Differences in Interprovincial Productivity Levels

by

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Abstract

This study examines provincial differences in productivity (GDP per job) using decomposition and regression analysis. In the first stage of the study, the relative size of productivity differences across provinces is examined. Then, these differences are decomposed into two components—the first is the portion of the difference that arises from industry-mix, and the second is due to 'real' productivity differences at the industry level. The paper also examines the contributions of the 'new' and 'old' economy sectors to differences in provincial productivity. Finally, regression analysis is performed in order to determine the statistical significance of interprovincial productivity differences. The paper finds that British Columbia, Alberta, Saskatchewan, Ontario and Quebec do not differ significantly from one another in terms of GDP per job after differences in industry mix are considered. Manitoba and the Atlantic Provinces lag behind the others. Most of the difference in the latter two cases stems from 'real' differences at the industry level rather than from the effect of differences in industry mix. The Natural Resources sector plays an important role in bolstering the performance of Alberta and Saskatchewan.

Keywords: labour productivity, province


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Executive Summary

Using decomposition analysis, this paper compares labour productivity across provincial business sectors, separating them into differences attributable to industry mix and to "real" productivity differences. Industry-mix effects capture differences in industry structure, whereas "real" productivity differences capture the difference in value-added per job in a given industry compared to the same industry in Ontario (the control province used in this study).

An examination of the industry mix and "real" productivity shift components for each province's commercial sector is conducted to determine the overall relative productivity of all provinces. A further decomposition of the industry mix and "real" productivity shift components into nine major industrial sectors provides insight regarding the contributions of specific industrial sectors to overall provincial productivity differences. Following this, a sectoral comparison across provinces is provided in order to assess the relative performance of key industrial sectors.

The paper finds:

- Alberta has the highest labour productivity, producing roughly 18% more value-added per job than Ontario, which comes second.

- Saskatchewan is close to Ontario, trailing by just 4%. Quebec and British Columbia are next, lagging by 8%, followed by Manitoba at 22%. The Atlantic region trails at 26%.

- Actual 'real' productivity differences of specific industry sectors are generally more important than industry-mix differences in explaining overall differences in business sector productivity across provinces.

- The Natural Resources sector plays a key role in determining overall interprovincial productivity differences. The Natural Resources sector is largely responsible for the size of Alberta's overall lead. In Saskatchewan, advantages in the Natural Resources sector largely offset productivity disadvantages in other industrial sectors.

- Differences in the productivity of the new high-knowledge sectors do exist. But they are relatively small compared to the differences in the Natural Resources sector. Most provinces lag Ontario in the High Wage (eg., finance and wholesale) service sector and the Core manufacturing sector (eg., electronics and chemicals), two of the more innovative sectors.

- After the interprovincial differences in industry mix and differences in the productivity of different industries (primarily the resource sector) are taken into account, British Columbia, Alberta, Saskatchewan, Ontario and Quebec are found to be about equally productive. But Manitoba and the Atlantic region lag behind the others.


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1. Introduction

This paper examines interprovincial differences in the level of gross domestic product (GDP) or output per worker—a variant of a labour productivity measure. In particular, it focuses on interprovincial differences in this measure at the industry level. Differences in output per worker arise from a range of factors—differences in capital intensity, differences in the intensity of use of other factors that complement labour, differences in the size of operations, and differences in efficiency.

The first objective of this paper is to examine differences in the measure of labour productivity across provinces. To do so, it uses a new database on provincial productivity that links recently created provincial input/output tables on GDP by industry to data on labour input by industry.

Differences in the levels of GDP per worker across provinces translate into differences in standards of living as measured by GDP per capita. When standard of living gaps (GDP per capita) between provinces and the national average are decomposed into the gap associated with productivity and the gap associated with the participation rate (workers divided by the population), Orr (2000) argues that for most provinces the overall standard of living gap is accounted for by productivity differences—that is most of the difference across provinces in GDP per capita occurs because of differences in GDP per worker and not because of differences in employment to population ratios. Understanding the causes of these productivity differences is of interest to both those concerned with economic development and those concerned with social policy.

One cause of these differences is the particular industrial structure of a province. Provinces differ in terms of their natural endowments. Some possess substantial natural resources. Others lie in the heartland of industrial North America, in close proximity to the major markets of the U.S. central states. Partially as a result, the Canadian provinces differ in terms of their industrial structure. Since industries differ in terms of their productivity, the differences in industrial structure might be expected to affect the differences in overall average productivity levels between provinces. Therefore, the second objective of the paper is to examine whether interprovincial productivity differences are due to differences in industry structure.

As part of this investigation, the paper also focuses on the extent to which productivity differences are more important in industries associated with the 'new' economy. Arguments about directions that development policy should take often focus upon the desirability of the 'new' economy. In essence, it is argued that there is a distinction between 'new' industries that are high-technology, high-knowledge based, and 'old' industries that use less technology and are not as knowledge intensive. Therefore, this paper examines the contributions of the 'new' and 'old' economy to differences in provincial industrial structure and to provincial productivity differences.

The paper uses two related techniques to examine these issues. First, it decomposes productivity differences into two components: one due to real-productivity differences for individual industrial sectors and one due to industry-mix differences between provinces. Second, it uses multivariate covariance analysis to assess the statistical significance of these findings.

2. Data

Productivity is defined as current dollar value-added per job in this study.[1] This can be considered as a type of labour productivity measure. Value-added when summed across all industries is equivalent to Gross Domestic Product (GDP). Differences in productivity occur because of many different factors, only one of which arises because of differences in efficiency. Therefore, differences in GDP per job should not be interpreted to necessarily mean that the industry of one province is more 'advanced' than another. Differences can arise because a sector in one province uses more capital, or in the case of natural resources, one province may have a richer resource base. It also may be the case that one sector is inherently different than the same sector elsewhere.[2]

All data used in this study come from a database created by the Micro-Economic Analysis Division of Statistics Canada. The database is created from provincial output data collected by the Input-Output Division and a compilation of employment data collected in the Labour Force Survey (LFS), the Annual Census of Mining (ACM), the Annual Survey of Manufactures (ASM) and the Survey of Employee Payroll Hours (SEPH). This database was created as part of an initiative by the System of National Accounts at Statistics Canada to provide more comprehensive high-quality statistics at the industry level for the provinces. This study uses value-added at basic prices[3], wages and salaries, and total paid worker and self-employed worker employment data.

Data are available at the 243 industry level for two years—1996 and 1997. This is the working (W) level of industry detail used in the Input/Output system of tables.[4] Rather than present the two sets of data separately for each of 1996 and 1997, data for the two years were averaged together to remove anomalies.[5] Many international studies that compare output per worker deflate the ratio of current dollar GDP per worker by the ratio of prices across the two countries being compared. This was not done here because we lacked relative price levels across Canadian regions. This will not be a major problem to the extent that the free flow of goods and services within Canada equates prices across regions in Canada.

[1] Conventional labour productivity measures are defined as value-added per hour-worked; but employee hours worked by industry at the provincial level were not of sufficient accuracy for use herein.

[2] While the robustness of our results to the level of industry detail used is examined here, we recognize that even finer levels of industry detail than are used here, may produce different results. This is a problem that all decomposition analyses face.

[3] See Baldwin, Beckstead et al. (2001), Appendix 1 for a definition of GDP at basic prices.

[4] The working-level classification system is used by the Input-Output Division to divide the entire Canadian economy into 243 separate industries. This is the level that the Input-Output Division uses to create much of its output data.

