Regional Productivity Change in Canadian Manufacturing: A Multifactor/Shift-Share Approach*

Mustafa Dinc
World Bank
Washington D.C.
20433

Kingsley Haynes
Institute of Public Policy,
George Mason University
Fairfax, VA 22030

William P. Anderson
Department of Geography
Boston University
Boston, MA 02215

The arrival of the "Information Age" has tended to change economic structures of countries significantly. Increasing international economic integration, technological advancements and modernisation has played a fundamental role in changing economic as well as political systems. Since the 1960s, manufacturing sector's growth has slowed particularly in western economies while the share of the service sector has been increasing. The Canadian economy has had its share of restructuring related to the change in the rate of growth of output and capital across these sectors. In addition to slow output growth, strong gains in labour productivity has had a significant influence on manufacturing employment in most industrialised countries (Rigby and Anderson 1993). Despite this slowdown the manufacturing sector in many countries, including Canada, still generates a significant portion of the gross domestic product, and provides a large number of well paying jobs. Manufacturing also plays a crucial role in regional development, we all recall the competition among the US states to locate or relocate large manufacturing companies within the state. Therefore, it becomes an important task for policy makers to understand the causes of the change in manufacturing employment. There are several approaches to investigate structural sectoral change in a regional economy, and one of them is the well known shift-share analysis.

This paper examines the foundations of economic performance and employment change in manufacturing for the provinces of Canada by employing an extension of shift-share analysis. This extension of shift-share takes account of the impact of output and productivity change on manufacturing employment as well as non-labour factors' effects in investigating industrial and regional differences.

The first section of the paper describes the traditional shift-share model. Extensions by Rigby and Anderson (1993) and Haynes and Dinc (1997), both of which adjust for variations in productivity growth, are discussed in the second section. The third section sheds light on some data problems. The fourth presents and interprets results for the Canadian provinces, comparing results from the two extended models.

Shift-Share Basics

Shift-share analysis is a sectoral decomposition procedure widely used by regional economists, geographers, regional scientists and regional development analysts. Because of its simple formulation and modest data requirements, shift-share continues to be one of the most popular techniques for examining regional growth and decline. The traditional shift-share model examines economic change in a region by decomposing it into three additive components: the reference area component, the proportionality shift and differential shift (Dunn 1960). It has been applied most frequently to decompose employment changes, but it can also be applied to changes in income, value added, number of establishments or a variety of other measures of the level of economic activity.

The following notation is used in the equations. E_{irt}, is employment in sector i of region r at the beginning of a time interval extending from t to t+1. The rate of growth over the same time interval in employment in industry i of region r is $g_{ir} = (E_{ir(t+1)} - E_{irt})/ E_{\text{irt}}$ (a negative rate indicates decline). The rate of growth of employment in industry i in the reference area, n, is gin $= (E_{in\ (t+1)} - E_{int})/ E_{int}$. (The reference area is generally the nation, but for smaller area analysis it may be a state or province.) The rate of growth of all industries combined in the reference area is g_n.

The reference area component (or "national share") of regional employment growth is the growth that would occur if employment in all sectors of region r grew at the overall national rate:

$$NS = \sum_i E_{irt} g_n \quad (1)$$

The proportionality shift (industrial mix, composition shift or structural effect) is that component of employment growth that is due to regional specialisation in industries that are fast-or-slow-growing nationally. Thus, a region that contains a relatively large share of industries that are slow (fast) growing nationally will have a negative (positive) proportionality shift.

$$PS = \sum_i E_{irt}(g_{ir} - g_n) \quad (2)$$

The differential shift (regional share or competitive effect) is the component that is due to regional industries growing faster or slower than their national counterparts. This component is positive or negative due to locational advantages or disadvantages that affect the performance of individual industries. Even though we do not always know what these advantages or disadvantages are, we can determine by looking at the differential shift component which industries are performing particularly well in the region.

$$PS = \sum_i E_{irt}(g_{ir} - g_n) \quad (3)$$

The three components sum to the total shift, which is the actual growth or decline in employment.

$$TS = NS + PS + DS$$
$$TS = \sum_i E_{ir} g_n + \sum_i E_{ir}(g_{in} - g_n) + \sum_i E_{ir}(g_{ir} - g_{in}) \quad (4)$$

Since the introduction of the model in 1960 it has gained widespread acceptance as a practical tool. At the same time, it has been heavily criticised. These criticisms concentrate on such issues as temporal, spatial and industrial aggregation, theoretical content and predictive capabilities (Knudsen and Barff 1991). But the criticisms have spawned various efforts to address the weaknesses of the traditional shift-share model. For a detailed literature review and evaluation of the criticisms see Stevens and Moore (1980), Qiangsheng et al (1997) and Dinc et al (1998). The discussion that follows focuses on a particular weakness of the traditional shift-share formulation: its inability to account for regional and industrial differences in productivity growth.

Model Development

The Rigby-Anderson Extension

Rigby and Anderson (1993) argued that the traditional shift-share model measures the combined effects of output growth and productivity change on employment. For example a positive value of PS may be found in a region where output growth for most sectors is more rapid than at the national level, while productivity growth in industries is equivalent to the corresponding national rate. A positive value may also occur where output growth in each sector is equivalent to the corresponding national rate but growth in the average product of labour is *slower* than at the national rate for most sectors. The former is an indication of good economic performance, but the latter is not. Thus regional performance cannot be unambiguously evaluated. To overcome this problem, they extended the basic shift-share method to separate the effects of changes in output and productivity on employment.

In their extension Q_{irt} represents output in industry *i* in the region *r* at time *t*, then qirt represents average labour productivity in industry *i* in the region at time *t*.

$$q_{irt} = \frac{Q_{irt}}{E_{irt}} \quad (5)$$

The change in employment anticipated in industry *i* in the region over the given time period, if productivity remains constant and output changes as observed, is

$$A_{ir} = \frac{(Q_{ir(t+1)} - Q_{irt})}{q_{irt}} \quad (6)$$

The potential change in employment in industry *i* in the region resulting from variations in productivity with output constant is

$$B_{ir} = \frac{Q_{ir(t+1)}}{q_{ir(t+1)}} - \frac{Q_{ir(t+1)}}{q_{irt}} \quad (7)$$

In relative terms $a_{ir} = A_{ir} / E_{irt}$ represents the rate of employment change in industry i in the region resulting from variations in output over the given time period with productivity constant; $b_{ir} = B_{ir} / E_{irt}$ represents the rate of employment change in industry *i* in the region resulting from variations in productivity over the given time period with output constant. Then, $g_{ir} = a_{ir} + b_{ir}$ and these rates of change may be defined at the level of industry, the region or the nation. Given these definitions, components of employment growth are redefined as follows.

$$TS = TS(a) + TS(b) = \sum_i E_{irt}[(a_{ir} - a_n) + (b_{ir} - b_n)] \quad (8)$$

$$PS = PS(a) + PS(b) = \sum_i E_{irt}[(a_{in} - a_n) + (b_{in} - b_n)] \quad (9)$$

$$DS = DS(a) + DS(b) = \sum_i E_{irt}[(a_{ir} - a_{in}) + (b_{ir} - b_{in})] \quad (10)$$

Rigby and Anderson applied this model to data for manufacturing industries in Canadian provinces over the period 1961-1986, yielding significant insights over the conventional model. For example, their results differentiated regions such as Quebec that had slow employment growth due primarily to slow output growth from regions such as British Columbia that had slow employment growth due primarily to rapid productivity growth.

The Interaction Problem

The productivity issue is not new in regional economic analysis, even in the shift-share framework. Ledebur and Moomaw (1983) used the shift-share model to compare regional labour productivity in the manufacturing sector of various regions in the U.S by substituting productivity and productivity change for employment and employment change in the traditional shift-share model.

Like Rigby and Anderson (1993), Ledebur and Moomaw (1983) define labour productivity in its most common form: the ratio of output to labour input (commonly called the average product of labour.) They ignore other factors of production such as capital, technology, infrastructure and material inputs. This is important because "when two or more distinct inputs, or factors of production, work together in producing a common output, it may be (and often is) misleading to concentrate on the productivity of one input to the neglect of the others. A high measured productivity of input a (labour) in producing an output *x* may result from wasteful overuse of one or more cooperant inputs *b, c*,..(machine, land ....)" (Bronfenbrenner 1985: 97). In other words, rapid growth in the average product of labour may reflect growth in capital or some other input, rather than any "pure" increase in the quality of labour.

