Regional Employment Changes in a Booming Resource Economy: A Modified Shift-Share Analogue Regression of Changes in Employment Patterns within the Economic Regions of Alberta

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Dedication: This paper is dedicated to the memory of Christos C. Paraskevopoulos (1934-2007) who introduced us to the shift-share modelling technique. Chris published a number of papers using this model, applied to issues of industrial growth (1975, 1974), labour and wage changes (1973), and general regional asymmetries (1971). Chris continued his interest in economic asymmetries throughout his career.

Abstract: This paper seeks to answer how a thriving energy sector in Alberta, Canada, has affected rates of employment growth in various occupations and industries within the regions of the province. To accomplish this, both a traditional shift-share method and a shift-share model based on occupational employment, rather than on the conventional industry data and a version combining both sets of data are utilized. For all versions of the model, the regression analogue is used to estimate and test changes in eight regions across Alberta, Canada.

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1. Introduction

The objective of this paper is to investigate simultaneously industry and occupation patterns in regions across the province of Alberta, Canada, by applying the traditional shift-share model and the shift-share regression analogue. The paper contributes to the extensive work performed in the area of shift-share analysis by moving to demonstrate the value of adopting Statistics Canada sub-regional data, and in the process employing human capital and activity-mix versions of the shift-share model to capture potential bottlenecks in growth and productivity. Adopting occupational-based data in conjunction with the traditional industry-mix version of the shift-share model provides the opportunity to test for consistency while assessing the economic development and growth prospects of particular regions.

Some studies have begun to look closely at labour-market adjustments in response to structural shifts that may result in major changes to regional relationships, for example, Dussel-Peters (1995) and Ehrenberg (1994) in relation to changes in the Mexican and American economies, respectively, following the formation of the North American Free Trade Agreement (NAFTA), and Blien and Wolf (2002) for Germany following reunification.

It has been argued that labour markets should be examined at a disaggregate level, specifically considering age-sex and possibly racial cohorts (Gabriel and MacDonald 1996 and Anderson and Dimon 1999). A select number of studies have investigated the

employment prospects of different age-sex cohorts approached in relation to factors such as education, income and retirement (Bottoms 1981, Hostland 1985). Brox and Carvalho (2006 and 2008) offer an alternative perspective by utilizing the shift-share model to explore age-cohort employment patterns on a regional scale. Adapted to take into account specific groups, the shift-share model is employed to establish employment perspectives by age-sex cohorts according to regional industrial concentration.

This paper will measure the impact created by changes in the mix of industries which will then be compared to the impact created by the mix of occupations in regions across Alberta. Industry and occupation mix will each be measured by employing the traditional shift-share model and the Patterson (1991) regression analogue for the purpose of testing for statistical significance.

The paper is organized as follows. In section 2, we provide an overview of the performance of the Albertan economy. The theoretical form of the standard shift-share model applied to industry and occupation data and the functional form of the regression analogue model are described in section 3. We analyze the results in section 4, while in the final section we summarize the findings and suggest some policy implications arising from the analysis.

2. A Thriving Provincial Economy

The province of Albert in Canada is blessed with the presence of oil, and the Albertan economy is experiencing significant growth in response to a strong performance by the energy sector. Between 2003 and 2005, Alberta experienced a 43% increase in income, as measured on the basis of gross domestic product. The province's per capita

gross domestic product is almost double the national average and labour income has increased by 10% per year on average (Cross and Bowlby 2007).

Alberta's exports are dominated by crude oil and natural gas which together in 2005 comprised two-thirds of the province's $134 billion total exports. Agriculture, in particular grains and livestock, accounts for the province's largest non-energy exports. The destination for 90% of Alberta's international exports is the United States, with 75%, representing energy-related products (Cross and Bowlby 2007).

The rise in the level of activity in Alberta's energy sector has supported growth opportunities realized by other provincial industries, for example, the growth of metal and fabrication industries responsible for supplying materials to the oil and natural gas industries. In addition, the province's construction industry has experienced considerable growth, and unlike other parts of Canada, Alberta's non-residential construction is nearly twice that of the residential construction sector. The redirection of construction activity from residential to non-residential has contributed to a housing shortage and subsequent rise in housing prices across the province of Alberta.[1] A strong-performing energy sector has also supported growth in tertiary activity and, in particular, in business, computer and financial services which accounted for a provincial trade deficit (Cross and Bowlby 2007).

Finally, despite the migration from other parts of Canada, Alberta continues to suffer from both skilled and unskilled labour shortages (Nikiforuk 2006). For example, in 2006 one-quarter of manufacturers in the province reported a shortage of unskilled labour in the "Survey of Business Conditions" (Statistics Canada, various dates). This

[1] Prices of homes in Calgary and Edmonton increased by 49% and 28% respectively between 2005 and 2006.

compares to an estimate of 2% in 2003.

3. Model and Data Requirements

The traditional shift-share model has commonly been employed to assess regional development performance as measured in relation to variables such as income, employment, value added, or a variety of others. The shift-share model subdivides growth into three components: (1) the national-growth component, which measures the growth that would have occurred in the event that all industries in the study region had experienced the same rate of growth as the reference area average; (2) the industry-mix component, which measures the growth in the study region attributed to the growth rate of the regional mix of industries; and (3) the competitive or differential-shift component, which attributes regional growth to the dynamism or attractiveness of the region and is measured residually.

Some studies have been critical of the more conventional form and variation of the shift-share model, while others have pointed to the relevance of the analysis, especially for the purpose of assessing and, to some extent, predicting regional development and growth. Among others, Houston (1967), Brown (1969), and Richardson (1978) criticize the shift-share model on the basis of five principle areas, including a lack of theoretical foundation, concerns regarding aggregation, weighting bias, instability of the competitive effect, and interdependence between the industry-mix and competitive effects.

Regarding the first area of criticism, Chalmers and Beckhelm (1976) attempt to provide the shift-share model with a theoretical framework based on location theory.

Fothergill and Gudgin (1979) suggest that while it could be argued on theoretical grounds that the foundations of the shift-share model may in fact be questionable, the model does provide the basis for enabling the testing of the hypothesis. For instance, Andrikopoulos, Brox and Carvalho (1990) show that forecasts based on shift-share present more accurate results relative to analyses that utilize aggregate employment changes. In addition, Ireland and Moomaw (1981) and Andrikopoulos, Brox and Carvalho (1987) use shift-share analysis in predicting investment decisions at the regional level, while Rigby and Anderson (1993) adapt the shift-share model to study variations in labour productivity in Canada.

In response to concerns related to aggregation, a number of empirical studies, including those performed by Ashby (1968), Fothergill and Gudgin (1979), and Esteban (2000), suggest that shift-share models are no more sensitive to the level of aggregation than other analytical techniques performed at the regional level.

Richardson (1978) reports that factors such as business cycles, demographic shifts, and other similar developments could impose a weighting bias on the selection of the base year. The weighting bias is found to be minimal, especially in the short run, by McDonough and Sihag (1991) and can be accommodated in the longer-term analysis through the application of a "dynamic shift-share model". In their empirical study of eleven regions in Britain, Fothergill and Gudgin (1979) further show the effects of weighting to be relatively insignificant.