[5] The separate results for 1996 and 1997 were sufficiently similar that they were averaged here.

3. Industrial Grouping

For the purposes of this study, non-business industries were removed leaving 219 industries, which were aggregated to 9 major sectors. These include the traditional resources sectors, several manufacturing sectors classified in terms of their innovation profile and several service sectors that were likewise based on their knowledge-intensive profile.

The sectors are: Agriculture, Fishing and Trapping; Natural Resources; Core Manufacturing; Secondary Manufacturing; Other Manufacturing; Construction; and High Wage, Medium Wage and Low Wage Service sectors. The use of this taxonomy allows us to study productivity differences across broad categories of the industrial structure and to relate them both to differences in the resource base and to differences in the presence of the 'new' economy.

The Natural Resources industrial group includes the Logging, Forestry, Mining, as well as Crude Petroleum and Natural Gas sectors. This sector, along with Agriculture, Trapping and Fishing, forms the heart of the traditional, established resource industries.

Manufacturing was divided into three categories that differ in terms of their innovation profile. The classification is based on the taxonomy used by Robson et al. (1988), who classify industries according to their degree of innovation. Core Manufacturing represents highly innovative industries that produce innovations or technologies for self-use or use in other sectors. The Secondary Manufacturing category is less innovative in that it also uses technologies produced by other sectors, but produces some innovations for use in other sectors. The 'Other' Manufacturing sector principally absorbs technologies and innovations (specifically machinery and equipment, and intermediate products) produced by the Core and Secondary sectors. Data from the 1993 Canadian Innovation Survey (Table 1) show the Core Manufacturing sector to be producing more innovations than the Secondary and tertiary 'Other' sectors (Baldwin and Hanel, 2002).

Table 1. Innovators by Manufacturing Sector (Company Weighted)

Sector	% of firms
Core	48
Secondary	34
Other	29

Source: Baldwin and Hanel, 2002

The Core Manufacturing sector consists of Electrical and Electronic Products, Machinery, Pharmaceuticals, Chemical and Chemical Products and Refined Petroleum. The Secondary Manufacturing sector consists of Primary Metal, Transportation, Rubber, Plastic Products, Fabricated Metal Products, and Non-metallic Minerals. 'Other' Manufacturing is comprised of Tobacco, Paper and Allied Products, Beverages, Primary Textiles, Printing and Publishing, Wood, Other Manufacturing, Textiles, Furniture and Fixtures, Clothing, and Leather and Allied Products.

As was the case with the manufacturing sector, the service sector is divided into three knowledge-based sub-sectors. It is not possible to group service industries by their innovation rates because extensive surveys of this activity have not been carried out across the entire sector.[6] Instead, industries are grouped according to their average wage rate, with the average wage being taken as a proxy for knowledge intensity. High-knowledge industries tend to be equated with above average wages while low-knowledge industries are often associated with lower wages paid.

Average earnings are used to classify service industries into high, medium and low wage sectors (Table 2).[7] Average earnings are calculated by dividing the sum of provincial wages and salaries for each industry by the sum of all provincial employment in each of the industries. Low Wage Services includes Accommodation and Food, Retail and Other Services. Medium Wage Services consists of Transportation, Business Services, and Communication. High Wage Services consists of Wholesale; Storage; Utilities; Finance, Insurance and Real Estate Services; and Pipeline Transport. These groupings correspond roughly to those used in a previous Statistics Canada study that uses industrial skill requirements (Johnson, Baldwin and Hinchley, 1997)—with the exception of the Wholesale and Storage industries that are typically grouped with low-knowledge industries. Individuals employed in the Wholesale and Storage industries were found to be receiving much higher average wages than those in both the Low and Medium Wage Service sectors.

Table 2. Average Income in Services

Industry	Income ($000)
Low Wage Services	
Accommodation and Food Services	15.2
Other Services	16.1
Retail Services	16.5
Medium Wage Services	
Transportation	27.8
Business Services	28.2
Communication	32.9
High Wage Services	
Storage	36.7
Wholesale	38.1
Finance, Insurance and Real Estate	41.6
Utilities	47.3
Pipeline Transport	55.7

Details of the concordance from the working-level industry to the aggregate sectoral categories used in this paper are provided in Appendix B.

[6] For the results of one survey that covered only business services, finance, and communications see Baldwin, Gellatly, Peters and Johnson (1998).

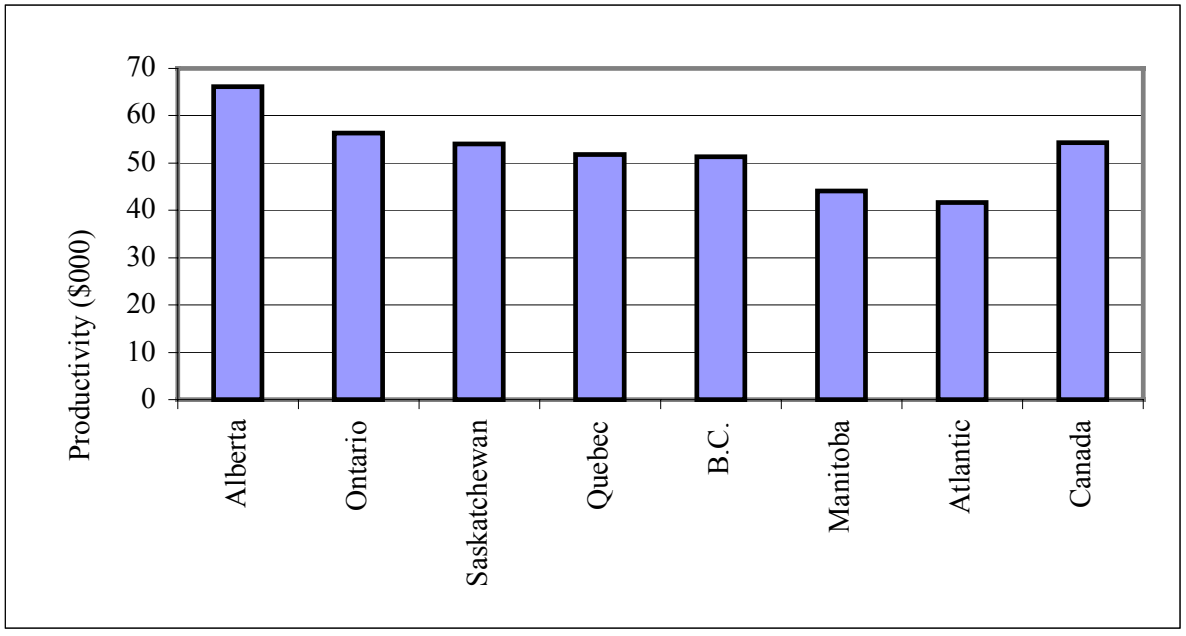
[7] For the purpose of this study, the private education and health sectors were omitted from the analysis. The latter are heavily affected by government reimbursement policies. In addition, all utilities were left in the service sector. Including both health and education and splitting the utilities between goods and services does not affect the key conclusions of the paper.

4. Interprovincial Productivity Differences

Differences in provincial productivity, measured as value-added per job, are presented in Figure 1. Only Alberta is more productive than Ontario, producing roughly 18%[8] more value-added per job. Average productivity in Alberta stands at $66,200 value-added per job, compared to $56,300 for Ontario. Ontario and Saskatchewan are roughly on a par. Quebec and British Columbia trail Ontario by about 8%, producing $5,000 less per job than Ontario. Manitoba and the Atlantic region have the lowest productivity levels, producing 22% and 26% less value-added per job than Ontario, respectively.

