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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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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 utilised. For all versions of the model, the regression analogue is used to estimate and test changes in eight regions across Alberta, Canada.

Key Words: Shift-share model, regional employment patterns, regression analogue.

JEL Codes: J21, J62, R12.

Résumé. Les changements régionaux de l'emploi dans une économie prospère des ressources naturelles: Une régression analogue de base de l'analyse modifiée du transfert de la répartition de la croissance des changements de courbe d'emploi dans les régions économiques d'Alberta.
Cet article cherche à expliquer comment le secteur prospère d'énergie canadienne en Alberta a eu un effet sur les taux de croissance de l'emploi dans les divers occupations et industries des régions de la province. Pour cela, nous employons la méthode traditionnelle d'analyse du transfert de la répartition de la croissance et un modèle de base de l'analyse du transfert de la répartition de la croissance basé sur des données d'emploi catégorisées par occupations plutôt que sur les données conventionnelles d'industrie. Nous utilisons aussi une version qui combine les deux séries de données. Pour toutes les versions du modèle, nous appliquons une régression analogue pour estimer et vérifier les changements dans huit régions d'Alberta.

Dans cette étude, l'analyse du transfert de la répartition de la croissance va au delà de l'application conventionnelle qui évalue les performances des industries car elle considère l'impact de la croissance ou de la décroissance régionale de l'économie par catégories d'occupations particulières. Nous calculons les taux provinciaux de croissance comme auparavant, et ensuite nous calculons la croissance de l'emploi qui se serait produite si la croissance avait égalé celle des professions de l'économie de référence, ce que nous appelons « l'effet de capital humain ». Ceci nous permet donc de calculer un effet de compétitivité pour chaque région après avoir considéré les effets de croissance dans la province et aussi par professions.

La version finale du modèle combine les données et joint l'effet de l'ensemble des industries à l'effet de capital humain pour produire un seul modèle. Nous offrons en outre les versions analogues par régression de tous les modèles pour tester les différences entre les diverses versions du modèle.

Mots clés : Modèle traditionnelle d'analyse du transfert de la répartition de la croissance, patrons d'emploi régional, modèles analogues par régression.

Codes JEL : J21, J62, R12.

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 province of Alberta 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. The rise in the level of activity in Alberta's energy sector has supported growth opportunities realised by other provincial industries, for example, the growth of metal and fabrication industries responsible for supplying materials to the oil and natural gas industries.

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 utilising 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 organised as follows. In the next section, 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. We analyse the results in the following section, while in the final section we summarise the findings and suggest some policy implications arising from the analysis.

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) criticise 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. These five areas of criticism have been demonstrated to be of limited concern by numerous studies, including Chalmers and Beckhelm (1976), Fothergill and Gudgin (1979), Andrikopoulos, Brox and Carvalho (1987, 1990), Ireland and Moomaw (1981), Rigby and Anderson (1993), Ashby (1968), Esteban (2000), McDonough and Sihag (1991), Paraskevopoulos (1971, 1975), Danson, Lever and Malcolm (1980), Arcelus (1984), Loveridge and Selting (1998), and Keil (1992).

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:

$$N^r = E_i^r g^n \tag{1}$$

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

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

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 i^{th} industry, E_i^r, times the regional rate of employment change in the i^{th} industry, g_i^r, less the national rate of employment change in the i^{th} 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. Utilising these new data provided by Statistics 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: http://www.alis.gov.ab.ca/wageinfo/). 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.

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 organised according to the North American Classification System (NAIC-S). Occupation data are drawn from CANSIM

Table 282-0063 and organised according to the National Occupational Classification for Statistics (NOC-S) standard. Both tables provide annual data sets.[1]

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

$$Y = (EU + EV + EH + EW)\,\beta + \varepsilon \tag{4}$$

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 normalised 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:

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

and

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

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.

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

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 heteroscedasticity. In this case, the shift-share regression is weighted by the total employed population of Alberta. In addition to WLS, heteroscedasticity-robust standard errors are used, as suggested by Wooldridge (2006).

Patterson's model, modified for human capital mix, is:

$$Y = (EU + EV + EH + EW)\,\beta + \varepsilon \tag{7}$$

The addition of occupation data (h) alters the dimensions such that:
Y is [*irh*×1], E is [*irh*×*irh*], and U, V, H, W are [*irh*×(*n*+*i*+*r*+*h*)] and β is [(*n*+*i*+*r*+*h*)×1] where *Y* is the change in employment in each industry and region over time; *E* is employment weights of dimension *irh*×*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:

$$\frac{\Delta \mathrm{Eir}}{\mathrm{E_{Al}}} = \frac{E_{ir}(U + V + W)\beta}{\mathrm{E}_{Al}} + \mu \tag{8}$$

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.

Analysis

Traditional Shift-Share Analysis

The traditional shift-share model is based on the standard industrial mix classifications including: agriculture; oil and gas; construction; manufacturing; professional, scientific and technical services; and public administration. The occupational classifications utilised for the human-capital-mix analysis consist of: natural and applied sciences; services; trades and transport; occupations unique to primary industry; and occupations unique to processing, manufacturing. 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 1 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 analysed 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. 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 2.

TABLE 1 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 administraton [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

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.

TABLE 2 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

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 affecting employment which can range from regional policy to natural endowments. The calculations for the competitive shares for the various regions are reported in Table 3.

TABLE 3 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

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 competitive 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[2].

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 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, 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. As shown in Table 4, across Alberta the occupation with the highest rate of growth is the applied science category, which displayed an 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.

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

TABLE 4 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

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 6 and 7 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 1. We concentrate on this version of the model in our discussion of the analogue regression.

NOC-S Competitive Share: The results for the competitive share based on occupational data as presented in Table 5 vary between regions. For instance, the competitive share displayed positive growth for: manufacturing occupations in Lethbridge and Camrose; primary-industry occupations in Banff and especially Cold Lake which experienced significant growth in the 1997-2006 period; applied-science related occupations in Lethbridge; and the sale and service, as well as the trade occupations in Red Deer.

Calagry and Edmonton are remarkably different. In Calgary the competitive share increased for all except the trade occupations, whereas in Edmonton the competitive share

declined for all occupations except trade in the second decade and primary-industry in the first decade.

TABLE 5 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

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 6 reports the reference area's growth and activity-mix components for the same two periods considered throughout. Table 7 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.

Regression Results

The analogue regression version of the shift-share model, as developed in section 2, 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 8, 9, and 10, respectively.

TABLE 6 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

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 10) 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%.

TABLE 7 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

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.

TABLE 8 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**

Note: 1) Number of observations=1064; 2) Basic R-Squared = .3123350920870992, r2bar=.3024925600081933; 3) **Items in bold are significant at the 10% level or greater.**

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.

TABLE 9 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

Note: 1) Number of observations=912; 2) Basic R-Squared = .3055203603927549, r2bar=.2946812132862872

Conclusions and 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.

TABLE 10 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 Services	| -.0147005	.0288573	-0.51
Public Administration	**| -.0431849**	**.0248562**	**-1.74**

Note: 1) Number of observations=2736; 2) Basic R-Squared = .2898162158699461, r2bar=.2830001293482106

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.

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