Consider a hypothetical economy with a fixed labour force of constant skills and standards of performance. In this economy, any investment in equipment or any technological change will result in an increase in output. Where this occurs, labour productivity increases, even though the contribution of labour to this improvement in performance is zero. In this case the contribution of

capital or technology is being implicitly misattributed to labour. Further consider two different regions with the same levels of capital, labour, land and technology, but one of which has more or better infrastructure. Munnel and Cook (1990), Lynde and Richmond (1992) and Andrews and Swanson (1995) found that infrastructure has a positive and statistically significant impact on production. Thus we would expect the region with better infrastructure to have higher output than the other region. Since both regions have the same labour input, one regions will have higher labour productivity, despite the fact that it is infrastructure, and not labour factors, that accounts for the difference in economic performance.

This issue is particularly relevant to the Rigby and Anderson (1993) extension of shift-share. Various changes in factors of production may occur over the study period in a region or regions under consideration. The output of a lagging region may increase due to new investments in infrastructure or new plants and equipment, or due to investments in education and training programs that increase the productive capacity of labour. The Rigby-Anderson model is not able to distinguish between these two types of output enhancements. Therefore, the results of this model should be interpreted with caution, and could even be misleading in cases where massive investments in capital are reflected in productivity growth.

Haynes-Dinc Formulation

To improve the Rigby and Anderson extension, Haynes and Dinc (1997) separated labour's contribution to productivity from that of other inputs by employing the total factor productivity (TFP) approach (see Kendrick 1961, 1973, 1983, 1984). Their concern was the relationship between output and inputs (in particular, labour input), in real terms, over time in a dynamic economy. Therefore, their basic objective was to measure the impact of labour productivity on production and employment change as distinct from the impacts of changes in other inputs. The TFP approach provides a simplified way of doing this.[1]

In the TFP approach, productivity is defined as the relationship between output of goods and services and the levels of various inputs. This is usually expressed in ratio form, i.e. the ratio of aggregate output to linear combination of input levels. Output is measured as the combined market value of all goods and services produced. The inputs are weighted by their shares in total costs in constant prices.[2] In the case where there are only two inputs -- capital (K) and labour (L) we have:

$$TFP = \frac{Q}{\alpha E + (1-\alpha)K} \quad (11)$$

where (following the conventional notation of production functions) Y is the total output, *L* and *K* are the quantities of labour and capital inputs, respectively, and α is the weight of the inputs and derived as the estimated shares of factor payments in national (regional) income. At the sectoral level total factor productivity can be calculated as:

$$TFP_i = \frac{Q_i}{\alpha_i E_i + (1-\alpha_i)K_i} \quad (12)$$

where subscript *i* represents the *i*th sector under consideration.
Equation (11) can be rewritten as:

$$\frac{1}{TFP} = \frac{\alpha E + (1-\alpha)K}{Q} \quad (13)$$

$$\frac{1}{TFP} = \frac{\alpha E}{Q} + \frac{(1-\alpha)K}{Q} \quad (14)$$

$$\frac{1}{TFP} = \frac{1}{TFP_L} + \frac{1}{TFP_K} \quad (15)$$

where $1/TFP_L \equiv \alpha E/Q$ and $1/T_{FPK} \equiv (1 - \alpha)K/Q$ are the inverse of labour and capital productivity, respectively. We now rewrite equation (5) to represent TFP rather than just labour productivity:

$$q_{ir}^{*} = \frac{Q_{ir}}{\alpha_i E_{ir} + (1-\alpha_i)K_{ir}} \quad (16)$$

Following (14) and (15)

$$\frac{1}{q_{ir}^{*}} = \frac{\alpha_i E_{ir}}{Q_{ir}} + \frac{(1-\alpha_i)K_{ir}}{Q_{ir}} \quad (17)$$

$$\frac{1}{q_{ir}^{*}} = \frac{1}{q_{irL}} + \frac{1}{q_{irK}} \quad (18)$$

$$\frac{1}{q_{irL}} = \frac{\alpha_i E_{ir}}{Q_{ir}} \quad (19)$$

$$\frac{1}{q_{irK}} = \frac{(1-\alpha_i)K_{ir}}{Q_{ir}} \quad (20)$$

By substituting the new value of qirL and qirK in equations (6) and (7) we can calculate new versions of A_{ir} and B_{ir}.

$$A_{irL} = \frac{Q_{ir(t+1)} - Q_{irt}}{q_{irL}} \quad (21)$$

$$A_{irK} = \frac{Q_{ir(t+1)} - Q_{irt}}{q_{irK}} \quad (22)$$

$$B_{irL} = \frac{Q_{ir(t+1)}}{q_{irL(t+1)}} - \frac{Q_{ir(t+1)}}{q_{irLt}} \quad (23)$$

$$B_{irK} = \frac{Q_{ir(t+1)}}{q_{irK(t+1)}} - \frac{Q_{ir(t+1)}}{q_{irKt}} \quad (24)$$

$$a_{irL} = \frac{A_{irL}}{E_{ir}}; a_{irK} = \frac{A_{irK}}{K_{ir}} \quad (25)$$

$$a_{irL} = \frac{A_{irL}}{E_{ir}}; a_{irK} = \frac{A_{irK}}{K_{ir}} \quad (26)$$

Comparing (21) and (23) to (6) and (7), it is evident that $A_{irL} = \alpha_i A_{ir}$ and $B_{irL} = \alpha_i B_{ir}$. Thus (since $\alpha_i < 1$) the absolute value of the component of employment change attributable to labour productivity growth is smaller than in the Rigby-Anderson formulation and increases in the cost share of labour. We can rewrite the shift-share equations to investigate employment change as:

$$TS_L = NS_L + PS_L + DS_L \quad (27)$$

$$NS_L = NS(aL) + NS(bL) = \sum E_{ir}(a_{rL} + b_{rL}) \quad (28)$$

$$NS_L = NS(aL) + NS(bL) = \sum E_{ir}(a_{rL} + b_{rL}) \quad (29)$$

$$DS_L = DS(aL) + DS(bL) = \sum E_{ir}[(a_{irL} - a_{irL}) + (b_{irL} - b_{irL})] \quad (30)$$

and to investigate capital change as:

$$TS_K = NS_K + PS_K + DS_K \quad (31)$$

$$NS_K = NS(aK) + NS(bK) = \sum K_{ir}(a_{rK} + b_{rK}) \quad (32)$$

$$PS_K = PS(aK) + PS(bK) = \sum K_{ir}[(a_{irK} - a_{rK}) + (b_{irK} - b_{rK})] \quad (33)$$

$$DS_K = DS(aK) + DS(bK) = \sum K_{ir}[(a_{irK} - a_{irK}) + (b_{irK} - b_{irK})] \quad (34)$$

Because of the lack of reliable capital stock data at the region and sector level, they estimated non-labour factors' contribution as a residual. To determine the contribution of other factors

(capital, technology, infrastructure raw material etc.) to total productivity, and hence their impact on employment change, they let ΔE be the actual employment change over time in the region, and ΔE_L the employment change resulting from output and labour productivity variations in the region or state. Then they estimated the difference between ΔE and ΔE_L as the employment change resulting from the all production factors' contribution to total labour productivity, ΔE_P. They formulated it as:

$$\Delta E_P = \Delta E - \Delta E_L \quad (35)$$

Analysis

The period of investigation is from 1970 to 1994. However, this period is divided into two sub-periods, 1970-1982 and 1981-1994, because of changes in the definition of Standard Industrial Classification in 1980.[3] The data come from Statistics Canada's publication Manufacturing Industries in Canada (Catalogue number 31-203).

Labour inputs are measured as total manufacturing employment. Output is measured by value added and productivity is defined as output per worker according to the share of labour in the given sector's total value added.[4] The share of labour in income (α) is measured as the ratio of total wages and salaries to sector specific value added. Value added and wage data are in 1992 Canadian dollars.

In some years (particularly in the early 1970s) and in some sectors there are missing data due to disclosure problems associated with the size of the sector in a given province. These missing data are estimated by interpolating or in some years by simply taking the average values of prior and following years.