Value-added per job differs substantially by industry (Table 3). In the East, the High Wage Services sector has the highest output per job, while the Low Wage Service sector is among the lowest in the country. From Ontario westward, value-added per job in the Natural Resources sector exceeds that of the High Wage Services sector, especially in Saskatchewan, Alberta and British Columbia. The variance in output per job across the three manufacturing sectors is less than for services. While the Core Manufacturing sector may be described as more innovative, it does not consistently post the highest value-added per job, as Secondary Manufacturing in both Quebec and Ontario surpasses it.

Figure 1. Value-added Per Job by Province



[8] Calculated as the difference between Alberta productivity and Ontario productivity, all divided by Ontario productivity.

The relative ranking of these sectors varies across provinces. Alberta is the most productive in the Core Manufacturing sector, which is the most innovative manufacturing sector, followed by Ontario, Quebec and Manitoba. Ontario and Quebec lead in the Secondary Manufacturing sector. Ontario and Alberta lead in High Wage Services. But they are not as dominant in the 'Other' manufacturing sector. Here Saskatchewan and British Columbia's productivity equals that of Ontario and Alberta.

Alberta and Saskatchewan have the highest productivity in the Natural Resources sector. Saskatchewan produces over $360,000 of value-added per job in this sector, while Alberta produces over $290,000 of value-added per job in this sector. British Columbia follows Alberta, producing close to $140,000 of value-added per job in the Natural Resources sector. However, the gap between Alberta and British Columbia is in excess of $155,000 of value-added per job.

The Atlantic region is generally behind the other regions. It is at the bottom of the value-added per job ranking with regards to Core Manufacturing, Secondary Manufacturing, and Low Wage Services. It is tied with Manitoba for last in Medium and High Wage Services.

Table 3. Provincial Productivity by Industry

	CAN	ONT	ATL	QUE	MAN	SASK	ALTA	BC
	(value-added per job in $000)							
Provincial productivity								
Agriculture, Fishing and Trapping	24.6	20.0	26.2	29.9	25.7	30.6	24.1	20.0
Natural Resources	184.2	118.3	79.0	74.4	106.3	363.9	295.7	138.9
Core Manufacturing	80.9	78.1	54.7	80.9	79.8	68.1	112.7	73.9
Secondary Manufacturing	91.0	97.1	55.5	90.8	71.1	68.3	82.6	65.9
Other Manufacturing	67.6	71.6	58.1	64.7	49.1	70.0	71.4	71.2
Construction	43.5	42.1	40.2	46.0	38.7	49.2	47.6	41.6
Low Wage Services	24.9	25.4	20.2	25.1	22.0	21.2	25.9	26.5
Medium Wage Services	51.7	53.2	46.3	48.6	45.8	51.0	53.9	54.3
High Wage Services	93.3	98.2	82.8	87.3	82.7	89.4	100.3	91.3
All Sectors	54.3	56.3	41.7	51.8	44.1	54.1	66.2	51.3
Difference from Ontario								
Agriculture, Fishing and Trapping			6.2	9.9	5.7	10.6	4.1	0
Natural Resources			-39.3	-43.9	-12.0	245.6	177.4	20.6
Core Manufacturing			-23.4	2.8	1.7	-10.0	34.6	-4.2
Secondary Manufacturing			-41.6	-6.3	-26.0	-28.8	-14.5	-31.2
Other Manufacturing			-13.5	-6.9	-22.5	-1.6	-0.2	-0.4
Construction			-1.9	3.9	-3.4	7.1	5.5	-0.5
Low Wage Services			-5.2	-0.3	-3.4	-4.2	0.5	1.1
Medium Wage Services			-6.9	-4.6	-7.4	-2.2	0.7	1.1
High Wage Services			-15.4	-10.9	-15.5	-8.8	2.1	-6.9
All Sectors			-14.6	-4.5	-12.2	-2.2	9.9	-5.0

Provincial differences in productivity at the entire economy level are determined not only by productivity differences at the industry level but also by industrial structure. If a province has a larger share of its employment in high productivity industries, it will tend to have a higher overall average productivity. In contrast, if it has a higher proportion of employment in low productivity industries, it will have a lower overall average productivity.

To examine variations in industrial structure, the provincial employment share across industries is presented in Table 4. In addition, the difference between each province and Ontario is provided.

There are greater similarities in industry employment shares across provinces than there are in terms of productivity. The three service sectors generally account for at least 60% of each province's labour force. Variations from Ontario are around 3 percentage points, with the exception of Saskatchewan that has only 58% of employment in the Services sectors. Generally, the percentage of employment in Low Wage Services is highest and about equal to the percentage in both the other two service categories. Ontario, Manitoba and Saskatchewan have the lowest concentration in the Low Wage sector while the Atlantic region has the highest—the difference being about 6 percentage points.

Despite its high productivity level, the Natural Resources sector generally accounts for a relatively low proportion of employment share. Alberta has the largest share of provincial employment in this sector—at 6%.

Table 4. Provincial Employment Shares by Industry

Provincial Employment Shares (%)	ON	ATL	QUE	MAN	SASK	ALTA	BC
Agriculture, Fishing and Trapping	3.9	6.4	3.6	12.0	22.9	9.5	4.4
Natural Resources	0.8	3.2	1.4	1.6	3.3	6.2	3.2
Core Manufacturing	6.6	1.5	5.1	3.2	2.8	3.8	2.3
Secondary Manufacturing	7.0	2.6	4.6	3.7	1.0	1.5	1.8
Other Manufacturing	8.3	9.4	12.3	8.0	3.7	5.1	8.1
Construction	8.3	10.1	7.5	8.5	8.4	11.6	11.2
Low Wage Services	31.9	38.3	33.6	31.9	31.5	32.2	37.2
Medium Wage Services	16.7	15.5	16.6	15.8	11.9	16.5	16.8
High Wage Services	16.6	13.1	15.8	15.6	14.8	13.7	15.1
Share Difference from Ontario (%)		**ATL**	**QUE**	**MAN**	**SASK**	**ALTA**	**BC**
Agriculture, Fishing and Trapping		2.5	-0.4	8.1	19.0	5.6	0.5
Natural Resources		2.4	0.6	0.8	2.6	5.5	2.5
Core Manufacturing		-5.1	-1.6	-3.5	-3.9	-2.9	-4.4
Secondary Manufacturing		-4.4	-2.4	-3.3	-6.0	-5.5	-5.2
Other Manufacturing		1.1	4.0	-0.4	-4.7	-3.2	-0.3
Construction		1.9	-0.8	0.2	0.1	3.4	3.0
Low Wage Services		6.4	1.7	0.0	-0.4	0.4	5.4
Medium Wage Services		-1.2	-0.1	-0.9	-4.8	-0.2	0.1
High Wage Services		-3.5	-0.8	-1.1	-1.8	-2.9	-1.5

In manufacturing, Ontario devotes 22% to all three manufacturing sectors. This is larger than Manitoba (15%), Saskatchewan (8%), Alberta (10%), British Columbia (12%), and the Atlantic region (14%). The biggest differences occur in the Core and Secondary sector, where Ontario has a considerably higher proportion of employment. Quebec has the same proportion of employment in manufacturing as Ontario, but its distribution is skewed towards the 'Other' sector and is less concentrated in the Core and Secondary sectors.