According to Brown (1969), instability of the competitive effect essentially renders the shift-share model ineffective, both for the purposes of forecasting and policy analysis. Paraskevopoulos (1971) concludes: "In this short empirical analysis a counter

test was performed to demonstrate that Brown's empirical test with regard to the stability of the regional-share component is misleading and confusing. The empirical evidence presented here demonstrates that the shift and share method still remains a useful tool of regional economic analysis" (112). Paraskevopoulos' position is further supported by several other regional studies, including Danson, Lever and Malcolm (1980) in their analysis of urban areas in Britain. Further, Brown's criticism is shown to be of only a minor concern in forecasting studies in regions such as Oklahoma by Ireland and Moomaw (1981) and Ontario and Quebec by Andrikopoulos, Brox and Carvalho (1990).

The interdependence of components or its absence is at the core of assessing the validity of shift-share analysis, as noted for instance by Arcelus (1984), Houston (1967), and Paraskevopoulos (1975). A number of studies have responded by proposing variations of the shift-share model designed to reduce the correlations between the industry mix and the competitive effects. Loveridge and Selting (1998) examine a number of the modified versions of the shift-share models, including models by Esteban-Marquillas (1972) and Arcelus (1984). They conclude that the Esteban models do not alleviate the very problem that they were designed to solve, as one form of interdependence simply replaces another, a conclusion that is further supported by Keil (1992). According to Loveridge and Selting, if the significance of interdependence is permitted to be abolished, the Esteban-Marquillas and Arcelus models become considerably more complex. They fail to meet what Loveridge and Selting identify as "the zero rational deviation property," that is, the industry mix and competitive effects summing to zero. Loveridge and Selting (1998) conclude that, based on the empirical results and opportunity for application by practitioners, "the classic model and its close

substitutes are overall winners" (55).

The application of the conventional shift-share analysis normally involves assessing the industrial performance of a region in relation to the reference economy, where the national economy is often used as the reference economy. The analysis is frequently conducted on the basis of employment which offers the most readily available data, according to the following specification:

$$N^r = E_i^r g^n \quad (1)$$

$$I^r = E_i^r (g_i^n - g^n) \quad (2)$$

$$C^r = E_i^r (g_i^r - g_i^n) \quad (3)$$

where the national-growth component, N^r, is given by regional employment in the *ith* industry , E_i^r, times the overall rate of employment change in the reference economy, the province, g^n. The national-growth component, therefore, represents the growth in employment that would have resulted if the region had experienced the same growth as the reference economy. The industrial-mix component, I^r, is given by regional employment in the *ith* industry, E_i^r, times the provincial (reference economy) rate of employment change in the *ith* industry, g_i^n, less the overall rate of employment change in the nation, g^n. Thus, the industry-mix effect represents the employment growth that would have resulted had each regional industry displayed a growth rate consistent with that experienced by the corresponding industry in the reference economy. The industry-mix effect is often viewed as a measure of the strength of the industrial composition in the region. The competitive component, C^r, is given by regional employment in the *ith* industry, E_i^r, times the regional rate of employment change in the *ith* industry, g_i^r, less the

national rate of employment change in the *ith* industry, g_i^n. This component is often interpreted as indicative of the location advantage (disadvantage) of the specific industry in the region.

In this paper, the shift-share analysis is extended beyond its conventional application of assessing regional industrial performance by accounting for the impact of regional economic growth or decline in particular occupational categories. Here we calculate the provincial growth rate as before, and then calculate the growth in employment that would have occurred if growth had matched that of the occupation in the reference economy which we refer to as the "human capital effect". This then allows for the calculation of a competitive effect for each region, after allowing for both the provincial and occupational growth effects. Utilizing these new data provided by Statistic Canada, we are able to test for the consistency of the competitive component for each region measured against both industry and occupation growth in the region.

In this paper, the conventional shift-share model, as outlined above, for both the traditional industry-mix and the human-capital-mix versions, is applied to eight regions in Alberta, namely: Lethbridge, Camrose, Calgary, Banff, Red Deer, Edmonton, Athabasca, and Cold Lake (see Figure 1). The shift-share components for each region are calculated in relation to industrial employment data and occupational employment data for the two periods 1987 to 1996 and 1997 to 2006.

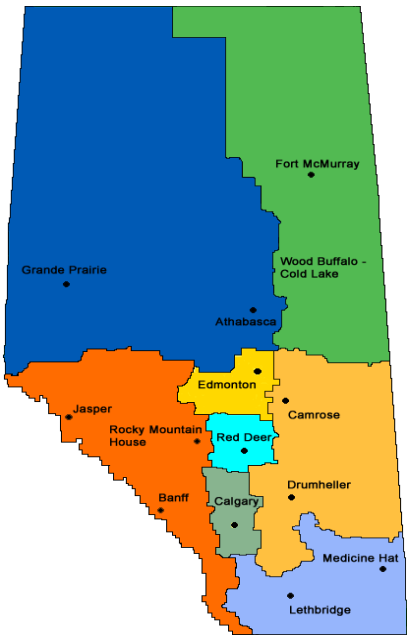

Figure 1: The Regions in Alberta:

1. Lethbridge-Medicine Hat [4810]
2. Camrose-Drumheller [4820]
3. Calgary [4830]
4. Banff-Jasper-Rocky Mountain House [4840]
5. Red Deer [4850]
6. Edmonton [4860]
7. Athabasca-Grande Prairie-Peace River [4870]
8. Wood Buffalo-Cold Lake [4880]

Square brackets contain Statistics Canada economic region code.

The raw data utilized in the computations are drawn from the CANSIM collection provided by Statistics Canada. Industry data are obtained from CANSIM Table 282-0061 which is drawn from the Labour Force Survey (LFS) and organized according to the North American Classification System (NAIC-S). Occupation data are drawn from CANSIM Table 282-0063 and organized according to the National Occupational Classification for Statistics (NOC-S) standard. Both tables provide annual data sets.[2]

While the traditional shift-share model is able to provide insights into the direction and magnitude of changes, it is silent with respect to the significance of such impacts. To overcome this problem, Patterson (1991) suggests the use of a full-analogue regression model of the shift-share method. The primary advantage of the full-analogue regression model over the shift-share method is that the regional share variables can be

[2] Monthly data on the same breakdown (by region and industry or occupation) are available from CANSIM Tables 282-0060 and 282-0062.

separated into statistically verifiable variables. The form of the model as proposed by Patterson is as follows:

$$Y = (EU + EV + EH + EW)\,\beta + \varepsilon \qquad (4)$$

where:

Y is a vector of the growth or decline in employment for every industry by region;

E is a diagonal matrix representing the employment weight for each industry-by-region combination in the base year;

U is a matrix representing the national dummy variable;

V is a matrix consisting of industry fixed-effect variables;

W is a matrix of regional fixed-effect variables;

β is a vector of coefficients and ε is a vector of residuals.