The estimation of missing data gives rise to another relatively small problem. In the shift-share model, two kinds of data are used to investigate regional and sectoral economic performances. The first is the individual sector's employment, wages or output for a given time in a given region. The second is the whole economy measure or in this case the sum of a group of industries' employment, wages or output in a given province or region for a given time. Theoretically, whole economy employment numbers should at least be equal to but more likely greater than the sum of the individual industries' employment numbers. The latter is likely because of the fact that whole economy numbers include hidden values from disclosures and other undercount reasons. In some provinces, the sum of individual sectors' employment change may not add up to total manufacturing employment change. This may have resulted from exclusion of some sectors such as tobacco, or textile in some provinces, estimation errors of missing data and rounding of numbers. Therefore, results for such provinces need to be interpreted with caution.

The dynamic shift-share approach of Barff and Knight (1988) is adopted. This method calculates components of employment change on an annual basis and aggregates them over the study period. In this way information on year-to-year variations are preserved. Such information is lost in the conventional method which only employs data from the first and final years of the study period.

Results and Interpretation

From 1970 to 1980, manufacturing employment in Canada followed an upward trend, increasing from 1,637,001 in 1970 to 1,855,393 in 1980. Thereafter, despite growth in some years, it followed a downward trend and declined to 1,452,456 in 1994, for an overall decline of 11 % over the study period (Figure 1). Over the same period manufacturing output (value added) in Canada followed an upward trend with pronounced business cycle fluctuations. Until 1991, output grew more quickly than employment, but the two variables tended to track together. From 1991 to 1994, however, output grew to its second highest level, while employment declined to its lowest level for the study period. Thus the overall picture is one of slumping employment accompanied by substantial growth in the average product of labour.

Employment growth patterns varied significantly across sectors (Table 1). From 1970 to 1982, 12 sectors posted net employment growth for a total of 109,340 new jobs. Among them, the largest growth took place in the printing and publishing, machinery, transportation equipment, rubber and plastics, wood and chemical sectors. These sectors accounted for 77 % of the total growth in manufacturing. Declining sectors, on the other hand, lost a total 36,923 jobs during the same period. (Thus the net employment gain was 72,417.) The textile, knitting mills, clothing and leather products sectors had the largest losses, total 27,156 jobs or 74 % of all losses.

FIGURE 1 Indexes of Employment and Value Added in Canadian Manufacturing (1970=100)

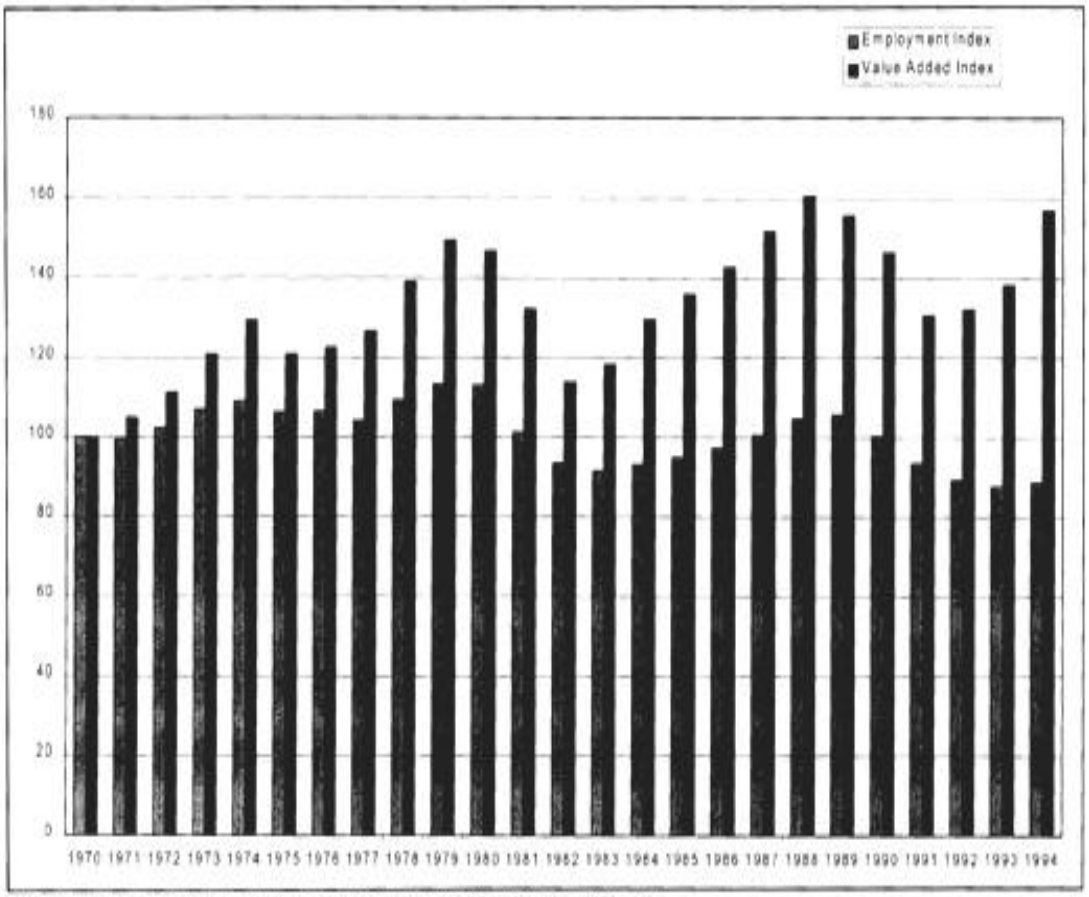

FIGURE 1 Indexes of Employment and Value Added in Canadian Manufacturing (1970=100)

TABLE 1 Employment Change in Canadian Manufacturing Industries

1970-1983		**1981-1994**	
1 Food and Beverage	5178	**10** Food	-6591
2 Tobacco Products	-1281	**11** Beverage	-7420
3 Rubber and Plastic	12887	**12** Tobacco Products	-4144
4 Leather	-5329	**15** Rubber Products	-2853
5 Textile	-10298	**16** Plastic Products	19382
6 Knitting Mills	-5417	**17** Leather and Allied	-14280
7 Clothing	-6112	**18** Primary Textile	-13419
8 Wood	9296	**19** Textile Products	-4779

9 Furniture and Fixtures	5051	**24** Clothing	-32905
10 Paper and Allied	1683	**25** Wood	5412
11 Printing and Publishing	22543	**26** Furniture and Fixtures	-2100
12 Primary Metal Industries	-3330	**27** Paper and Allied	-24372
13 Metal Fabrication	862	**28** Printing and Publishing	15120
14 Machinery	15375	**29** Primary Metal Industries	-41253
15 Transportation Equipment	14675	**30** Fabricated Metal Products	-16499
16 Electrical Products	-3677	**31** Machinery	-13078
17 Non-Mettalic Industries	-1479	**32** Transportation Equipment	28517
18 Pretoleum and Coal	5854	**33** Electrical and Electronic	-28453
19 Chemical and Products	8966	**35** Non-Metallic Industries	-13822
20 Misc. Manufacturing	6970	**36** Refined Petroleum and Coal	-9084
		37 Chemical and Products	-6127
		39 Other Manufacturing	-4243
Total	72417	**Total**	-176991

From 1981 to 1994, the number of growing sectors fell to four, which created 68,431 new jobs while declining sectors lost 245,422 jobs, for a net decline of 176,991 (Table 1). From 1970 to 1994, the printing and publishing, transportation equipment, rubber and plastics and the wood products sectors were the driving growth sectors in Canadian manufacturing. These sectors had net growth in both parts of the study period.

Tables 2 and 3 give the results of the Haynes and Dinc (1997) version of the shift-share model for Canadian provincial data for the periods 1970-1982 and 1981 to 1994 respectively. Here NS, PS, and DS refer to the national share, proportional shift, and differential shift components of employment change, and *a* and *b* indicate that the components are calculated holding labour productivity and output constant respectively. So, for example, NS(a) is the expected growth in employment for each province if the output of all sectors grew at the national rate (a_{nL}) and labour productivity were held constant; and NS(b) is the expected growth if labour productivity for all sectors grew at the national rate (b_{nL}) and output were held constant.