These industrial sector productivity estimates and employment shares form the basis for the analysis that is used in the next section to decompose the overall productivity differences across provinces into 'real' productivity and industry-mix effects.

5. Decomposition Analysis

This section decomposes productivity differences between provinces into their industry-mix and real-productivity components. The industry-mix component represents that part of the overall difference between provinces that is accounted for by differences in industry mix. The 'real' component represents differences that are due to the province having lower productivity across individual industries.

Each of the provinces is compared against a base case, which is Ontario for this particular study.[9]

Mathematically the differences in productivity between any two provinces may be expressed as:

$$TS = \sum_{i=1}^{I} s_{p_j,i} * va_{p_j,i} - \sum_{i=1}^{I} s_{ON,i} * va_{ON,i} \qquad (1)$$

where:

$s_{p_j,i}$ is the share of employment in province *j*, industry *i*;

$s_{ON,i}$ is the share of employment in industry i in Ontario;

$va_{p_j,i}$ is the value-added per job in province *j*, industry *i;*

$va_{ON,i}$ is the value-added per job in industry *i* in Ontario.

This equation can be decomposed into:

$$TS = \sum_{i=1}^{I} s_{p_j,i} * va_{p_j,i} - \sum_{i=1}^{I} s_{ON,i} * va_{p_j,i} + \sum_{i=1}^{I} s_{ON,i} * va_{p_j,i} - \sum_{i=1}^{I} s_{ON,i} * va_{ON,i}$$

Grouping these terms results in:

$$TS = \sum_{i=1}^{I} \left(s_{p_j,i} - s_{ON,i} \right) * va_{p_j,i} + \sum_{i=1}^{I} s_{ON,i} * \left(va_{p_j,i} - va_{ON,i} \right) \qquad (2)$$

Alternatively, this can be expressed as:

$$TS = \sum_{i=1}^{I} \left(s_{p_j,i} - s_{ON,i} \right) * va_{ON,i} + \sum_{i=1}^{I} s_{p_j,i} * \left(va_{p_j,i} - va_{ON,i} \right) \qquad (3)$$

Adding equations (2) and (3) and dividing by two, gives us the average decomposition using the two alternative calculation methods. This is the decomposition equation used in this paper:

[9] For confidentiality purposes, the Atlantic provinces were treated as a group.

$$TS = \sum_{i=1}^{I} \frac{(s_{p_j,i} + s_{ON,i})}{2} * (va_{p_j,i} - va_{ON,i}) + \sum_{i=1}^{I} (s_{p_j,i} - s_{ON,i}) * \frac{(va_{p_j,i} + va_{ON,i})}{2} \qquad (4)$$

The first summation term in equation (4) represents the aggregate 'real' productivity difference component between the given province and Ontario, while the second term represents the aggregate industry-mix component.

This paper also examines each of the individual industry components of both the aggregate 'real' productivity differences and industry-mix productivity differences. In accordance with the first term of equation 4, the individual industry 'real' productivity component for province i is calculated as the product of the average employment shares of that industry in Ontario and in province i with the difference in the industry value-added per job between province i and Ontario. It measures the change that would occur if value added per worker in a particular sector were changed to the Ontario level. Summed together, the individual industry components add to the total real effect.

Individual industry-mix differences are also examined here. Coming from the second term of equation 4, they are measured by the product of the differences in industrial employment shares between province *i* and the control case (Ontario in this study), and the average value-added per job in both provinces for a particular industry. The individual industry-mix component captures the extent to which differences in provincial productivity can be attributed to having less or more employment share in a particular industry.

It should, however, be noted that the individual industry-mix differences are more difficult to interpret than the individual industry 'real' effects. The individual 'real' component captures a partial effect—the change that would occur if productivity went up in the province relative to Ontario, everything else being held constant. The individual industry-mix effect captures what would happen if the employment share of an industry increased. But the employment share in one sector cannot increase without the share in another sector necessarily declining—therefore, the individual industry-mix effect does not have the same convenient partial interpretation as the 'real' effect.

Together, the industry 'real' productivity component plus the industry-mix shift component make up what is referred to here as the weighted productivity difference by industry—the component of the overall difference for a particular province across all industries that arises from a particular industry. Since it is partially comprised of the industry-mix component, it is not a pure partial measure in the sense that changes that occur in it as a result of employment share changes are not independent of what occurs in other industries. This does not concern us since we will be focusing mainly on individual industry 'real' effects. When we examine industry-mix effects, we do so jointly across all industries.

6. Results of Decomposition

The results are presented at two different levels for each of the provinces—one for the overall business sector (Table 5) and the other at the individual industrial sector level (Table 6). The results for the individual industrial sector levels contain the 'real' and the industry-mix components as well as the sum of the two—the individual weighted contributions—for each of the industrial sectors.

Decompositions are calculated using Ontario as the basis for comparison. Alternatively, a comparison against the national average could have been chosen; however, it was felt that analysis against an actual province would be more concrete. Since Ontario is often so close to the national average (Table 3), Ontario was chosen as the point of comparison.

6.1 Business Sector

The total industry-mix and 'real' components as well as the overall productivity differences for each of the provinces as compared to Ontario are provided in Table 5. The overall weighted productivity difference for an industry is by construction equal to the 'real' and industry-mix components of that industry.

Table 5. 1996-1997 Average Business Sector Productivity Decomposition ($000)

Province	'Real' Productivity Component	Industry-mix Component	Overall Productivity Difference
Atlantic region	-9.9	-4.6	-14.6
Quebec	-3.3	-1.2	-4.5
Manitoba	-7.9	-4.3	-12.2
Saskatchewan	2.3	-4.4	-2.2
Alberta	8.8	1.1	9.9
British Columbia	-1.8	-3.3	-5.0

The components of the decomposition analysis take on both positive and negative values. A negative component value indicates a province is less productive than Ontario because of either industry-mix or 'real' productivity differences or both. A positive value indicates higher productivity relative to Ontario.

Only Alberta has higher overall productivity in the business sector when compared against Ontario. Alberta has an overall productivity advantage of just under $10,000 per job. The decompositions reveal that these differences are due to both 'real' productivity and industry-mix differences. Alberta enjoys a 'real' productivity advantage of $8,800 of value-added per job over Ontario, accounting for 89% of the overall difference.

There is only a small difference in output per job between Ontario and Saskatchewan ($2,200), much of which is accounted for by an industry-mix effect. The industry-mix effect and the 'real' productivity effect in Saskatchewan have opposite signs, with 'real' productivity advantages being realized and offsetting some of Saskatchewan's industry-mix disadvantage.

Manitoba and the Atlantic region are the most disadvantaged—with negative overall productivity differences of $12,200 and $14,600 respectively, relative to Ontario. At least two-thirds of the difference is accounted for by 'real' productivity differences in each case.

Quebec and British Columbia are about equally matched in terms of productivity differences from Ontario. Quebec has an overall productivity disadvantage of $4,500 and British Columbia has one of $5,000. Quebec's productivity disadvantage stems more from 'real' productivity disadvantages than does British Columbia's. Specifically, Quebec's 'real' productivity disadvantages account for close to three-quarters of total productivity differences whereas 'real' productivity differences in British Columbia account for only about one third of its overall productivity difference from Ontario. British Columbia, therefore, suffers more from its employment mix than does Quebec.

