Brieux
4715051	Flett's rings No. 429	Beatty
4715054	Invergordon No. 430	Yellow Creek
4715057	St. Louis No. 431	Kinistin
4715061	Duck Lake No. 463	Duck Lake
4715067	Birch Hills No. 460	Birch Hills
4715075	Lakeland No. 521	Christoper Lake
4715079	Garden River No. 490	Meath Park
4715099	Paddockwood No. 520	Brock
4716005	Mayfield No. 406	Denholm
4716008	Great Bend No. 405	Radisson
4716013	Blaine Lake No. 434	Blain Lake
4716018	Redberry No. 435	Hafford
4716023	Douglas No. 436	Speers
4716033	Round Hill No. 467	Rabbit Lake
4716038	Meeting Lake No. 466	
4716041	Leask No. 464	Leask
4716046	Shellbrook No. 493	Shellbrook
4716056	iritwood No. 496	Spiritwood
4716062	Medstead No. 497	Medstead
4716075	Big River No. 555	
4717001	Meota No. 468	Chitek Lake
4717008	Turtle River No. 469	Edam
4717013	Paynton No. 470	Paynton
4717017	Eldon No. 471	Maidstone
4717022	Wilton No. 472	Lashburn
4717032	Frenchman Butte No. 501	St. Walburg
4717045	Mervin No. 499	Smeaton
4717047	Parkdale No. 498	Glaslyn
4717054	Meadow Lake No. 588	Meadow Lake
4717056	Loon Lake No. 561	Loon Lake
4717062	Beaver River No. 622	Peirceland
4718090	Division No. 18, Unorganized	La Ronge
4809002	Clearwater No. 99	Rocky Mountain House
4810016	Beaver County No. 9	Tofield
4810026	Minburn County No. 27	Vegreville
4810048	Two Hills County No. 21	Two Hills
4810058	Lamont County No. 30	Lamont
4811032	Brazeau No. 77	Devon
4812014	St. Paul County No. 19	St. Paul
4812022	Smoky Lake County No. 13	Smoky Lake

4813001	Lac Ste. Anne County	Mayerthorpe
4813018	Barrhead County No. 11	Barrhead
4813028	Westlock No. 92	Westlock
4813029	Woodlands No. 15	Whitecourt
4813036	Thorhild County No. 7	Thorchild
4813044	Athabasca County No. 12	Athabasca
4814003	Yellowhead No. 94	Hinton
4817031	Opportunity No. 17	Slave Lake
4817062	Clear Hills No. 21	Hines Creek
4817076	Northern Lights No. 22	Manning
4817095	Mackenzie No. 23	Rainbow Lake
4818015	Greenview No. 16	Greenview
4819041	Smoky River No. 130	Falher
4819049	Birch Hills No. 19	
4819054	irit River No. 133	Spirit River
4819059	Saddle Hills No. 20	
4819066	Fairview No. 136	Fairview

Appendix C

Table C-1: Business Structure Breakdown

Financial Business	**Manufacturing**
Banks	Food
ATM's	Apparel
Credit Agencies	Lumber and Wood
Security and Commodity Brokers	Printing
Insurance	Stone and Concrete
	Primary Metal and Metal Fabrication
Transportation	
Machinery Transportation	**Building Materials**
Transportation	Other Wholesale
Air Transportation	Lumber and Building Materials
	Construction
Food and Drug Stores	
Grocery Stores	**Entertainment**
Other Food Stores	Eating and Drinking
Drug Stores	Recreation
	Hotels
Miscellaneous Retail	
General Merchandise	**Personal Services**
Furniture	Other Personal Services
Computers and Entertainment	Beauty and Barber Shops
Miscellaneous Retail	Apparel
Business Services	**Fuel Sales**
Professional Business Services	Bulk Fuel
Other Business Services	Service Stations
Communication and Utilities	
Services to Primary	**Automobile Sales and Service**
Real Estate	**Miscellaneous Repair and Hardware Sales**

Appendix D

Table D-1: Strong Forestry CCSs Showing Those Eliminated by Oil/Gas or Mining, 1991

1991					
CCS Name	Forestry LQ	Agriculture LQ	Oil and Gas LQ	Mining LQ	
4602041	2.19	1.04	0.18	0.76	
4619045	2.71	1.75	0.57	0.66	
4621078	2.51	0.34	0.00	7.88	(O/G/M)
4714001	14.07	3.46	0.00	0.51	
4715075	3.21	1.23	0.00	0.00	
4716075	11.34	3.27	0.00	0.60	
4813029	8.90	1.68	11.62	4.85	(O/G/M)
4814003	4.45	1.58	5.60	5.78	(O/G/M)
4817031	4.74	4.08	7.35	2.47	(O/G/M)
4817062	7.48	0.41	1.35	2.96	
4817076	6.70	1.07	4.24	2.32	
4818015	4.03	3.81	14.07	5.18	(O/G/M)

Table D-2: Strong Forestry CCSs Showing Those Eliminated by Oil/Gas or Mining, 2001

2001					
CCS Name	Forestry	Agriculture	Oil and Gas	Mining	
4601043	3.23	2.49	0.00	0.98	
4616063	7.63	3.85	0.00	0.00	
4619045	2.19	1.00	0.00	1.30	
4621078	2.86	0.43	0.00	0.90	
4714001	15.09	3.18	0.00	0.00	
4716075	17.74	3.91	0.00	0.65	
4717054	4.80	3.82	0.00	0.77	
4718090	3.73	0.10	0.23	5.75	(O/G/M)
4813029	6.05	0.88	9.89	5.73	(O/G/M)
4814003	6.07	1.23	6.53	4.88	(O/G/M)
4817031	5.98	2.11	7.92	3.61	(O/G/M)
4817095	7.19	3.76	7.33	2.43	(O/G/M)
4818015	3.31	2.58	16.52	4.66	(O/G/M)