TABLE 2 Aggregate Shift-share Results, 1970-1982

								Total	Total	Actual	Non-Labour
	NS(a)	NS(b)	PS(a)	PS(b)	DS(a)	DS(b)	TS(a)	TS(b)	Shift	Change	Factors
NF	1246	-1204	130	-279	1838	1810	3214	327	3540	3228	-312
PE	279	-271	-8	3	80	121	351	-148	203	26	-177
NS	3904	-3752	925	-1090	4170	-4366	8999	-9208	-209	890	1099
NB	3889	-3754	865	-429	4793	-443	9548	-4626	4921	931	-3990
QP	75140	-72405	-3391	-2650	-7772	-19955	63977	-95009	-31032	-31813	-781
ON	117999	-113225	2680	3985	-4981	-3271	115698	-112511	3187	42333	39146
MN	7081	-6770	-18	-14	7873	-7446	14936	-14229	706	5847	5141
SK	1846	-1720	227	-65	3267	73	5340	-1712	3628	4846	1218
AL	6978	-6533	1173	218	17754	-4516	25904	-10831	15073	28559	13486
BC	19273	-18549	5846	1232	11969	-725	37088	-18042	19046	15904	-3142
Y&N	11	-10	-1	4	-158	-60	-148	-65	-214	-12	202

TABLE 3 Aggregate Shift-share Results, 1981-1994

									Total	Actual	Non-Labour

	NS(a)	NS(b)	PS(a)	PS(b)	DS(a)	DS(b)	TS(a)	TS(b)	Shift	Change	Factors
NF	738	-1898	692	-675	-39	-4898	1391	-7471	-6080	-4338	1742
PE	291	-634	146	-30	667	-283	1103	-947	157	671	514
NS	2243	-5644	1765	-1180	446	-981	4455	-7805	-3350	-3	3347
NB	2326	-5631	1806	-1563	5838	-5133	9970	-12327	-2358	3113	5470
QP	38060	-93199	9057	-13464	8048	-12469	55165	-119132	-63967	-25371	38596
ON	69339	-170078	36359	-22420	-16113	22758	89585	-169740	-80156	-64493	15663
MN	4316	-10567	1484	-933	878	1211	6678	-10289	-3611	-3481	130
SK	1500	-3631	743	-285	2631	-2499	4874	-6415	-1541	1277	2818
AL	6562	-17714	3279	-2297	14760	-6210	24601	-26221	-1619	14101	15720
BC	11155	-29598	18748	-22437	12718	-16641	42622	-68676	-26054	9304	35358
Y&N	--	--	--	--	--	--	--	--	--	--	--

The findings of the analysis reveal that in the first part of the study period, labour productivity had a significant negative impact on employment change, but in most provinces the positive effect of output growth was larger, resulting in a positive total shift. The impacts of non-labour factors were positive in some regions and negative in others. In the second period, the negative effect of productivity growth overcame the positive effect of output growth in all but PEI. In this period, however, non-labour factors played a consistently positive role. As a result four of the ten provinces had employment growth.

At this point it is instructive to consider why the contribution of non-labour factors is sometimes positive and sometimes negative. One kind of positive effect is from the output stimulation due for instance, to capital formation and investment in infrastructure. The Haynes-Dinc model attributes only part of output growth to labour, with the remainder assigned to capital.[5] (Recall from above that when comparing the H-D and R-A models, $A_{irL} = \alpha_i A_{ir}$.) Holding output constant, however, an increase in capital or other non-labour inputs has a substitution effect, whereby the same amount of output may be produced with less labour. Thus, there may be both positive and negative employment effects associated with growth in non-labour inputs. A decline in those inputs levels, as might occur due to scrapping of equipment or plants, or the abandonment of infrastructure components such as railway lines, can also have positive and negative effects due, respectively, to output contraction and substitution of labour for capital. Thus, there is some ambiguity in how we interpret non-labour input effects on growth in employment, which can only be resolved if data on those inputs are observed. (This question is explored further in the technical appendix.)

Between 1970 and 1982, if labour productivity remained constant and output changed with the exception of Yukon and Northwest Territories, all provinces would have increased their manufacturing employment. If output remained constant and productivity varied, with the exception of Newfoundland all provinces would have experienced employment decline in manufacturing which implies that these provinces have improved their productivity. The combined impact of output and productivity change on employment is presented in the tables as Total Shift. In Quebec and Nova Scotia, employment loss resulting from improvement in productivity outpaced employment gain due to output growth. If the only measures were labour productivity and output, provinces of Canada would have the same employment change as shown in the total shift. Instead, they gained (lost) employment with the help of the contribution of other factors such as new entries (exits), investment (under-investment) in capital stock, infrastructure and new technology. The effect of these factors is labeled as Non-labour Factors in Tables 2 and 3.

Table 2 shows that in the first half, non-labour factors had a negative impact on employment change in five provinces and a positive impact on seven provinces. For example, Nova Scotia would have lost 209 jobs in manufacturing if there were no contribution of non-labour factors. Instead, it gained 890 new jobs with the help of the above mentioned other factors. In British Columbia, on the other hand manufacturing sectors would have had 4,921 new jobs instead of 931 if there had been no negative impact of non-labour factors (-3,990). During this period, only Nova Scotia outperformed its national counterparts in terms of output growth and productivity gain. Alberta, New Brunswick, Newfoundland, Manitoba, Saskatchewan and Prairies performed well in output growth, but had greater losses due to productivity gain relative to the nation.

In the second half of the study period, all provinces gained employment in manufacturing due to output growth, and experienced employment decline resulting from productivity improvements. Note that in this period the Yukon and Northwest Territories region is not included because of missing data problems. Employment decline from the productivity effect outpaced employment gains in all regions with the exception of Prince Edward Island. Hence, if the output and productivity effects were the only measures these regions would have lost employment as shown in the total shift. Non-labour factors, however, had a positive impact on manufacturing

employment and saved regions from heavy losses. For example, New Brunswick, Saskatchewan, Alberta and British Columbia would have lost employment. Instead, they all have ended up with net employment gains. In the remaining regions, non-labour factors reduced the magnitude of employment losses. National trends and industry mix of regions had an important role in their overall performance in manufacturing employment.

To have a better understanding of the regional differences we have investigated the four largest manufacturing regions, Quebec, Ontario, Alberta and British Columbia in more detail. Table 4, 5, 6 and 7 show the sources of employment change by sector in these regions from 1970 to 1982 and 1981 to 1994.

Quebec (Table 4a) improved its productivity in all sectors during the study period with the exception of the primary metal sector between 1970 and 1982 period, and had employment loss due to this improvement. In addition, in five sectors in the 1970-1982 period and in four sectors in the 1981-1994 period employment declined due to output decreases. In the first half, Quebec lost total 31,813 employment jobs. In this period, the rubber and plastics, wood, printing and publishing, machinery, transportation equipment, electrical products and the petroleum and coal sectors performed well. In these sectors, Quebec improved its productivity and at the same time output growth and the positive effects of non-labour factors created an overall employment gain. In the food and beverage, tobacco, clothing, paper products, fabricated metal products, chemical products and miscellaneous manufacturing sectors, output growth generated new employment, but decline in employment caused by improvements in productivity and the negative impacts of non-labour factors outpaced this gain. Quebec suffered heavy losses in textile and related sectors resulting from output decline, productivity improvements and the negative impacts of non-labour factors.

In the second period, Quebec (Table 4b) had a similar pattern in sectoral employment change and lost an additional 25,371 manufacturing jobs. In this period, the electrical products and petroleum and coal sectors became declining sectors because of productivity improvements while other growing sectors remained the same. The clothing sector joined the other textile related sectors by having employment losses resulting from all three measures.

Between 1970 and 1982, Ontario (Table 5a) gained 42,333 new manufacturing jobs. In this period in ten sectors, all factors were favourable for Ontario; it improved its productivity, posted output growth and non-labour factors were positive (new investments and entries) and hence it gained employment. In another seven sectors, Ontario losses from productivity growth outpaced its gains from output growth in these sectors. The transportation equipment, printing and publishing, chemical products, rubber and plastics products and furniture and fixtures sectors were the fastest growing sectors in this period. The primary metal, non-metal industries and fabricated metal products sectors were this period's heavy losers.