In summary, at the 9-sector level used here, 'real'-productivity differences account for a substantial proportion of the difference in overall productivity variations across provinces. Saskatchewan and British Columbia were the exceptions to this. In fact, Saskatchewan actually displays 'real' productivity advantages that are offset by industry-mix disadvantages.

Since this result may be partly due to the level of aggregation used here (9 sectors), we repeated the decomposition using the working-level of industry detail contained in the input/output tables (219 industries for the definition of the business sector used here). In the Atlantic region, the 'real' productivity component still accounts for almost all of the productivity difference. In Quebec, this productivity component plays a slightly lesser role than it does at the 9-sector level of aggregation. Manitoba, like the Atlantic region reveals stronger 'real' productivity disadvantages at the 219-industry level of aggregation than it does at the 9-sector level of aggregation. The results of this finer level of aggregation in British Columbia tips the scales slightly as British Columbia now reveals slightly greater 'real' productivity disadvantages and less of an industry-mix disadvantage. The most notable changes are those in Alberta and Saskatchewan where 'real' productivity advantages diminish substantially, placing much greater focus upon the role of industry-mix in the determination of overall productivity differences.

In summary, in the two regions where the overall productivity differences are largest (Manitoba and the Atlantic region), the effect of moving to the most disaggregated industry level increases the importance of the 'real' component.

6.2 Business Sector Industrial Decomposition

6.2.1 The Methodology

The previous section examined differences in productivity of the overall business sector at the provincial level. This section investigates the extent to which certain industries drive provincial productivity differences. To do so, the individual industry components that were described previously are tabulated by region in Table 6. All entries are measured in terms of value-added per job.

This table contains the overall difference in productivity between a region and that of Ontario (final row) that corresponds to the overall result reported in Table 5. It decomposes each of these provincial differences down by sector into 'real' sectoral (panel A, final row) and 'industry-mix' sectoral components (panel B, final row), which together sum to the overall productivity difference by industry.

Panel A contains the 'real' productivity difference by sector by province (first term, equation 4). The real-productivity component of a sector can be interpreted as the change that would occur if the productivity of the sector were increased to the Ontario level. 'Real' positive productivity advantages occur in a sector when a province is more productive than Ontario in that sector. Together, the real-productivity shifts of individual sectors sum to the overall real-productivity difference for the province as a whole—the last row in Panel A.

Panel B contains the individual sector industry-mix components. These correspond to the second term in equation 4. At the industrial sector level, the industry-mix component is only an indicator of relative employment share with Ontario. These components cannot be interpreted as partial effects as we can for the 'real' productivity difference components by sector since an increase in the employment of one sector requires a decrease in at least one of the other sectors. Together, the industry-mix components sum to the overall industry-mix component—the last line of Panel B. And this value tells us the effect of reallocating all the industry shares simultaneously to reflect the employment mix of Ontario.

The sum of each industry's 'real' productivity effect and its industry-share effect is the weighted industry productivity difference (Panel C). This is not the industry difference presented earlier in Table 3, but the weighted difference—the difference weighted by the average share of employment. Together, these weighted differences summed across all industries equal the overall business productivity difference reported in Table 5 and in the bottom line of Table 6. A comparison of any one sector to the total allows us to estimate the contribution of that sector to the overall difference.

6.2.2 Overview of Results

The Core and Secondary Manufacturing, Natural Resources and High Wage Services sectors make the most substantial contributions to overall business sector productivity differences across provinces.

Most provinces are behind Ontario in the High Wage Services sector in terms of overall weighted productivity (Table 6, panel C). This is also the case for the Core and Secondary Manufacturing sectors. However, those provinces with strong Natural Resources sectors are able to offset these disadvantages, some to the point where their advantage in the Natural Resources sectors enables them to overtake Ontario in terms of overall provincial productivity.

In Alberta and Saskatchewan, the Natural Resources sector provides substantial productivity advantages, enabling Alberta to substantially surpass Ontario in terms of overall provincial productivity and enabling Saskatchewan to mostly offset substantial productivity disadvantages in other sectors.

In terms of weighted productivity differences, Quebec is behind Ontario in Secondary Manufacturing and in High Wage Services. Since no sectors display advantages sufficient to offset these disadvantages, Quebec's overall business sector productivity is behind Ontario. In British Columbia the story is similar; however, disadvantages also exist in the Core Manufacturing sector. In Manitoba and the Atlantic Region, most sectors display disadvantages relative to Ontario. The Atlantic region is behind Ontario, as is Manitoba, in the Secondary Manufacturing and High Wage Services sectors. However, the Atlantic region is even farther behind Ontario than Manitoba in its overall productivity as a result of its performance in Core Manufacturing.

Putting the sectoral productivity contributions into a 'new' economy 'old' economy perspective, the 'new' economy as represented by Core Manufacturing and High Wage Services plays a different role in the relative productivity differences across provinces. Deficiencies in the High Wage sector are particularly important in Manitoba and the Atlantic region. Differences in the Core Manufacturing sector are less important in these two provinces. However, the importance of the 'old' economy, as represented by the Natural Resources sector must not be discounted, as it is the driving force that allows some Western provinces to exceed the productivity level of Ontario or to closely match it despite productivity disadvantages in other sectors.

Table 6. Provincial Productivity by Industry

	Sector Productivity Differences with Ontario ($000)					
	Atlantic	Quebec	Manitoba	Saskatchewan	Alberta	British Columbia
A) Real Productivity						
Agriculture, Fishing and Trapping	0.3	0.4	0.4	1.4	0.3	0
Natural Resources	-0.8	-0.5	-0.1	5.0	6.2	0.4
Core Manufacturing	-0.9	0.2	0.0	-0.5	1.8	-0.2
Secondary Manufacturing	-2.0	-0.4	-1.4	-1.1	-0.6	-1.4
Other Manufacturing	-1.2	-0.7	-1.8	-0.1	0	0
Construction	-0.2	0.3	-0.3	0.6	0.5	0
Low Wage Services	-1.8	-0.1	-1.1	-1.3	0.2	0.4
Medium Wage Services	-1.1	-0.8	-1.2	-0.3	0.1	0.2
High Wage Services	-2.3	-1.8	-2.5	-1.4	0.3	-1.1
Overall Real Productivity	-9.9	-3.3	-7.9	2.3	8.8	-1.8
B) Industry Mix						
Agriculture, Fishing and Trapping	0.6	-0.1	1.8	4.8	1.2	0.1
Natural Resources	2.4	0.6	0.9	6.1	11.3	3.1
Core Manufacturing	-3.4	-1.2	-2.7	-2.8	-2.7	-3.3
Secondary Manufacturing	-3.4	-2.3	-2.7	-4.9	-4.9	-4.2
Other Manufacturing	0.7	2.6	-0.2	-3.3	-2.3	-0.2
Construction	0.8	-0.4	0.1	0	1.5	1.2
Low Wage Services	1.5	0.4	0	-0.1	0.1	1.4
Medium Wage Services	-0.6	-0.1	-0.5	-2.5	-0.1	0
High Wage Services	-3.1	-0.7	-1.0	-1.7	-2.9	-1.4
Overall Industry Mix	-4.6	-1.2	-4.3	-4.4	1.1	-3.3
C) Overall Productivity						
Agriculture, Fishing and Trapping	0.9	0.3	2.3	6.2	1.5	0.1
Natural Resources	1.6	0.1	0.7	11.1	17.5	3.5
Core Manufacturing	-4.3	-1.1	-2.6	-3.3	-0.9	-3.5
Secondary Manufacturing	-5.3	-2.6	-4.1	-6.1	-5.6	-5.5
Other Manufacturing	-0.5	1.9	-2.1	-3.4	-2.4	-0.2
Construction	0.6	-0.1	-0.2	0.6	2.0	1.2
Low Wage Services	-0.3	0.3	-1.1	-1.4	0.3	1.8
Medium Wage Services	-1.7	-0.9	-1.7	-2.9	0	0.2
High Wage Services	-5.4	-2.5	-3.4	-3.1	-2.5	-2.5
Overall Productivity Difference	-14.6	-4.5	-12.2	-2.2	9.9	-5.0