Since the $x'x$ matrix is singular as specified, one industry dummy and one regional dummy can be dropped. The suppressed coefficients can then be recovered from the adding-up constraints and the resulting coefficients normalized to reflect the requirements of the traditional shift-share model. However, following Patterson (1991), the required adding-up constraints may be applied directly to the maximum likelihood estimation. The equations:

$$v_{n1}b_{i1} + v_{n2}b_{i2} + \ldots + v_{np}b_{ip} = 0 \qquad (5)$$

and

$$w_{n1}b_{i1} + w_{n2}b_{i2} + \ldots + w_{nq}b_{iq} = 0 \qquad (6)$$

may be applied directly to the maximum likelihood estimation. These restrictions imply that the sum of the weighted industry effects and the weighted regional effects must both add up to the national employment changes.

As noted by Blien and Wolf (2002), the shift-share regression model has several advantages over the use of panel data which treat the region as the base of analysis. These include the ability to separate the effects of industry and region. Additionally, since the shift-share regression model is based on employment in each industry in each region, the estimation precision is improved because of the increased number of observations.

Following the work of Blien and Wolf (2002), as well as Patuelli et al. (2006) we restructure the regression using weighted least squares (WLS). This is intended to reduce the impact of outliers as a remedy for heteroskedasticity. In this case, the shift-share regression is weighted by the total employed population of Alberta. In addition to WLS, heteroskedasticity-robust standard errors are used, as suggested by Wooldridge (2006). Patterson's model, modified for human capital mix, is:

$$Y = (EU + EV + EH + EW)\,\beta + \varepsilon \qquad (7)$$

The addition of occupation data (h) alters the dimensions such that:
Y is [$irh \times 1$], E is [$irh \times irh$], and U, V, H, W are [$irh \times (n+i+r+h)$] and β is [$(n+i+r+h) \times 1$] where Y is the change in employment in each industry and region over time; E is employment weights of dimension $irh \times irh$; U, V, H and W are matrices of dummy variables for national (reference area), industry, human-capital and competitive-regional shares, respectively.

Using WLS, Patterson's model becomes:

$$\frac{\Delta Eir}{E_{Al}} = \frac{Eir(U + V + W)\beta}{E_{Al}} + \mu \qquad (8)$$

where ΔE_{ir} is the change in employment in each industry region over each period. The weighting term E_{Al} is the total employment in Alberta. The right-hand side of the equation, which Patterson weights by the first-period industry regional employment over that of the total employment in the base region, remains effectively the same. Using WLS, the major change to the shift-share regression is that the industry regional growth is now relative to the base region of Alberta, rather than being described in simple percentage terms.

The re-specified regressions explain more variation in growth. However, the occupational data alone stand out because the explanatory variables seem to be jointly significant, while individual categories offer very little in the way of possible explanations of employment-growth changes.

4. Analysis

4.1 Traditional Shift-share Analysis

The traditional shift-share model based on the standard industrial mix classifications follows the breakdown as presented in Table 1. The occupational classification utilized for the human-capital-mix analysis is described in Table 2. By using the actual labour-force survey data, it is possible to link data into specific activities by combining industry and occupational data into activity pairs. The difficulty is that not all occupation industry pairs exist, or often there are very few people actually doing certain activities and thus data cannot be used because of confidentiality concerns. Table 3 shows the activity matrix employed in this study. These pairs have been chosen

because they are thought to provide an adequate representation in all regions. For example, it makes little sense to attempt to measure the activity represented by the occupation industry pair, “natural and applied sciences” and “construction”, because there are so few people involved in that activity.

The approach taken has been to determine appropriate activities which have a sufficient number of people employed therein. The remaining occupation industry pairs have been combined into a miscellaneous remainder variable. This remainder can be constructed by industry, or by occupation. The results reported in this paper use the industry basis for the remainder categories.

The National (Provincial) Growth

Driven by a strong resource sector, total growth in the province of Alberta has been strong over the whole period being analyzed in this study. In the first decade studied, 1987 to 1996, total employment in the province of Alberta increased by 18%. In the second decade studied, 1997 to 2006, growth was even stronger, with total employment in the province increasing by 29%. The growth rate obtained for the reference area, the province, is common to all the versions of the shift-share analysis applied in this paper.

NAIC-S Industry Mix

The industry-mix portion of growth is the share of employment change in any area that can be attributed to the growth rate of the regional mix of industries. It is calculated by examining the difference between the growth in a given industry across the province minus the growth of the reference area, multiplied by the regional employment.

Measurements of industry mix are based on points for 1987-1996 and have been compared to the period 1997-2006. Change in total employment is calculated for each industry using the provincial industry data. These results are reported in Table 4.

When we look at the results obtained for the two periods, the continued decline in the growth of the agriculture industry is striking. Overall, however, there is strong positive growth in the oil and gas sector, and in construction. Professional, scientific and technical services show the highest growth at over 50%. The industry mix in services and manufacturing each show a slight decline.

Based on overall employment, the agriculture industry continues to employ relatively fewer people as a percentage of total employment in Alberta. Employment in agriculture declined from 6% in 1996 to less than 3% in 2006. Oil and gas, and construction increased their overall share of employment. Total employment in manufacturing industries decreased slightly. Professional, scientific and technical service industries also increased from 5.8% in 1996 to 7.6% of total employment in 2006. The aggregated services industry shows a slight decrease in total employment. However, the change is less than 2% of all employment. The service-industries category remained the largest employer at close to 65% of all employment.

Since non-residential construction accounts for more than twice the spending of the residential market, it is likely that the growth in the oil and gas industry is in large part driving the construction industry. The increase in population in Alberta, with the accompanying increased demand for housing, is also contributing to the growth in the residential component of construction activity.

The rise in demand for oil is likely also driving the increase in professional,

scientific and technical industries. The rapidly expanding provincial economy relating to oil and gas infrastructure developments demands the expansion of business and technical support services (Cross and Bowlby 2007).

Some caution in interpretation of the findings is required given that the Albertan workforce has increased rapidly over the period with significant migration from other provinces. The total workforce was just over 1.2 million in 1987, but is currently approaching 1.9 million. This implies that in relative terms it is possible for an industry to be responsible for a smaller percentage share of the total employment, while in absolute terms accounting for the employment of a larger number of people as compared to earlier periods.

NAIC-S Competitive Share

The competitive share, also known as the regional share, accounts for the regional components which affect employment. As noted, this can be affected by diverse factors ranging from regional policy to natural endowments. As outlined in section 3, the competitive share component is measured residually as the difference in growth between the regional industry and the industry average in Alberta. These calculations are reported in Table 5. Starting with Lethbridge, the following examines each region in Alberta more closely.

Lethbridge

The region around the cities of Lethbridge and Medicine Hat, located in the southern part of the province next to the U.S. border, still contains reserves of oil. The Lethbridge region has experienced a decrease in growth in the agriculture, construction, professional, science and technology, and service industries. However, oil and gas have

shown significant growth. In 1996 the oil and gas industry accounted for just 3% of regional employment, but by 2006 it amounted to 10.5%.

Overall, the region experienced a 20% increase in the working population in the 1996 to 2006 period. Total regional employment in agriculture dropped from over 16% in 1996 to just over 5% by 2006. Construction, manufacturing, and professional, scientific and technology industries increased their share of total employment over this period. While remaining the largest employer, the service industry declined by almost 2% to 62% of total regional employment in 2006.