TABLE 4a Sectoral Shift-Share Results, Quebec, 1970-1982

							Total	Total	Total	Actual	Other
	NS(a)	NS(b)	IM(a)	IM(b)	RS(a)	RS(b)	a	b	Shift	Change	Factors
QUEBEC	75140	-72405	-3391	-2650	-7772	-19955	63977	-95009	-31032	-31813	-781
1 Food and Beverage	8829	-8590	-1112	-3	-2498	-157	5219	-8751	-3531	-5205	-1674
2 Tobacco Products	912	-881	-402	-180	105	-956	615	-2017	-1402	-1828	-426
3 Rubber and Plastic	1857	-1786	595	1401	-1165	204	1288	-181	1107	870	-237
4 Leather	1902	-1859	-1330	-866	-1182	347	-610	-2378	-2988	-4330	-1342
5 Textile	5469	-5319	-3269	14	-3399	1487	-1200	-3819	-5019	-9476	-4457
6 Knitting Mills	2149	-2085	-2834	796	-914	577	-1599	-713	-2312	-4401	-2089
7 Clothing	9910	-9642	-1516	-4719	-3053	852	5341	-13508	-8167	-8176	-9
8 Wood	3304	-3187	1574	2025	1866	-2580	6744	-3742	3001	4125	1124
9 Furniture and Fixtures	2560	-2463	-24	1073	-2545	722	-9	-668	-677	-1510	-833
10 Paper and Allied	6172	-5915	2968	-2729	464	-3637	9605	-12282	-2677	-599	2078
11 Printing and Publishing	3379	-3260	2545	-635	-943	-250	4981	-4145	836	3512	2676
12 Primary	3650	-	-	6144	2815	411	3315	3150	6465	1425	-5040

Metal Industries		3405	3150								
13 Metal Fabrication	5193	-4958	-988	76	658	-4408	4864	-9291	-4427	-2305	2122
14 Machinery	2011	-1878	1092	531	4057	-7056	7161	-8403	-1242	3733	4975
15 Transportation Equipment	4124	-3992	637	-302	4145	-4439	8907	-8733	173	1193	1020
16 Electrical Products	4677	-4493	1110	-5106	-3807	2565	1979	-7034	-5054	-4747	307
17 Non-Metalic Industries	2123	-2030	-1007	1031	-1211	697	-95	-302	-397	-1684	-1287
18 Pretoleum and Coal	475	-451	934	-843	-13	-73	1396	-1366	30	945	915
19 Chemical and Products	4004	-3878	728	-832	-993	-3320	3740	-8030	-4290	-3117	1173
20 Misc. Manufacturing	2440	-2332	57	474	-161	-940	2336	-2798	-463	-238	225

TABLE 4b Sectoral Shift-Share Results, Quebec, 1981-1994

							Total	Total	Total	Actual	Other
	NS(a)	NS(b)	IM(a)	IM(b)	RS(a)	RS(b)	a	b	Shift	Change	Factors
QUEBEC	38060	-93199	9057	-13464	8048	-12469	55165	-119132	-63967	-25371	38596

10 Food	4129	-9766	1485	-527	-2372	3049	3243	-7243	-4000	-1491	2509
11 Beverage	936	-2049	-357	183	375	-595	955	-2461	-1507	-1807	-300
12 Tobacco	--	--	--	--	--	--	--	--	--	--	--
15 Rubber	--	--	--	--	--	--	--	--	--	--	--
16 Plastic	853	-2278	2250	1150	-657	344	2447	-784	1663	4993	3330
17 Leather	558	-1377	-3322	868	239	-436	-2525	-945	-3470	-4253	-783
18 Primary Textile	1224	-2777	-1734	-961	-349	195	-858	-3543	-4402	-4714	-312
19 Textile	1171	-2874	-1309	2003	365	-1180	226	-2052	-1826	-764	1062
24 Clothing	4937	-11474	-10017	4034	-226	-3458	-5306	-10898	-16204	-17457	-1253
25 Wood	2642	-5891	10654	-14036	-961	3603	12335	-16324	-3989	9145	13134
26 Furniture&Fixtures	1186	-2946	-303	1343	385	-1458	1268	-3061	-1793	1110	2903
27 Paper and Allied	3386	-8069	2656	-2395	-4505	5118	1537	-5346	-3809	-7353	-3544
28 Printing & Publishing	2727	-6548	2469	2893	-15	425	5182	-3230	1952	5416	3464
29 Primary	216	-	603	-	791	-	106	-	-	-3646	4692

Metal	5	5450		5230	7	8343	85	19023	8338		
30 Fabricated Metal	2133	-6086	-3346	5510	-201	-761	-1414	-1337	-2751	-1846	905
31 Machinery	1024	-2888	-320	535	1976	-996	2680	-3349	-670	2590	3260
32 Transport Equip.	2718	-7393	9346	-7916	257	-2240	12322	-17549	-5227	3113	8340
33 Electrical&Electronic	2994	-7107	103	-1073	4302	-3199	7399	-11378	-3979	-1240	2739
35 Non-Metallic	976	-2362	-1153	366	577	-697	400	-2694	-2294	-934	1360
36 Petroleum&Coal	147	-473	-158	263	1032	-965	1022	-1175	-153	-2032	-1879
37 Chemical	2153	-5389	1508	-475	-92	-873	3569	-6737	-3169	-1088	2081
39 Other Manufacturing	--	--	--	--	--	--	--	--	--	--	--

TABLE 5a Sectoral Shift-Share Results, Ontario, 1970-1982

							Total	Total	Total	Actual	Other
	NS(a)	NS(b)	IM(a)	IM(b)	RS(a)	RS(b)	a	b	Shift	Change	Factors
ONTARIO	117999	-113225	2680	3985	-4981	-3271	115698	-112511	3187	42333	39146

1 Food and Beverage	12200	-11701	-1104	-583	-369	-1634	10727	-13918	-3191	2219	5410
2 Tobacco Products	468	-447	-143	-204	-78	608	247	-43	204	277	73
3 Rubber and Plastic	4697	-4536	1538	3323	-1566	-5	4669	-1218	3451	5951	2500
4 Leather	1784	-1735	-1343	-987	894	-115	1335	-2837	-1502	-960	542
5 Textile	4377	-4230	-2772	-255	2067	-206	3672	-4690	-1019	-1225	-206
6 Knitting Mills	1058	-1019	-1426	310	1062	-768	694	-1477	-783	-428	355
7 Clothing	3313	-3230	-643	-1753	1755	-746	4425	-5728	-1303	1441	2744
8 Wood	2711	-2608	1913	805	-462	-802	4162	-2606	1556	2351	795
9 Furniture and Fixtures	2765	-2601	-186	1187	1625	-2	4203	-1416	2787	5256	2469
10 Paper and Allied	6348	-6112	3487	-3382	-1415	197	8420	-9297	-877	-977	-100
11 Printing and Publishing	6187	-5902	5255	-1543	-584	-1186	10858	-8631	2227	10568	8341
12 Primary Metal Industries	10354	-9944	-7655	14673	-2702	845	-4	5574	5570	-4826	-10396
13 Metal Fabrication	11910	-11430	-2182	69	-4385	4223	5343	-7139	-1796	-2349	-553

14 Machinery	7122	-6760	2508	3110	-7585	5806	2045	2156	4201	1745	-2456
15 Transportation Equipment	15577	-15034	-407	3472	-878	131	14293	-11432	2861	11581	8720
16 Electrical Products	10892	-10422	2928	-12950	3227	-4788	17047	-28160	-11114	-1616	9498
17 Non-Metalic Industries	3922	-3775	-1897	1903	-1968	949	56	-923	-867	-2849	-1982
18 Pretoleum and Coal	1135	-1076	2887	-2601	7342	-8658	11363	-12335	-972	3496	4468
19 Chemical and Products	5857	-5543	1714	-1507	-644	3712	6927	-3338	3589	8845	5256
20 Misc. Manufacturing	5322	-5120	211	897	-317	-830	5216	-5053	163	3833	3670

TABLE 5b Sectoral Shift-Share Results, Ontario, 1981-1994

							Total	Total	Total	Actual	Other
	NS(a)	NS(b)	IM(a)	IM(b)	RS(a)	RS(b)	a	b	Shift	Change	Factors
ONTARIO	69339	-170078	36359	-22420	-16113	22758	89585	-169740	-80156	-64493	15663
10 Food	7070	-16640	2269	-584	3246	-954	12585	-18178	-5593	2455	8048