6.2.3 Results for Individual Provinces

Alberta

Alberta enjoys higher overall relative business sector productivity (value-added per job) than Ontario (Table 6, last row). This is despite overall productivity disadvantages in all three Manufacturing sectors and High Wage Services (Table 6, panel C). Its overall advantage occurs because of the strength of the Natural Resources sector in Alberta. With an average productivity of $296,000 in this sector (Table 3), Alberta is able to raise its overall average provincial productivity to $66,200, which is $10,000 higher than for Ontario. Alberta also enjoys overall advantages over Ontario in the Agriculture, Fishing and Trapping industry, as well as the Construction industry.

The strength of the Natural Resources sector arises both because of the larger share of employment allocated to the sector compared to Ontario—as indicated by an industry-mix component of +11.3 (Table 6, panel B) and by 'real' productivity advantages (Table 6, panel A)—as indicated by a 'real' productivity component of +6.2. 'Real' productivity differences account for roughly one-third of the Natural Resource sector's productivity differences.

In the other sectors, the negative contribution made to the weighted productivity difference (Table 6, panel C) in Core Manufacturing, 'Other' Manufacturing and High Wage Services comes not from having 'real' productivity disadvantages (Table 6, panel A), but from having negative industry-mix effects (Table 6, panel B). That is, these sectors had higher productivity than Ontario, but relatively lower employment shares than Ontario. Despite having a higher 'real' productivity than its counterpart in Ontario (Table 6, panel A), Alberta's Core Manufacturing sector contributes a negative amount to the overall business sector productivity difference (Table 6, panel C) because of its lower employment share.

Saskatchewan

Saskatchewan has a slightly lower overall level of productivity than Ontario in the business sector. Like Alberta, it has a large advantage in Agriculture and the Natural Resources sector. This offsets its poor overall relative performance in the manufacturing and service sectors.

Like Alberta, Saskatchewan has an overall productivity disadvantage in each of the two most innovative manufacturing sectors—Core and Secondary Manufacturing—and High Wage Services (Table 6, panel C). But, unlike Alberta, it also trails Ontario in the Low and Medium Wage Service sectors. The Secondary Manufacturing industry accounts for much of the Saskatchewan's productivity disadvantage relative to Ontario, with a weighted productivity difference of –6.1. But only 20% of this is the result of 'real' productivity disadvantages (Table 6, panel A). Most comes from the industry-mix effect. Saskatchewan has a much lower percentage of its labour force in this sector than Ontario (Table 6, panel B).

The Agriculture, Fishing and Trapping sector enjoys an advantage, but it comes primarily from an industry-mix effect. Overall, this sector possesses productivity advantages over Ontario of $6,200 value-added per job. The Natural Resources sector has an even larger overall productivity advantage relative to Ontario, with a weighted productivity difference of $11,100, of which just under half of this difference is attributable to 'real' productivity differences.

Saskatchewan is thus able to mostly offset its slightly weaker performance in the manufacturing sector through advantages in the Agriculture, Fishing and Trapping, as well as the Natural Resources sector. As with Alberta, the 'real' productivity differences at the sectoral level account for a smaller proportion of the weighted productivity difference than the industry-mix differences. However, at the overall business sector level, 'real' productivity differences summed across all industries exert more of an influence than does the industry-mix difference, because the industry-mix effects are offsetting.

In essence, Saskatchewan's relatively higher productivity in the Resource sector provides it with sufficient advantages to largely offset its weaknesses elsewhere.

British Columbia

In British Columbia, the Secondary Manufacturing sector has a large negative overall productivity difference of $5,500 while the Natural Resource sector has a large positive differential of $3,500.

There are, however, no large 'real' productivity differences in the Natural Resources sector. Rather, the weighted difference here (Table 6, panel C) is the result of an industry-mix effect (Table 6, panel B); British Columbia has a greater percentage of its employment in Natural Resources.

The disadvantages in the two more-innovative manufacturing sectors—Core and Secondary Manufacturing—stem mainly from industry-mix effects. Together, the disadvantages in the manufacturing sectors slightly offset the positive industry-mix effect in Natural Resources, leaving British Columbia behind Ontario overall.

Despite fairly even productivity performance in Agriculture, Fishing and Trapping and Medium Wage Services and advantages in Construction, Low Wage Services and Natural Resources, British Columbia is not able to sufficiently offset productivity disadvantages in Manufacturing and High Wage Services. As a result, British Columbia has lower overall productivity levels than Ontario.

Manitoba

Manitoba, like British Columbia, lags Ontario in the weighted contribution of all of the manufacturing sectors, with the disadvantage the most pronounced in the Secondary Manufacturing sector. There are also large differences in the Services sectors. In fact, Manitoba is less productive than Ontario in all sectors save Agriculture, Fishing and Trapping and Natural Resources in terms of overall value-added per job (Table 6, panel C).

The overall productivity advantages in the Agriculture, Fishing and Trapping industry are largely due to the relatively larger share of labour allocated to that industry (shown by an industry-mix component of +1.8 in Table 6, panel B). 'Real' productivity advantages here are not large (Table 6, panel A*)*.

Elsewhere, there are 'real' productivity disadvantages across almost all industries—in the Secondary and tertiary 'Other' Manufacturing, and in all of the Service sectors (Table 6, panel A). Real productivity differences account for 65% of the total difference of $12,200 with Ontario. The 'real' productivity component accounts for 34% of the Secondary Manufacturing sector weighted productivity difference of –$4,100. In 'Other' Manufacturing, 'real' productivity differences account for almost all of the sector's productivity disadvantages. 'Real' productivity differences also account for much of the productivity disadvantages in the three services sectors.

Manitoba thus performs poorly compared to Saskatchewan because, although like the latter, most of its manufacturing and service sectors are less productive than those of Ontario, the performance of its Natural Resource sector does not offset these disadvantages. Furthermore, most of the disadvantage is due to 'real' productivity disadvantages; in Saskatchewan, industry-mix effects are more important.

Quebec

Unlike Manitoba, Quebec does not experience large overall differences in the Manufacturing Sectors as a whole (Table 6, panel C). Indeed, its core sector just trails that of Ontario. This accords with other work that finds a substantial restructuring in Quebec from labour intensive industries into the science-based sectors (Baldwin and Rafiquzzaman, 1994; Baldwin and Brown, 2001). Where Quebec does lag is in Secondary Manufacturing and High Wage Services.

There are few large 'real' differences between Quebec and Ontario (Table 6, panel A). The differences in the Manufacturing sectors are each small. Of the total weighted disadvantage in the Secondary Manufacturing sector, only a small proportion is accounted for by 'real' productivity differences. Most comes from industry mix (Table 6, panel B).