The significant growth in the oil and gas industry reflects the recent surge in world oil prices. Overall, the region is benefiting from the boom in the oil industry. It is interesting to note that the regional share for the construction industry declined, even as the industry mix demonstrated strong growth.

Camrose

Camrose and the dinosaur badlands at Drumheller are included in an area east of a line drawn down the middle of Alberta roughly parallel to the Saskatchewan border. The Camrose region has experienced an increase in regional share of employment in the agriculture, oil and gas, construction and manufacturing industries, and a decrease in the professional, scientific and technical and other services industries.

However, the increase in the competitive share for the regional agricultural industry has not translated into overall employment gains. Instead, overall employment in agriculture fell from 23.5% in 1996 to 15% in 2006. Nevertheless agriculture still remains the largest employer in Camrose, after services. Manufacturing has also experienced an overall decrease in its share of total employment despite a positive

competitive-share effect. The oil industry and the construction industry each experienced positive competitive shares that translated into increases in overall employment.

The overall growth in the working population of Camrose was 15% between 1996 and 2006.

Banff

We apply the name Banff to the area which encompasses Alberta's share of the Rocky Mountains, including Banff and Jasper National Parks, and the adjacent foothills. The Banff region's competitive share of growth showed consistent signs of decline. Most notably, oil and gas at 60% displayed the largest decline while manufacturing decreased by 50%. The competitive share for the agriculture, construction and services industries also experienced modest declines.

Overall, the working population increased by 11% in Banff which represents the lowest percentage increase across all regions. Banff is limited in growth perhaps by the restrictions imposed by the presence of national and provincial parks in the area. The share of total employment in agriculture, oil and gas and manufacturing declined, and only construction had an increase in share of total regional employment.

Red Deer

The area surrounding Red Deer is located centrally between the provincial capital, Edmonton, and its financial capital, Calgary. In the Red Deer region, the competitive share for the manufacturing industry displayed solid growth. The competitive share also increased for the agricultural, professional, scientific and technological service industries, and the "other services" industry category. The construction industry showed a decline in

the competitive share over both periods while the decline for oil and gas industry employment was limited to the second period.

Services, at 4%, displayed the largest increase in share of total employment. The professional and scientific services and the manufacturing industries also demonstrated a modest gain in share of total employment. The oil industry employed approximately 8% of the working population in the region in both time periods, while the construction industry increased its total share of total employment from 6.4% in 1996 to 9% in 2006.

From 1996 to 2006 the entire working population in the Red Deer region grew by 30%. This implies that, in absolute terms, industries such as oil, which maintained the same share of total employment over the 1996 to 2006 period, actually employed more people.

Athabasca

The north-western quarter of Alberta makes up Athabasca and includes the Peace River district and the community of Grande Prairie. In the Athabasca region, the competitive share displayed a strong performance for the professional and scientific industries in the 1997 to 2006 period. In the same time period, the competitive share increased slightly (5%) for the oil and gas industry, and decreased for the agricultural, construction and manufacturing industries.

The overall share of employment declined for agriculture, a pattern consistent with that observed in almost every other region. The share of total employment in oil, construction and professional and scientific services, and other service industries has increased overall. These findings are consistent with the strong industry-mix results obtained for the oil and gas, construction, and professional and scientific services, noted

earlier.

In 1996, the agricultural industry was the second largest employment category after the services industry. By 2006, agriculture was the fourth largest employment category after the services, oil, construction, and the manufacturing industries.

Cold Lake

The north-easterly quarter of Alberta is home to the military base at Cold Lake, but more importantly it is home to the oil-rich tar sands. Fort McMurray is the heart of the largest tar sands development projects. The competitive share for the oil and gas industry actually decreased, by a slight margin, between 1997 and 2006. However, relative to all other regions in Alberta, the oil and gas industry in Cold Lake accounted for the largest proportion of employment. In 1996, 20% of the working population was employed by the oil and gas industry. By 2006, the total amount employed had increased to 23%. The competitive share declined for the construction and services industries and for the manufacturing industry in the second ten-year period.

Somewhat surprisingly, agriculture also showed strong regional growth. Initially, the performance of the regional competitive share for the agriculture industry appears contradictory until the industry's share of total regional employment is examined. Overall, the agricultural industry basically remained the same across periods, accounting for about 3.5% of the working population.

The fact that agriculture has retained the same share of employment is somewhat impressive, given that in every other region of Alberta there was a notable decline in overall share of employment. The oil and gas industry increased its share of employment to 23% in 2006, making the industry the largest employer after the services industry at

57%. The construction industry also gained in overall share of employment and is the third largest employer at 10.5%.

Calgary and Edmonton

The two regions encompassing the principal cities of Edmonton and Calgary are of interest because their competitive shares are very different. We note that Calgary is home to the head offices of the oil and gas industry. Calgary experienced positive growth in the oil and gas, construction, professional and scientific services, and other services industries, but displayed a decline in the manufacturing industry. Overall, the share of total employment share increased in every relevant industry except for manufacturing. It is interesting to note that the single largest employer after "other services" is the professional, scientific and technical service industry which employs 11.4% of the workers in Calgary.

Edmonton is home to the provincial legislature. Edmonton's competitive share demonstrated a consistent pattern of decline across all industries. The professional, scientific and technical industry declined close to 40%, although the industry's share of employment increased by a negligible amount overall.

The oil and gas industry retained the same share of employment across both periods (4%). The construction industry experienced an increase in share of total employment from 5.8% in 1996 to 9.9% in 2006, while the manufacturing industry showed a decline in share of total employment from 9.5% to 8% in the same period.

In summary, the overall share of total employment for the agricultural industry decreased or was static in every region in Alberta. The competitive share results obtained for the agricultural industry across all regions support the observed decline in share of

total employment. While the Cold Lake, Red Deer, and Camrose regions had positive competitive shares in the second period for agriculture, the share of total employment for the industry declined in all regions, except in the Cold Lake region where it was static in 2006.

The Banff and Red Deer regions stand out from the other rural regions because they have a negative competitive share in the oil and gas industries. This result shows the declining status of conventional oil regionally. As described earlier, the northern tar sands are becoming more heavily utilized compared to the traditional oil producing locations (National Energy Board, 2006).

Using Occupational Data Instead of Industrial Data

Industry employment data are most often used in the shift-share methodology. In addition to industrial data, this paper makes use of occupational data available for the regions of Alberta in order to gain additional insight into the regional components of employment growth.

The shift-share methodology based on industry data specifies that overall growth is subdivided into provincial growth (i.e., the growth of the reference area), the industry-mix and the competitive-share components, where the industry mix is the growth of a given industry minus the provincial growth. The same shift-share accounting procedure can be extended to incorporate occupational data by determining how employment growth can be broken down according to growth across various occupations. Employment growth can be decomposed into growth in the reference area, the human-capital mix, and the competitve share in terms of occupational categories.