11 Beverage	1127	-2358	-482	212	278	-152	922	-2298	-1376	-2539	-1163
12 Tobacco	--	--	--	--	--	--	--	--	--	--	--
15 Rubber	1172	-2765	1398	-2398	-776	-488	1795	-5650	-3855	-2526	1329
16 Plastic	2163	-5504	5150	2713	673	-1167	7987	-3957	4030	11657	7627
17 Leather	953	-1932	-4785	1376	-813	569	-4646	13	-4633	-6237	-1604
18 Primary Textile	791	-1848	-1250	-870	408	-71	-52	-2789	-2841	-3425	-584
19 Textile	1000	-2459	-1171	1822	-722	538	-892	-99	-992	-1915	-923
24 Clothing	2722	-6088	-5222	1894	-366	3212	-2866	-981	-3847	-7692	-3845
25 Wood	1724	-4339	8335	-11141	-4344	8819	5714	-6662	-947	4155	5102
26 Furniture&Fixtures	1823	-4764	-524	1921	-1552	592	-254	-2251	-2504	-1147	1357
27 Paper and Allied	3392	-8129	2811	-2613	-1975	409	4228	-10332	-6104	-6881	-777
28 Printing & Publishing	5276	-13246	5300	5755	-58	276	10517	-7215	3302	5548	2246
29 Primary Metal	4876	-1165	1059	-114	-496	8849	965	-1422	-132	-1857	-5320

		2		18	9			1	56	6	
30 Fabricated Metal	5401	-15331	-8393	14032	235	-1071	-2758	-2371	-5129	1719	6848
31 Machinery	2829	-8014	-1570	2093	-2728	-503	-1468	-6424	-7892	-6083	1809
32 Transport Equip.	13746	-31198	32802	-23174	2460	2190	49008	-52182	-3175	39141	42316
33 Electrical&Electronic	6244	-16282	503	-2729	-6257	3185	490	-15825	-15335	-18790	-3455
35 Non-Metallic	1695	-4453	-2454	1003	1331	-1666	572	-5116	-4544	-3496	1048
36 Petroleum&Coal	644	-1670	-476	722	1591	-2863	1760	-3811	-2051	-5941	-3890
37 Chemical	4691	-11408	3061	-1037	-1774	3053	5978	-9392	-3413	-4779	-1366
39 Other Manufacturing	--	--	--	--	--	--	--	--	--	--	--

In the second period, however, Ontario (Table 5b) lost 64,493 of its manufacturing jobs. The number of growing sectors in this period declined to six -- the food, plastics, printing and publishing, fabricated metal and the transportation equipment sectors. In these sectors with the exception of fabricated metal, Ontario repeated its earlier performance in all three fronts. The transportation equipment sector was the leader of this period with an increase of 39,141. In this sector, losses due to productivity growth outpaced the gains due to output growth, but non-labour factors saved it from employment decline. In the declining sectors, productivity improvements accompanied by output decline and the negative effects of non-labour factors caused large amounts of employment losses. During the study period Ontario, like Quebec, followed the national trends and with the exception of a few sectors, national rather than regional dynamics were the driving forces.

The third province examined is Alberta (Tables 6a and 6b). Manufacturing employment increased in Alberta in both periods by 28,559 and 14,101 respectively. The transportation

equipment sector was the only sector in the first half of the study period that lost employment driven by non-labour factors. In the growing sectors, driving forces were output growth and non-labour factors, although there have been improvements in productivity and resulting decline in employment. The leading sectors in this period were fabricated metal products, printing and publishing, machinery, food and beverages and chemical products.

In the second period (Table 6b), the number of declining sectors in Alberta increased to six -- the beverage, textile, clothing, primary metal products, non-metallic industries and the petroleum and coal products sectors. The non-metallic industries and primary metal products sectors lost the largest amount of jobs in this period, 1,601 and 1,242 respectively. On the other hand, the electric and electronic sector was the leading sector followed by the wood products and machinery sectors. In these sectors, as for the other growing sectors Alberta had the advantage of output growth and the positive effects of non-labours factors, and improved its productivity. In general, regional dynamics played an important role in its manufacturing employment change.

British Columbia (Tables 7a and 7b) was another winner in both periods, with 15,904 and 9,304 new jobs. In the first period, employment loss took place in only one sector, chemical products. The printing and publishing sector gained the largest amount of employment followed by transportation equipment, wood products and the paper products sectors. In the wood products sector, despite the negative impacts of productivity and non-labour factors large increases in output and resulting employment gain saved this sector from losses.

In the second half (Table 7b), the declining sectors were the beverage, paper products, primary metal products, transportation equipment and the petroleum and coal products sectors. In the paper products sectors improvement in productivity was the sole reason for employment decline while in other declining sectors, all factors had a negative impact on employment. In this period, the largest improvement in productivity took place in the wood products sector causing a significant amount of employment decline, but increasing output accompanied by positive effects from non-labour factors save this sector. In British Columbia, national and regional dynamics had a mixed impact on employment change.

TABLE 6a Sectoral Shift-Share Results, Alberta, 1970-1982

							Total	Total	Total	Actual	Other
	NS(a)	NS(b)	IM(a)	IM(b)	RS(a)	RS(b)	a	b	Shift	Change	Factors
ALBERTA	6978	-6533	1173	218	17754	-4516	25904	-10831	15073	28559	13486
1 Food and Beverage	2085	-1982	-112	-192	1244	681	3217	-1492	1725	2981	1256

2 Tobacco Products	--	--	--	--	--	--	--	--	--	--	--
3 Rubber and Plastic	169	-158	74	103	286	-309	529	-364	164	488	324
4 Leather	29	-28	-26	-18	80	7	83	-38	45	78	33
5 Textile	110	-109	-66	-26	400	-262	444	-397	47	301	254
6 Knitting Mills	--	--	--	--	--	--	--	--	--	--	--
7 Clothing	--	--	--	--	--	--	--	--	--	--	--
8 Wood	774	-745	483	324	302	472	1558	51	1609	939	-670
9 Furniture and Fixtures	148	-133	-2	51	436	-81	582	-162	419	804	385
10 Paper and Allied	241	-222	118	-78	605	-452	964	-752	213	889	676
11 Printing and Publishing	416	-378	696	-292	1529	485	2641	-185	2456	4443	1987
12 Primary Metal Industries	411	-379	-433	836	1669	-2098	1648	-1641	7	846	839
13 Metal Fabrication	661	-613	-248	-51	3129	-510	3542	-1174	2368	4696	2328
14 Machinery	183	-150	282	1	3675	-2184	4140	-2333	1807	4257	2450
15 Transportation Equipment	602	-583	37	97	-623	399	16	-86	-71	-797	-726
16 Electrical Products	159	-149	82	-290	2396	-1162	2637	-1602	1035	1289	254
17 Non-Metalic Industries	446	-413	-443	327	1103	-24	1106	-109	997	2007	1010

18 Pretoleum and Coal	129	-116	486	-470	-310	825	306	239	545	1291	746
19 Chemical and Products	248	-221	208	-81	994	-494	1450	-796	654	2653	1999
20 Misc. Manufacturing	166	-153	36	-25	838	190	1041	11	1053	1394	341

TABLE 6b Sectoral Shift-Share Results, Alberta, 1981-1994

							Total	Total	Total	Actual	Other
	NS(a)	NS(b)	IM(a)	IM(b)	RS(a)	RS(b)	a	b	Shift	Change	Factors
ALBERTA	6562	-17714	3279	-2297	14760	-6210	24601	-26221	-1619	14101	15720
10 Food	1246	-3150	377	60	733	-309	2357	-3399	-1042	1779	2821
11 Beverage	238	-483	-116	105	-130	140	-8	-238	-246	-567	-321
12 Tobacco	--	--	--	--	--	--	--	--	--	--	--
15 Rubber	--	--	--	--	--	--	--	--	--	--	--
16 Plastic	171	-412	377	195	-3	-56	544	-273	271	906	635
17 Leather	--	--	--	--	--	--	--	--	--	--	--
18 Primary Textile	--	--	--	--	--	--	--	--	--	--	--
19 Textile	39	-136	-74	78	-40	34	-75	-24	-99	-135	-36
24 Clothing	115	-342	-321	122	411	-594	205	-814	-609	-172	437

25 Wood	478	-1334	2622	-3565	998	-505	4098	-5404	-1306	2563	3869
26 Furniture&Fixtures	152	-467	-90	64	1011	465	1073	62	1135	1902	767
27 Paper and Allied	297	-707	295	-384	1418	-712	2010	-1803	207	1628	1421
28 Printing & Publishing	767	-1909	710	800	-685	1084	792	-25	768	681	-87
29 Primary Metal	249	-686	26	-620	466	-361	741	-1667	-926	-1242	-316
30 Fabricated Metal	644	-1978	-1074	1414	818	406	388	-159	230	805	575
31 Machinery	464	-1305	-127	261	756	606	1093	-439	655	2357	1702
32 Transport Equip.	111	-496	689	-631	310	-206	1111	-1333	-223	1330	1553
33 Electrical&Electronic	296	-834	-20	-118	5452	-4087	5728	-5038	691	3057	2366
35 Non-Metallic	258	-843	-462	83	-575	26	-779	-734	-1513	-1601	-88
36 Petroleum&Coal	250	-609	133	-166	1380	-413	1763	-1188	575	-48	-623
37 Chemical	552	-1338	295	-64	955	-673	1802	-2075	-273	1092	1365
39 Other Manufacturing	235	-685	38	70	1485	-1055	1758	-1670	88	1096	1008