High Wage Services and Secondary Manufacturing together have the largest negative productivity differences relative to Ontario, producing about $2,500 less in weighted value-added per job in Quebec than in Ontario. 'Real' productivity differences in the High Wage Services sector account for roughly 70% of the overall differences, compared to only 15% for Secondary Manufacturing.

Across all sectors, the real disadvantages sum to $3,300—some three quarters of the total difference of $4,500. Slightly more than half of this is accounted for by the High Wage Services sector. There are substantial industry-mix effects in the Core and Secondary Manufacturing sectors that result from lower employment shares, but these are offset by higher employment shares in 'Other' Manufacturing, where Quebec has an advantage over Ontario.

In summary, Quebec's overall business-sector productivity disadvantages are largely driven by both real and industry-mix disadvantages in the High Wage Services and Secondary Manufacturing sectors.

The story of Quebec's productivity disadvantage is one of industrial structure. It has less employment in the Core and Secondary sectors and more in the labour-intensive 'Other' Manufacturing sector. Quebec also has a lower share of employment in High Wage industries. Moreover, those Secondary Manufacturing and High Wage industries that it does possess lag in terms of 'real' productivity.

Atlantic region

In the Atlantic region, there are 'real' productivity disadvantages in almost all sectors (Table 6, panel A). The largest disadvantages occur in the Secondary Manufacturing and the High Wage Services sector. Together, these 'real' disadvantages cumulate to $4,300. This is close to half of the total 'real' difference. There is also a large industry-mix effect in Core and Secondary Manufacturing and the High Wage Services sector—resulting from a smaller employment share in these sectors in the Atlantic region than in Ontario.

7. Sectoral Comparisons

Economists and policy analysts have increasingly examined the extent to which growth in the economy has turned towards the high-knowledge, high value-added sectors of the Canadian economy (Lee and Haas, 1996, Gera and Mang, 1997; Lavoie and Roy, 1998). In doing so, much attention has been devoted to the high-tech sector and to the knowledge-based economy. This is due to the perceived connection between the presence of high-growth sectors and higher overall productivity.

In light of this interest, it is important to ask two questions. First, are there large productivity differences in certain sectors that contain many of the industries that are generally defined as being high-tech or knowledge-intensive? Second, to what extent do these productivity differences account for a substantial proportion of the overall productivity difference between provinces?

To answer these questions, this section focuses on differences in the most innovative manufacturing sector—the Core sector—and the High Wage Services sector. It should be noted that these are not the only sectors where high-tech, high-knowledge firms can be found (Baldwin and Gellatly, 1999). Indeed, in the Secondary Manufacturing sector, many industries also produce more innovations than they employ themselves and pass them on to the 'Other' Manufacturing sector (Robson et al., 1988). In addition, the Medium Wage Service sector contains industries such as Business Services and Communications that are highly innovative.[10] For this reason, we will look broadly at the differences in productivity across these sectors, recognizing that there is a gradient rather than a sharp discontinuity across each in terms of their participation in the 'new' economy.

[10] See Baldwin, Gellatly, Peters, and Johnson (1998) for a study of innovation in the communications, business services and finance industries.

7.1 Service Sector

In order to compare differences across service sectors, we will focus on the real productivity difference of a particular sector relative to Ontario (Table 6, panel A). This is the first component of equation (4) and describes the amount of the overall difference across all sectors that is due to there being a 'real' difference in productivity in that sector compared to Ontario.

There is a similar pattern in interprovincial differences for both the High and the Medium Service sectors. Alberta is the only province to exceed Ontario in 'real' productivity in both the High and Medium Wage Services industries. British Columbia does, however, slightly exceed Ontario with respect to 'real' productivity in the Medium Wage Services sector. The Atlantic region, Quebec and Manitoba trail Ontario in terms of real productivity in these two service sectors, as does Saskatchewan but to a lesser extent.

For all but Alberta and Saskatchewan, it is these differences that make up much of the total 'real' provincial productivity differences (last row of panel A). Without these differences in the High Wage sector, the total real disadvantage of Quebec would be reduced by roughly 50%, while in Manitoba it would be reduced by 31%. In the Medium Wage sector, the 'real' disadvantage accounts for over 15% of the total disadvantage in Manitoba and about 25% of the disadvantage in Quebec. The total real disadvantage at the provincial level would be reduced by three quarters for Quebec and by half in Manitoba if the disadvantages in the two higher knowledge service sectors were to be eliminated.

The 'real' productivity disadvantage for Quebec, Manitoba and the Atlantic regions in the Low Wage Service sector is generally less than for the Higher Wage sector.

It should be noted that Alberta is more productive than Ontario in 'real' terms in each of the three service sectors. These advantages are not large. This does however reveal that Alberta's high-knowledge service workers are more productive in terms of value-added per job than are Ontario's high-knowledge service workers. In contrast to Quebec, where these differences in the services sectors account for a substantial proportion of the total real disadvantage (80%), in Alberta, they account for only 7% of the total real productivity difference.

7.2 Manufacturing

There is a substantial range in the productivity differences of the three manufacturing sectors. The productivity performance of the Core Manufacturing sector, which is seen to be at the centre of innovative activity, differs less from Ontario than does the performance of the Secondary and the 'Other' sectors.

In the Core sector, Alberta has the highest 'real' labour productivity. There is a gap between the Atlantic region and Ontario in favour of Ontario. Quebec and Manitoba perform about the same as Ontario. British Columbia and Saskatchewan trail Ontario in Core Manufacturing productivity, but not nearly to the same extent as the Atlantic region.

In the Secondary Manufacturing sector, there are disadvantages across all regions relative to Ontario. The Secondary Manufacturing sector in Ontario reveals such marked productivity advantages over the other provinces because of the dominant presence of the automobile industry.

In the 'Other' Manufacturing sector, the largest disadvantages relative to Ontario occur in Manitoba and the Atlantic region. The 'real' advantages for the other three western provinces are relatively small.

When summed together, the disadvantages in the Manufacturing sectors amount to around 40 percent of the total 'real' disadvantages in the Atlantic region and Manitoba. These disadvantages are less pronounced in Quebec, accounting for roughly 27% of the 'real' disadvantage experienced by Quebec.

7.3. Natural Resources

In the Natural Resources sector, only Alberta and Saskatchewan demonstrate large 'real' productivity advantages over Ontario (Table 6, row 2, panel A). These overall differences translate into substantial overall 'real' differences (last row, panel A). In Saskatchewan, in the absence of these 'real' productivity advantages, the overall productivity disadvantage would be more than three times larger than its actual level. In Alberta, Natural Resources 'real' productivity differences explain approximately two-thirds of overall 'real' productivity differences. British Columbia also reveals slight 'real' productivity advantages in this sector. None of the other provinces exhibit any sort of substantial 'real' productivity disadvantage relative to Ontario in the Natural Resources sector.

8. Regression Analysis

Productivity differences exist across industries and regions. A decomposition analysis was used in the previous section to examine these differences. Multivariate analysis provides an alternative. The latter offers more flexibility in that it can consider both separate effects and interaction terms. It also has the advantage that it provides statistical tests of differences. In the previous sections, we have shown that differences exist across a considerable number of categories—provinces and industries. But many of these are small. In this section, we ask which differences can be considered to be significant in light of the range of differences that exist.