Aggregating data across occupational categories requires that some consideration

be awarded to whether a given occupation is subject to barriers to entry in the form of skills or education. For example, when dealing with the industry data it was decided to add the "health" industry category to the "services" category. This was done under the assumption that many people employed in a service-oriented activity can work in a variety of different service-oriented firms with relatively little training. This reflects the fact that in many industries there are fewer skilled workers than there are unskilled workers. For example, in the health industry there are fewer highly skilled workers, such as doctors, relative to the less skilled. Therefore, when dealing with industry data it was decided to aggregate the service categories in order to account for the larger movements of labour between the goods and service industries[3].

The exception to the aggregation of service industries is the "professional, scientific and technical" services which are thought to contain a much higher ratio of skilled to unskilled workers. More importantly, it was thought that this industry would be directly affected by oil and gas industry growth, as expanding energy activity imposes increased demands on the professional, scientific and technical service industries. For example, legal, accounting and engineering firms would be employed by the oil industry to assist with infrastructure projects.

The relative skill level is much more relevant in the context of occupational as compared to industry data. When dealing with occupational data, many categories cannot be aggregated to the extent possible with industry data. The specific training and schooling required to enter an occupation acts as a barrier to entry for the less skilled labour. As a result, the "management" occupations and "business, finance and administrative" occupations were combined with the "sales and service" occupation

[3] Different forms of aggregation are, of course, possible, depending on the purpose of the study.

category. The other occupations involve significant barriers to entry in the form of education and training, talent, or occupational stability. While the NOC-S occupation data are not separated strictly according to any of these criteria, the aggregation of categories has been made in what is thought to be a reasonable approach. While the NOC-S data set from CANSIM does offer finer detail within the main categories listed in Table 2, this detail comes at the cost of suppressed data. Statistics Canada suppresses data because of concerns over privacy when dealing with small data sets. As a result of this limitation, the more detailed occupational categories have not been used. Instead, the aggregate categories supplied in the CANSIM tables have been used since they contain the least number of suppressed data points.

The "national" growth (reference or provincial growth) is of course the same here, that is, 18% in the first decade and 29% in the second, as was discussed above, for the traditional industry-based version of the shift-share model.

NOC-S Human-Capital Mix

The analogous measurement to the industry mix for occupations is the human-capital mix. The human-capital mix measures growth in each occupational category, and makes it possible to compare the growth rates of certain occupations relative to others. The occupational data can also be compared and contrasted with the industry data in order to gain a more meaningful insight into the forces affecting employment in a given region.

The human-capital mix is the growth of occupations within the province minus the provincial growth. Across Alberta the occupation with the highest rate of growth is

the applied science category, which displayed and increase of approximately 16% in the 1997-2006 period. This is similar to the growth in the professional, scientific and technical industry which also experienced the largest industry growth.

The human-capital mix for the service sector shows almost no change. This hides some significant sub-category changes not revealed in the aggregation used in this study. For example, health-related occupations had the second highest rate of growth at 13% in the period ending in 2006. The government occupation category experienced growth in both the 1987-1996 and the 1997-2006 periods. The trade occupations grew by 7% in the period, 1997-2006. However, sales and arts declined significantly in the same period. Declines in occupational growth unique to the primary industry were 2% in the first decade and 36%, in the second decade. This is partially related to the sharp decline noted in the agricultural industry. However, the primary-industry occupational category also includes some oil-and-gas-related positions. Overall, primary-industry-related occupations only accounted for 6% of total employment in 2006. As a percentage of overall employment, the applied science occupational category accounted for 7.5% of provincial employment. This is very close to the size of the professional, scientific and technical industry category.

The industry mix and the human-capital mix results are not in complete agreement. For instance, for manufacturing the industry mix yields a slight decline which is in contrast to the increase obtained for the human-capital mix. As noted above, the industry and occupational data sets are not directly linked, and therefore it is important not to assume and proceed with a one-to-one mapping of the categories, however related they may appear. A better approach is to use the data from each to supplement the other

when analysing the particular region. Tables 8 and 9 report the results based on an attempt to match occupational and industry data to create an activity-mix version of the model using the categories outlined in Table 3. We concentrate on this version of the model in our discussion of the analogue regression.

NOC-S Competitive Share

In the discussion that follows we use the regions of Alberta, as described earlier.

Lethbridge

In the Lethbridge region the competitive share based on occupational data points to growth in excess of 50% for manufacturing occupations, as well as significant growth for the applied-science-related occupations in the period, 1997-2006. Occupations such as trades, health, government, the arts, and sales all declined as did primary industry occupations.

Total employment in the region increased by 20% in the period extending from 1996 to 2006. The manufacturing occupations showed an increase in share of total employment from 5% in 1996 to 7.3% in 2006. The primary-industry occupations displayed a decline in share of overall employment, falling from 17% in 1996 to 11% in 2006. Applied science occupations experienced an increase in share of total employment from 2.9% in 1996 to 4.4% in 2006, as a result of the human-capital-mix growth.

Camrose

In the Camrose region, the competitive share based on human capital displayed positive growth at 34% for manufacturing occupations between 1997 and 2006. Overall employment in Camrose increased by 15%. Total employment by occupation revealed a modest gain between 1996 and 2006 for occupations such as applied science and

government which accounted for a 3.3% and 7.3% share of total employment respectively in 2006. The employment share for the trades occupation increased from 17% in 1996 to 19.7% in 2006.

The primary-industry share of employment declined from 26% in 1996 to 20% in 2006. This is similar to the decline in the agricultural industry's share of total employment, which dropped from 23% in 1996 to 14.7% in 2006. Recall that primary-industry occupations employ agricultural, forestry, as well as some types of oil and gas workers. The decline in agricultural workers explains in large part the decline in the primary-industry occupation category.

Finally, the human-capital mix and the competitive share were found to be positive for the trades occupations in Camrose, while the manufacturing occupations displayed the greatest growth in the region in the 1997 to 2006 period.

Banff

In the Banff region, the competitive share declined in the second ten-year period for manufacturing occupations (-16%), trade-related occupations (-25%), service occupations (-17%), and applied science occupations (-26%). The only occupation that showed an increase was the primary industry category (165).

Red Deer

The occupational data for Red Deer confirm the region’s industrial employment change. The sales and service occupation category increased by over 15% from 1996 to 2006. Employment in the trades occupations increased by 33%, and in the primary-industry occupations decreased by over 16% from 1996 to 2006.

The competitive share displayed an increase of more than 18% for manufacturing

occupations from 1997 to 2006 while the overall share of employment was just 5% in 2006.

Athabasca

While the tar sands of northeast Alberta are already under production, the tar sands are just beginning to be exploited in the Athabasca region. In 2006, the oil and gas industry accounted for 13% of total employment, up 3% from 1996. The competitive share based on industry data for the oil industry was positive in both the 1987-1996, and the 1997-2006 periods. However, based on occupational data, the competitive share was negative in the two periods.

It is interesting to note that despite the increase in the competitive share for the professional and scientific industry, there was a decrease in the competitive share for the applied science occupations. The health, government, sales, trades, and manufacturing occupations all showed a negative competitive share. The declining competitive share for almost all occupations is perhaps indicative of the skilled-labour shortage in the region.

In terms of overall employment, trades and sales increased the most over the two periods, with sales and trades occupations at 43% and 24%, respectively, employing the largest share of workers in the region over both periods.