TABLE 7a Sectoral Shift-Share Results, BC, 1970-1982

							Total	Total	Total	Actual	Other
	NS(a)	NS(b)	IM(a)	IM(b)	RS(a)	RS(b)	a	b	Shift	Change	Factors
BC	19273	-18549	5846	1232	11969	-725	37088	-18042	19046	15904	-3142
1 Food and Beverage	2593	-2502	-189	-184	1314	-740	3718	-3426	291	1091	800
2 Tobacco Products	--	--	--	--	--	--	--	--	--	--	--
3 Rubber and Plastic	146	-138	65	95	655	-307	866	-349	517	1022	505
4 Leather	--	--	--	--	--	--	--	--	--	--	--
5 Textile	152	-145	-124	2	384	-217	412	-360	52	132	80
6 Knitting Mills	--	--	--	--	--	--	--	--	--	--	--
7 Clothing	355	-350	-63	-167	-499	844	-207	326	119	221	102
8 Wood	6755	-6645	4556	1658	2373	-1168	13684	-6155	7529	1901	-5628
9 Furniture and Fixtures	238	-223	-10	109	-16	41	212	-74	138	212	74
10 Paper and Allied	2757	-2621	1624	-1669	-506	4199	3874	-91	3783	1786	-1997
11 Printing and Publishing	852	-812	819	-269	639	634	2310	-447	1862	2806	944
12 Primary Metal Industries	1120	-1071	-966	1873	1926	-2097	2080	-1296	784	550	-234
13 Metal Fabrication	1216	-1144	-245	-77	363	724	1334	-498	836	497	-339

14 Machinery	531	-494	381	97	1006	-873	1919	-1270	649	1592	943
15 Transportation Equipment	798	-730	-198	313	2362	-640	2962	-1057	1905	2289	384
16 Electrical Products	377	-352	127	-546	6	1081	510	183	693	541	-152
17 Non-Metalic Industries	503	-479	-323	282	1006	-688	1186	-885	301	836	535
18 Pretoleum and Coal	111	-104	306	-234	65	-299	481	-638	-157	233	390
19 Chemical and Products	452	-437	58	-76	168	-805	677	-1318	-641	-515	126
20 Misc. Manufacturing	316	-301	29	29	726	-414	1071	-687	385	710	325

TABLE 7b Sectoral Shift-Share Results, British Colunbia, 1981-1994

							Total	Total	Total	Actual	Other
	NS(a)	NS(b)	IM(a)	IM(b)	RS(a)	RS(b)	a	b	Shift	Change	Factors
BC	11155	-29598	18748	-22437	12718	-16641	42622	-68676	-26054	9304	35358
10 Food	1404	-3568	563	-123	346	-216	2314	-3906	-1593	2455	4048
11 Beverage	297	-631	-135	116	-342	432	-179	-83	-262	-634	-372

12 Tobacco	--	--	--	--	--	--	--	--	--	--	--
15 Rubber	--	--	--	--	--	--	--	--	--	--	--
16 Plastic	241	-674	532	317	520	-124	1293	-482	811	2154	1343
17 Leather	--	--	--	--	--	--	--	--	--	--	--
18 Primary Textile	--	--	--	--	--	--	--	--	--	--	--
19 Textile	86	-256	-116	128	494	-130	464	-258	205	463	258
24 Clothing	215	-731	-717	163	724	777	222	209	431	855	424
25 Wood	3472	-8479	16508	-22295	5249	-12007	25229	-42782	-17553	2486	20039
26 Furniture&Fixtures	142	-432	-74	87	301	-114	369	-459	-90	297	387
27 Paper and Allied	1446	-3723	1267	-1077	5308	-5808	8020	-10608	-2587	-1230	1357
28 Printing & Publishing	985	-2408	667	1029	859	13	2511	-1366	1145	1754	609
29 Primary Metal	297	-1064	-70	-868	-1694	323	-1467	-1609	-3076	-3631	-555
30 Fabricated Metal	671	-2011	-1013	1462	145	459	-196	-91	-287	1150	1437
31 Machinery	220	-907	-71	61	437	-606	586	-1452	-866	1033	1899
32 Transport Equip.	294	-1100	1733	-1607	-3221	2011	-1193	-696	-1889	-1529	360
33	418	-	-28	-149	228	-	267	-	-561	866	1427

Electrical&Electronic		1060			5	2027	5	3236			
35 Non-Metallic	356	-940	-458	150	236	488	134	-302	-167	250	417
36 Petroleum&Coal	65	-200	-49	120	337	-493	353	-573	-220	-214	6
37 Chemical	276	-673	175	-53	5	178	457	-548	-92	67	159
39 Other Manufacturing	268	-741	34	104	730	203	1031	-434	597	1183	586

Conclusion

In this study, we have focused on investigating the foundations of economic performance and employment change in manufacturing sectors in the provinces of Canada. To take account of industrial and regional differences in output growth, labour productivity, and non-labour factors on regional manufacturing employment change, we employed the Haynes-Dinc extension of shift-share.

Our findings suggest that the change in employment during the period of investigation in the regions of Canada has been driven by output growth (decline), and non-labour factors (new investments or under-investments in physical capital, and improvement in technology, new entry or exit), though labour productivity has also played a crucial role in employment change. In the first period, non-labour factors contributed to employment decline in Quebec, Atlantic, Newfoundland, Prince Edward Island, New Brunswick and British Columbia. In the second period, non-labour factors were the major contributor to employment growth in all provinces.

Further, with the exception of a few sectors in few a regions, the provinces of Canada basically followed national trends. During the study period, Alberta was the most active region followed by British Columbia and the Prairies.

The empirical analysis showed that the applied model provides some additional information about industry performance by including the role of non-labour factors. It has proven to be a useful tool in investigating and comparing regional economic performances. Although we have not undertaken the comparison empirically in this paper, the main difference between the Rigby-Anderson model and the Haynes-Dinc model lies in the allocation of causes of employment change. The Rigby-Anderson model attributes all changes in employment to productivity gain (loss) and output growth (decline). This could cause overestimation (underestimation) of labour's role in some regions.

There are, however, still some important issues to be investigated which were not covered in detail in this study. One is the impact of business cycles, national and international, on Canadian manufacturing employment. Given that a significant portion of Canadian manufacturing is

owned by foreign companies, international economic conditions could have a crucial impact on employment change. Another issue is the role of increasing deregulation in manufacturing.

References

Aigner, D., C. Lovell and P. Schmidt. 1977. "Formulation and Estimation of Stochastic Frontier Production Function Models". *Journal of Econometrics*, 6: 21-37.

Andrews, K. and J. Swanson. 1995. "Does Public Infrastructure Affect Regional Performance". *Growth and Change*, 26: 204-216.

Barff, R. and P. Knight III. 1988. "Dynamic Shift-Share Analysis". *Growth and Change*, 15: 1-10.

Baumol, W., S. Blackman and E. Wolff. 1989. *Productivity and American Leadership*. Cambridge: The MIT Press.

Bronfenbrenner, M. 1985. "Japanese Productivity Experience", in W. Baumol, and K. McLennan (eds.). *Productivity Growth and U.S. Competitiveness*. NewYork: Oxford University Press.

Denison, E.F. 1962. *Sources of Economic Growth in the United States and the Alternative Before Us*. New York: Committee for Economic Development.

Dinc, M., K. Haynes and L. Qiangsheng. 1998. "Evaluation and Comparison of Shift-Share Extensions: A Survey Article". *Australasian Journal of Regional Studies*, 4: 275-302.

Dollar, D. and E. Wolff. 1993. *Competitiveness, Convergence, and International Specialisation*. Cambridge: The MIT Press.

Dunn, E. 1960. "A Statistical and Analytical Technique for Regional Analysis".*Papers of the Regional Science Association*, 6: 97-112.