Overall, the working population in the Athabasca region increased by 15.7%, between 1996 and 2006.

Cold Lake

Both the Athabasca and Cold Lake regions showed similar proportions in relation to overall employment by occupation in the time periods considered. Sales, trades and

primary industry represented the three largest occupations by employment. In comparison to all other regions, the trades occupations in Cold Lake accounted for the largest proportion of total employment. The competitive-share component for primary-industry occupations increased by more than 100% in the second decade. It is interesting to note that the competitive share for the sales occupational category was lowest in the Cold Lake, Athabasca, and Camrose regions.

Calgary and Edmonton

Calgary and Edmonton, the two major urban centres in Alberta, are remarkably different. Calgary is growing rapidly in many industries, and Edmonton shows a pattern of regional decline in all industrial categories, and most occupational categories.

Both cities accounted for the highest ratio of people employed in health-related and manufacturing occupations and a similar number of people employed in sales occupations. As the provincial capital, it is not surprising that Edmonton has more people in government-related occupations. More interesting, however, is that Calgary has 11% of the region's total workforce employed in applied science occupations, while Edmonton has only 6.8%. This likely reflects Calgary's position as the primary location for businesses and especially the head offices for energy sector companies.

The competitive share increased for all except the trade occupations in the Calgary region. Services at 12% and primary-industry occupations at 20% experienced an increase in the competitive share in the second decade. The competitive share for the applied sciences occupations at 19% also demonstrated strong positive growth in the second ten-year period. Applied sciences represented the third largest employment category by occupation after the trades and aggregated sales and service occupations.

Edmonton showed a decline for all the occupation-based competitive-share components, except for trades in the second decade and primary-industry occupations in the first. There were significant declines in applied sciences (-24%), services (-12%), and manufacturing occupations (-21%) in the decade from 1997 to 2006.

Activity-Mix Using Linked Industry Occupation Data

As previously discussed, in using actual labour-force survey data, it is possible to link data to specific activities by combining industry and occupational data into activity pairs. Table 3 shows the activity matrix employed in this study. These pairs have been selected because they were thought to provide an acceptable representation in all regions.

The approach taken is to focus on the activities relevant to the analysis which also had a sufficient number of people employed in the particular activity. The remaining occupation-industry pairs have been combined into a miscellaneous remainder variable which could be constructed by industry, or by occupation. The results reported in this paper for the remainder categories are industry-based. Table 8 reports the reference area's growth and activity-mix components for the same two periods considered throughout. Table 9 contains the competitive-share components based on the activity-mix version of the model. The results obtained for the activity-mix version are similar to those discussed above, except that this breakdown shows greater variation as compared to using the more aggregated occupational data.

4.1 Regression Results

The analogue regression version of the shift-share model, as developed in section 3, has been applied to all three versions of the shift-share model. The results using the

industry data, the occupation data, and the linked industry-occupation data are reported in Tables 10, 11, and 12, respectively,

The regression results are generally consistent with each other and with the findings from the traditional shift-share analysis presented above. All the regressions have been estimated using the twenty-year period (1987 to 2006), but the number of observations varies considerably because of the number of industry, occupation or industry-occupation-linked observations available.

The activity-mix regression (Table 12) indicates the national growth to be 4.8% annually for the province of Alberta. The time trend, which has been included to capture the increase in growth in the second half of the period noted in the traditional analysis above, is not significantly different from zero. Looking at the regional dummy variables, we find that only the Edmonton region shows a growth rate significantly different from the provincial average. Employment growth in the Edmonton region is estimated to be about 1% less than the provincial average, or about 4%.

The industry-occupation link effects point to some interesting observations. For example, above we note that primary and service-sector occupations showed little aggregate effects. However, here we note that primary occupations linked to agriculture reveal growth significantly less than the average, while growth for primary occupations linked to the oil and gas sector is significantly above average. While the estimated growth for almost all service occupations is below the average, only those in general services and public administration is significantly so. Trades in the general service sector are found to have a growth rate below the provincial average.

The residual, "other occupations" categories indicate significantly positive growth

for science and technical services. Growth significantly below the provincial average is found for the oil and gas and public administration sectors. This negative activity-mix effect for the oil and gas sector is surprising, given that Alberta's growth is being driven by the energy sector. However, the estimated growth for the residual category, while below average, is positive. Also, the growth in the primary occupations linked to the oil and gas sector is estimated to be more than 10% per annum.

5. Conclusions and Policy Recommendations

The main contribution of this paper has been to illustrate the use of Statistics Canada sub-regional occupational employment data in place of, or in addition to, the use of industrial employment data in the shift-share analysis of regional economic development. We have performed this analysis using both the traditional shift-share decomposition and the regression analogue modeling approach to examine development and growth opportunities in regions across Alberta.

As an example of this procedure, this paper has examined the impact of a thriving energy sector on employment growth in various occupations and industries within the regions of Alberta. The major findings are that growth has been fairly balanced across the various regions of Alberta, with only the Edmonton region showing a significantly different rate of growth over the period. At the occupational level, we find that growth of most service occupations and occupations unique to agriculture and public administration have been significantly lower than the average rate of growth for the Albertan economy, while primary occupations in the oil and gas sector and professional scientific and technical services have grown faster than average.

The various forms of shift-share analysis undertaken in relation to both industry and occupational data are important in that they provide the basis for formulating and implementing economic development policies directed at the retention, expansion, creation and attraction of business activity while addressing labour requirements unique to regions across Alberta.

Table 1: NAIC-S Industry Categories and Explanations

Agriculture [1]	The agriculture category covers crop and animal production, as well as the NAIC-S categories for forestry and fishing.
Oil and Gas [2]	The oil and gas category includes employment in the mining industry, as well as oil and gas extraction.
Construction [4]	The construction category encompasses residential, heavy civil engineering construction, trade contractors and all their various sub-trades.
Manufacturing [5]	The manufacturing category covers food, textiles, as well as petroleum refineries and coal products. Resins, plastics and petrochemicals, primary metal manufacturing and computer manufacturing are also included.
Professional, scientific and technical services [9]	The professional, scientific and technical services category includes many highly skilled professional groups such as lawyers, accountants, managers, and scientific researchers. Also included are advertisers, and public relations firms.
Services [s]	The services category is by far the largest industry category measured by employment. Included in this category are wholesale trade, transportation, utilities, business services, education, health, information and culture, accommodation and food services, and other services.
Public Administration [16]	The public administration category includes federal government and provincial government employees. It also includes local, municipal, and regional public service employees, as well as aboriginal administration.

Table 2: NOC-S Occupation Categories and Explanations

Natural and applied sciences [8]	The natural and applied sciences category includes professional occupations in natural and applied sciences, as well as technical occupations related to applied sciences.
Services [s]	The services category includes management occupations, business occupations, sales and services, health, social sciences, public administration, arts and culture.
Trades and transport [22]	The trades and transportation category includes construction trades, contractors, machinists, mechanics, and heavy equipment operators.
Occupations unique to primary industry [28]	The primary-industry category includes occupations in agriculture (excluding labourers), forestry, fishing and mining and gas.
Occupations unique to processing, manufacturing [29]	The processing and manufacturing category includes supervisors, assemblers, machine operators, and labourers employed in manufacturing.

Table 3: Industry-Occupational Categories Used for the Activity-Mix Components

	Agriculture [1]	Oil & gas [2]	Construction [4]	Manufacturing [5]	Professional scientific & technical services [9]	Services-producing sectors [s]	Public administration [16]
Natural and applied sciences and related occupations [8]					8-9	8-s	
Sales and service occupations [s]		s-2			s-9	s-s	s-16
Trades, transport and equipment operators [22]			22-4			22-s	
Occupations unique to primary industry [28]	28-1	28-2					
Occupations unique to processing, manufacturing and utilities [29]				29-5			
All other occupations in given sector [a]	a-1	a-2	a-4	a-5	a-9	a-s	a-16

Table 4: National-Growth and Industry-Mix Components

	1987-1996	1997-2006
National Growth Rate (Alberta total)	0.18	0.29
Industry-mix		
Agriculture	-0.12	-0.69
Oil & Gas	-0.02	0.31
Construction	0.22	0.53
Manufacturing	-0.02	-0.14
Science & Technical Services	0.2	0.38
Services	0.01	-0.02
Public Administration	-0.28	-0.18

Table 5: **NAIC-S** Competitive-Share Components

1987-1996	Lethbridge	Camrose	Calgary	Banff	Red Deer	Edmonton	Athabasca	Cold Lake
Agriculture	-0.07	-0.01	-0.1	0.47	0.44	0.05	-0.07	-0.4
Oil & Gas	-0.14	0.24	-0.2	-0.17	0.85	0.34	0.72	-0.12
Construction	-0.1	-0.38	0.07	0.22	-0.03	-0.05	0.4	-0.1
Manufacturing	-0.04	-0.41	0.19	0.21	-0.46	-0.15	0.76	0.24
Science & Technical Services	0.9	-0.12	0.08	2.06	0.53	-0.2	-0.2	-0.27
Services	0.04	0.09	0.05	0.34	-0.17	-0.09	0.18	0.13
Public Administration	0.25	-0.06	0.09	-0.23	0.1	-0.09	-0.04	0.31
1997-2006	Lethbridge	Camrose	Calgary	Banff	Red Deer	Edmonton	Athabasca	Cold Lake
Agriculture	-0.18	0.15	0.03	0.2	0.03	-0.09	-0.11	0.86
Oil & Gas	3.38	0.29	0.01	-0.7	-0.31	-0.44	0.19	-0.7
Construction	-0.22	-0.01	-0.11	0.36	0.18	0.25	-0.32	-0.13
Manufacturing	0.25	-0.09	0.05	-0.31	0.56	-0.13	-0.01	-0.05
Science & Technical Services	1.26	0.33	0.18	-0.49	-0.22	-0.36	0.16	0.21
Services	-0.03	-0.01	0.11	-0.15	0.13	-0.11	0.04	-0.01
Public Administration	-0.03	-0.12	-0.25	0.23	1.21	0.17	-0.18	-0.2

Table 6: National-Growth and Human-Capital-Mix Components

	1987-1996	1997-2006
National Growth Rate (Alberta total)	0.18	0.29
Human-capital-mix		
Services [s]	0.01	0.01
Applied Science [8]	-0.06	0.16
Trades [22]	0.00	0.07
Primary-industry occupations [28]	-0.02	-0.36
Manufacturing [29]	0.02	0.01

Table 7: **NOC-S** Competitive-Share Components

1987-1996	Lethbridge	Camrose	Calgary	Banff	Red Deer	Edmonton	Athabasca	Cold Lake
Services [s]	0.07	-0.04	0.04	0.32	-0.18	-0.08	0.22	0.13
Applied Science [8]	0.03	-0.14	0.07	-0.21	-0.02	-0.12	0.56	-0.07
Trades [22]	-0.06	0.14	0.04	0.04	0.16	-0.1	0.14	0.05
Primary-industry occupations [28]	-0.1	-0.01	-0.02	0.33	0.45	0.03	-0.09	-0.33
Manufacturing [29]	-0.13	-0.46	0.22	0.31	-0.2	-0.1	0.46	-0.45
1997-2006	Lethbridge	Camrose	Calgary	Banff	Red Deer	Edmonton	Athabasca	Cold Lake
Services [s]	0.00	-0.07	0.12	-0.17	0.15	-0.12	0.02	0.00
Applied Science [8]	0.47	0.23	0.19	-0.26	-0.29	-0.24	-0.34	-0.11
Trades [22]	-0.02	0.05	-0.05	-0.25	0.33	0.03	0.03	-0.1
Primary-industry occupations [28]	-0.14	0.02	0.2	0.16	-0.16	-0.07	-0.1	1.05
Manufacturing [29]	0.56	0.3	0.07	-0.16	0.18	-0.21	-0.28	0.06

Table 8: National-Growth and Activity-Mix Components

	1987-1996	1997-2006
National Growth Rate (Alberta total)	0.18	0.29
Activity-mix		
8_9	0.61	0.46
8_s	-0.09	-0.12
s_2	-0.07	0.42
s_9	0.06	0.33
s_16	0.03	-0.01
s_s	-0.25	-0.16
22_4	-0.06	-0.04
22_s	0.26	0.57
28_1	-0.11	-0.69
28_2	0.65	0.61
29_5	0.12	0.1
Agriculture	-0.18	-0.66
Oil & Gas	-0.2	0.00
Construction	0.14	0.42
Manufacturing	-0.09	-0.28
Science & Technical Services	-0.05	0.06
Services	-0.01	-0.08
Public Administration	-0.36	-0.26