Haynes, K. and M. Dinc. 1997. "Productivity Change in Manufacturing Regions: A Multifactor/Shift-Share Approach". *Growth and Change*, 28: 150-170.

Jorgenson, D. 1995. Productivity, Volume1: Postwar U.S. *Economic Growth*. Cambridge: The MIT Press.

Kendrick, J. 1961. *Productivity Trends in the United States*. Princeton: Princeton University Press.

_____. 1973. *Postwar Productivity Trends in the United States, 1948-1969*. New York: National Bureau of Economic Research.

_____. 1983. *Interindustry Differences in Productivity Growth*. Washington D.C.: American Enterprise Institute.

_____. 1984. *Improving Company Productivity*. Baltimore: The Johns Hopkins University Press.

Knudsen, D. and R. Barff. 1991 "Shift-Share Analysis as a Linear Model". *Environment and Planning A*, 23: 421-431.

Ledebur, L. and R. Moomaw. 1983. "A Shift-Share Analysis of Regional Labour Productivity in Manufacturing". *Growth and Change*, 14: 2-9.

Lynde, C. and J. Richmond. 1992. "The Role of Public Capital in Production". *The Review of Economics and Statistics*, 1: 37-44.

Morrison, C. 1992. "Unraveling the Productivity Growth Slowdown in the United States, Canada and Japan: The Effects of Subequilibrium, Scale Economies and Markups". T*he Review of Economics and Statistics*, 3: 381-393.

Munnel, A. and L. Cook. 1990. "How Does Public Infrastructure Affect Regional Economic Performance?". *New England Economic Review*, September/October: 11-32.

Norsworthy, J. and S. Jang. 1992. Emprical Measurement and Analysis of Productivity and Technological Change. Amsterdam: North-Holland.

Qiangsheng, L., K. Haynes and M. Dinc. 1997. "A New Approach to Shift-share Decomposition and Its Application to the Washington Metropolitan Economy". *Applied Geographic Studies*, 1: 233-252.

Rigby, D. and W. Anderson. 1993. "Employment Change, Growth and Productivity in Canadian Manufacturing: An Extension and Application of Shift-Share Analysis". *Canadian Journal of Regional Science*, 16: 69-88.

Sato, B. 1970. "The Estimation of Biased Technical Progress and the Production Function". *International Economic Review*, 11: 179-208.

Serot, D. 1993. "Estimating Total Factor Productivity Using Parametric, Nonstochastic Cost Frontiers". *The Journal of Productivity Analysis*, 4: 407-418.

Shapiro, M. 1987. "Are Cyclical Fluctuations in Productivity Due More to Supply Shocks or Demand Shocks?". *AEA Papers and Proceedings*, 77: 118-124.

Solow, R. 1957. "Technical Change and the Aggregate Production Function". *The Review of Economics and Statistics*, 39: 312-320.

Stevens, B. and C. Moore. 1980. "A Critical Review of the Literature on Shift-Share as a Forecasting Technique". *Journal of Regional Science*, 20: 419-437.

Wolff, E. 1994. "Productivity Measurement within an Input-output Framework". *Regional Science and Urban Economics*, 24: 75-92.

Technical Appendix

A general shift-share model can be derived from a conventional growth accounting framework. The purpose of this exercise is first, to cast the components of employment growth defined in the R-A and H-D extensions in a theoretical framework, and second, to shed some light on the contribution of non-labour factors to employment growth in the H-D extension.

To simplify notation, we assume that the a and b values do not vary across sectors or regions. Therefore we can drop the subscripts *i* and *r*. Also, to simplify notation define period *t* as period 1 and period *t*+1 as period 2, and assume that the value of does not change across the two periods. We represent two inputs, employment (*E*) and capital (*K*), but the capital input can be taken to represent all non-labour inputs.

A general growth accounting framework is taken from Norsworthy and Jang (1992: 18):

$$\Delta Q = \ln Q_2 - \ln Q_1 = \sum_i w_i(\ln x_{i2} - \ln x_{i1}) + \Delta TFP \qquad \text{(A1)}$$

where the *w* are cost shares, the *x* are input quantities, and

$$\Delta TFP = \sum_i w_i\left(\ln\frac{Q_2}{x_{i2}} - \ln\frac{Q_1}{x_{i1}}\right) \qquad \text{(A2)}$$

Assuming that there are only two inputs (*E* and *K*) with cost shares $\alpha$and (1- α), respectively, and taking advantage of the fact that for relatively small changes,

$$\ln x_2 - \ln x_1 = \frac{x_2 - x_1}{x_1} \qquad \text{(A3)}$$

the growth accounting equation can be rewritten as follows:

$$\frac{Q_2 - Q_1}{Q_1} = a\frac{(E_2 - E_1)}{E_1} + (1-a)\frac{(K_2 - K_1)}{K_1} + a\left[\frac{\frac{Q_2}{E_2} - \frac{Q_1}{E_1}}{\frac{Q_1}{E_1}}\right] + (1-a)\left[\frac{\frac{Q_2}{K_2} - \frac{Q_1}{K_1}}{\frac{Q_1}{K_1}}\right] \qquad \text{(A4)}$$

The Rigby-Anderson model assumes that there is only one input, labour – or equivalently that α = 1. Thus

$$\frac{Q_2 - Q_1}{Q_1} = \frac{(E_2 - E_1)}{E_1} + \left[\frac{\frac{Q_2}{E_2} - \frac{Q_1}{E_1}}{\frac{Q_1}{E_1}} \right] \quad \text{(A5)}$$

$$E_2 - E_1 = \frac{(Q_2 - Q_1)}{Q_1} E_1 - \left[\frac{\frac{Q_2}{E_2}}{\frac{Q_1}{E_1}} - 1 \right] E_1 \quad \text{(A6)}$$

Referring back to equations (6) and (7), it is evident that the first term on the left hand side of this expression is equivalent to the A term (output change holding productivity constant) and the second term is equivalent to the B term (productivity change holding output constant).

Adopting a similar strategy for the Haynes-Dinc model, the expression for growth in employment is written:

$$E_2 - E_1 = \frac{1}{\alpha} \frac{(Q_2 - Q_1)}{Q_1} E_1 - \frac{(1-\alpha)}{\alpha} \frac{(K_2 - K_1)}{\frac{K_1}{E_1}} - \left[\frac{\frac{Q_2}{E_2}}{\frac{Q_1}{E_1}} - 1 \right] E_1 - \frac{(1-\alpha)}{\alpha} \left[\frac{\frac{Q_2}{K_2} - \frac{Q_1}{K_1}}{\frac{Q_1}{K_1}} \right] E_1 \quad \text{(A7)}$$

This expression yields considerable intuition about the factors that affect employment change. The first term on the right hand side is the positive effect of output growth on employment (analogous to the A component.) The second term is a negative input substitution effect of capital growth on employment. (Note that this effect is inversely related to the capital-labour ratio in the initial period.) The third term is the negative effect of growth in the productivity of labour (analogous to the B component). The fourth term is the negative effect of growth in the productivity of capital.

This equation also illustrates that, holding output constant, the effect of an increase in non-labour inputs on growth in labour is ambiguous. The substitution effect (term 3) is clearly negative. Note however that in the fourth term, if output were held constant then an increase in *K* would yield a positive overall effect on employment. If the values of K_1 and K_2 were known, the net effect could be calculated. This is not always possible, however, because of the paucity and poor quality of regional capital data.

Notes

1. For a detailed discussion of underlying assumptions and measurements of this method see Denison (1962), Baumol et al (1989), Bronfenbrenner (1985), Norsworthy and Jang (1992) and Dollar and Wolff (1993). For other methods of productivity measurement see Solow (1957), Sato

(1970), Aigner et al (1977), Shapiro (1987), Morrison (1992), Serot (1993), Wolff (1994), and Jorgenson (1995).

2. This weighting derives from the microeconomic result that under competition, the price of each input is equal to its marginal revenue product. In this case the cost share, defined as the quanity of each input times its price divided by the total value of output, is equal to the elasticity of output with respect to the input in question.

3. Even though the definition of SIC was changed in 1980, Statistics Canada published both SIC's until 1982. To capture the change in overlapping years we assumed that the first period is from 1970 to 1982 instead of 1970 to 1980.

4. Use of value added is equal to the value of shi9pments less any payments for purchased inputs such as materials and energy. Thus, the results of the model should be indifferent to changes in the quantities of these inputs.

5. This is consistent with the conventions of growth accounting -- see the technical appendix.