Table 9: Activity-Mix Competitive-Share Components

1987-1996	Lethbridge	Camrose	Calgary	Banff	Red Deer	Edmonton	Athabasca	Cold Lake
8_9	1.00	-1.1	0.43	-0.38	0.39	-0.47	0.93	-0.29
8_s	-0.36	0.96	0.15	-0.75	0.38	-0.15	0.35	-1.09
s_2	-0.43	0.06	-0.1	-0.52	1.08	0.51	0.88	-0.08
s_9	0.99	0.29	-0.04	2.65	0.81	-0.12	-0.23	-0.16
s_16	0.04	0.00	0.05	0.37	-0.23	-0.08	0.22	0.09
s_s	0.32	-0.18	0.01	-0.13	-01	-0.07	0.1	0.59
22_4	0.01	0.48	-0.02	0.35	0.18	-0.13	0.09	0.38
22_s	-0.17	-0.26	0.13	0.25	0.12	-0.09	0.2	-0.23
28_1	-0.07	0.03	-0.05	0.39	0.4	-0.06	-0.06	-0.4
28_2	-0.74	0.01	0.16	0.4	0.56	0.34	-0.21	-0.53
29_5	-0.16	-0.7	0.33	0.18	-0.43	-0.15	0.73	-0.56
Agriculture	-0.01	-0.41	-0.37	1.44	0.96	0.89	-0.17	-0.7
Oil & Gas	0.06	0.18	-0.21	-0.15	0.59	0.13	1.14	0.01
Construction	0.06	-0.7	-0.07	0.18	-0.33	0.05	1.09	0.45
Manufacturing	0.01	-0.25	0.13	0.22	-0.48	-0.15	0.75	1.05
Science & Technical Services	-0.31	0.74	-0.08	0.00	-0.72	0.85	-1.14	-1.14
Services	0.83	0.37	-0.07	0.36	0.13	-0.12	-0.44	0.7
Public Administration	0.14	0.21	0.27	-0.38	0.64	-0.18	-0.21	-0.12
1997-2006	Lethbridge	Camrose	Calgary	Banff	Red Deer	Edmonton	Athabasca	Cold Lake
8_9	0.97	0.62	0.2	0.35	-0.05	-0.43	0.07	0.36
8_s	0.45	-0.41	0.03	-0.7	0.02	0.03	-0.28	-0.04
s_2	4.32	0.1	-0.03	-0.85	-0.08	-0.13	0.05	-0.07
s_9	1.49	0.34	0.11	-0.57	-0.16	-0.31	0.16	0.13
s_16	-0.03	-0.06	0.14	-0.13	0.08	-0.12	0.03	-0.02
s_s	-0.1	002	-0.28	-0.15	1.22	0.11	0.2	-0.04
22_4	-0.06	0.28	-0.04	-0.18	0.49	-0.07	0.14	-0.02
22_s	-0.32	-0.09	-0.13	0.37	0.06	0.32	-0.14	-0.23
28_1	-0.21	0.17	0.03	0.26	-0.03	-0.06	-0.08	0.84
28_2	2.52	0.06	-0.3	-0.25	-0.11	-0.91	0.47	1.00
29_5	0.44	0.53	0.15	-0.12	0.18	-0.28	-0.24	0.16
Agriculture	0.34	-0.14	0.06	-0.05	1.09	-0.23	-0.36	1.21
Oil & Gas	4.76	0.54	0.23	-0.83	-0.73	-0.18	-0.07	-0.14
Construction	0.21	0.25	-0.04	0.3	0.75	0.1	-0.79	0.4
Manufacturing	0.04	-0.32	0.02	-0.4	0.89	-0.04	0.12	-0.05
Science & Technical Services	-1.35	-0.97	2.00	-1.15	-1.12	-0.33	8.89	0.00
Services	-0.18	0.59	-0.05	-0.21	0.21	-0.01	-0.19	2.14
Public Administration	0.14	-0.35	-0.16	2.11	0.93	0.46	-0.68	-0.35

Table 10: Regression Results: Industry Mix

Constrained linear regression Number of obs = 1064
F(15, 1049) = 8.48 Prob > F = 0.0000 Root MSE = .00196

y	Coef.	Std. Err.	t-statistic
ttrend	**.0013346**	**.0006318**	**2.11**
d_national	**.0214142**	**.0103908**	**2.06**
Lethbridge	-.0067127	.0108454	-0.62
Camrose	-.0021821	.0105458	-0.21
Calgary	.0062853	.0070915	0.89
Banff	.0073219	.0202845	0.36
Red Deer	-.0049784	.0081406	-0.61
Edmonton	**-.0155651**	**.006865**	**-2.27**
Athabasca	.0045134	.0125981	0.36
Cold Lake	.0113178	.0155939	0.73
Agriculture	**-.0561053**	**.0143346**	**-3.91**
Oil & gas	-.0076823	.0209115	-0.37
Construction	**.052862**	**.0172293**	**3.07**
Manufacturing	-.0064757	.0200306	-0.32
Science & technical services	**.0443517**	**.0209405**	**2.12**
Services	-.0022642	.0076592	-0.30
Public administration	**-.0246862**	**.0146123**	**-1.69**

Number of observations=1064

Basic R-Squared = .3123350920870992, r2bar=.3024925600081933

Items in bold are significant at 10% level or greater.

Table 11: Regression Results: Occupation Mix

```
Constrained linear regression Number of obs = 912
F( 14, 898) = 6.48  Prob > F = 0.0000  Root MSE = .00212
------------------------------------------------------------------------------
-------
y           | Coef.                Std. Err.   t-statistic
------------
+-----------------------------------------------------------------
ttrend            | .0014462        .0008946    1.62
d_national  | .017973         .0129343    1.39
Lethbridge    | -.0048394             .0107977    -0.45
Camrose       | -.006663        .0091796    -0.73
Calgary       | .0083174        .0085285    0.98
Banff         | .0062644        .0221428    0.28
Red Deer      | .0000733        .0114576    0.01
Edmonton    | -.0131969         .0062329    -2.12
Athabasca     | .0043509        .0114148    0.38
Cold Lake     | .0056933        .0152444    0.37
Services      | -.0022066             .0245539    -0.09
Natural and applied
 sciences     | .0160218        .0177466    0.90
trades            | .0060445        .0115806    0.52
primary       | -.0304756         .0131524    -2.32
manufacturing     | .0006386        .0220011    0.03
------------------------------------------------------------------------------
-------
Number of observations=912
------------------------------------
Basic R-Squared = .3055203603927549, r2bar=.2946812132862872
------------------------------------
```

Table 12: Regression Results Activity Mix Using Industry Remainders

Constrained linear regression Number of obs = 2736
F(26, 2710) = 7.04 Prob > F = 0.0000 Root MSE = .00092

y	Coef.	Std. Err.	t-statistic
ttrend	.000184	.0005574	0.33
d_national	**.0480243**	**.0097894**	**4.91**
Lethbridge	-.0040802	.0094128	-0.43
Camrose	-.0042384	.0085116	-0.50
Calgary	.0033434	.0058797	0.57
Banff	.0091139	.016719	0.55
Red Deer	-.0046612	.0079171	-0.59
Edmonton	**-.0109306**	**.0055313**	**-1.98**
Athabasca	.0023026	.010683	0.22
Cold Lake	.0091505	.0140147	0.65
dy_8_9	.0281298	.0196449	1.43
dy_8_s	-.0031525	.0274828	-0.11
dy_s_2	-.0151383	.0279577	-0.54
dy_s_9	-.0076195	.0235634	-0.32
dy_s_s	**-.0223329**	**.0070243**	**-3.18**
dy_s_16	**-.0345978**	**.0160404**	**-2.16**
dy_22_4	.0107864	.0135903	0.79
dy_22_s	**-.0276516**	**.0133685**	**-2.07**
dy_28_1	**-.0451379**	**.0164584**	**-2.74**
dy_28_2	**.0572734**	**.0228148**	**2.51**
dy_29_5	-.0011895	.0247206	-0.05
All other occupations in:			
Agriculture	-.0069477	.0400128	-0.17
Oil & gas	**-.0376327**	**.0194793**	**-1.93**
Construction	.0051786	.0205619	0.25
Manufacturing	-.0255155	.0181476	-1.41
Science & technical services	**.1834331**	**.0618308**	**2.97**
Other sevices	-.0147005	.0288573	-0.51
Public administration	**-.0431849**	**.0248562**	**-1.74**

Number of observations=2736

Basic R-Squared = .2898162158699461, r2bar=.2830001293482106

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