Regression analysis is used here as a complement rather than a substitute for the decomposition analysis. Its main purpose is to ask whether the differences that were outlined in the previous section are large in a statistical sense. They of course may be large in another sense. A $2,000 difference may be statistically small but still economically meaningful to those who suffer from the disadvantage.

In order to examine interprovincial differences using a multivariate framework, an ordinary least squares regression was performed by regressing value-added per job on a set of province and industrial sector binary variables. The omitted categories were the province of Ontario and Agriculture, Fishing and Trapping.

When province and industry binary variables are entered separately (Column 1 in Table 7), none of the province variables were found to be significantly different from Ontario in terms of productivity, though the rankings were broadly those produced by the decomposition analysis—Alberta, Saskatchewan, Ontario, Quebec, Manitoba and the Atlantic Provinces. But most sectors were significantly different from the Agriculture, Fishing and Trapping sector. The exceptions were Construction and the Low and the Medium Wage Services sectors.

The previous sections have shown that the Natural Resource sector differences are province specific. Therefore, in Model 2, we include interaction terms between the resource sector and two provinces—Saskatchewan and Alberta.

Model 2, unlike Model 1, indicates that the Atlantic region and Manitoba have significant lower labour productivity than Ontario (at the 1% significance level for the Atlantic region and at the 10% significance level for Manitoba). The other provinces do not differ significantly from Ontario.

Once again, all of the sectors are significantly different from the Agriculture, Fishing and Trapping sector at the 1% level, with the exception this time of the Low Wage Services sector. More importantly, their rankings are about the same as for Model 1.

Once these interaction terms are included, the provincial dummy variables for Saskatchewan and Alberta are substantially lower than those resulting from the estimation of Model 1. This illustrates the large impact of the Natural Resources sector in these two provinces.

Table 7. Multivariate Regression Results (Standard Error Estimates in Brackets)

Variable	Model 1	Model 2	Model 3
Intercept	23.31	30.33***	29.30***
	(18.6)	(5.2)	(4.0)
Provincial Variables			
ATL	-15.64	-15.64***	-12.69***
	(18.0)	(5.0)	(4.0)
QUE	-6.24	-6.24	-1.53
	(18.0)	(5.0)	(4.0)
MAN	-9.20	-9.20*	-8.85**
	(18.0)	(5.0)	(4.0)
SASK	23.11	-5.74	-4.71
	(18.0)	(5.2)	(4.0)
ALTA	23.37	3.08	4.11
	(18.0)	(5.2)	(4.0)
BC	-2.26	-2.26	-5.12
	(18.0)	(5.0)	(4.0)
Sector Variables			
NAT_RES	142.86***	79.68***	88.95***
	(20.4)	(6.3)	(9.0)
CORE_MFG	53.08***	53.08***	53.08***
	(20.4)	(5.7)	(4.3)
SEC_MFG	50.70**	50.70***	50.70***
	(20.4)	(5.7)	(4.3)
OTH_MFG	39.94*	39.94***	39.94***
	(20.4)	(5.7)	(4.3)
CONSTR	18.40	18.40***	18.40***
	(20.4)	(5.7)	(4.3)
LOW_WAGE	-1.45	-1.45	-1.45
	(20.4)	(5.7)	(4.3)
MED_WAGE	25.25	25.25***	25.25***
	(20.4)	(5.7)	(4.3)
HIGH_WAGE	65.07***	65.07***	65.07***
	(20.4)	(5.7)	(4.3)
Provincial-sector Interaction Terms			
ATL_NR	-	-	-26.57**
			(12.1)
QUE_NR	-	-	-42.40***
			(12.1)
MAN_NR	-	-	-3.11
			(12.1)
SASK_NR	-	259.63***	250.37***
		(12.3)	(12.1)
ALTA_NR	-	182.61***	173.34***
		(12.3)	(12.1)
BC_NR	-	-	25.75**
			(12.1)
Summary Statistics			
Adjusted R^2	0.53	0.96	0.98
F Value	5.91	102.94	144.31
Number of Observations	62	62	62

***Significant at the 1%, **Significant at 5%, *Significant at 10%.

Model 3 includes interaction terms for all the provinces and their respective Natural Resources sector. The results produced from this regression are similar to those produced from the estimation of Model 2.

These results show that after the effect of the Natural Resource sector is considered, there are really no significant productivity differences between British Columbia, Alberta, Saskatchewan, Quebec and Ontario.

9. Conclusion

Productivity as measured by GDP per job varies across Canada's regions. These productivity differences can be attributed either to industry-mix differences, that is differences in the importance of different industries, or to 'real' productivity differences. Comparing the industry-mix components to the 'real' productivity components reveals that the contribution of 'real' productivity differences often dominates the industry-mix effect as a contributor to overall productivity differences. In other words, 'real' productivity differences generally explain more of the productivity differences between provinces than do industry-mix differences.

The productivity differences are driven by different factors across the country. Alberta is the only province to create more GDP per job than does Ontario—almost 20% more. In Alberta, the high productivity of the resource economy accounts for most of this difference. But it should be noted that Alberta generally has a positive 'real' advantage across most industries. This is a highly productive economy that is generally as productive as Ontario in both the Manufacturing and Service sectors, pulling well ahead because of the productivity of its Natural Resources Sector.

Saskatchewan has about the same level of productivity as Ontario. It performs below Ontario in services and most of the other sectors especially in the Secondary Manufacturing sector—where Ontario substantially outperforms Saskatchewan because of its auto industry. The Natural Resources sector in Saskatchewan plays a large role in offsetting its productivity disadvantages in most of its other sectors. The difference between the relative overall performance of Saskatchewan and neighbouring Manitoba is quite low when the Natural Resources sector is removed.

Quebec is about 8% less productive than is Ontario. In Quebec, it is a disadvantage primarily in the Services sectors that leads to an overall disadvantage relative to Ontario. Here the largest component of the disadvantage stems from 'real' productivity differences in the High Wage and the Medium Wage sector—the two more innovative service sectors. On the other hand, Quebec has little disadvantage on the Manufacturing side. Indeed in the Core Manufacturing sector, it has a slight 'real' advantage. The 'Other' Manufacturing sector contributes positively, largely driven by its strong industry-mix component. While some of the overall disadvantage in Quebec comes from industrial structure, three-quarters of the weighted productivity difference comes from 'real' factors. And most of the total comes from 'real' differences in services (60%) and only 20% comes from 'real' differences in the manufacturing sectors.

British Columbia has about the same productivity as Quebec. British Columbia trails Ontario in the more-innovative sectors—Core and Secondary Manufacturing and High Wage Services. This stems mainly from industry-mix effects. So, despite fairly even productivity performance in Agriculture, Fishing and Trapping and Medium Wage Services and advantages in Construction, Low Wage Services and Natural Resources, British Columbia trails Ontario primarily because of its disadvantages in Manufacturing and High Wage Services.

Manitoba is ranked below Quebec, lying 22% below Ontario in average value-added per job. Some 65% of its disadvantage is due to 'real' and not industry effects. Like Quebec, Manitoba has a particularly large 'real' disadvantage in the High Wage Services sector relative to the 'real' disadvantages realized in other sectors. It also has the largest 'real' differences of all the provinces relative to Ontario in the 'Other' manufacturing sector. Manitoba's overall disadvantage comes slightly more from the service sector than the manufacturing sector. The sum of the 'real' differences in the service industries makes up 60% of the total 'real' difference; in manufacturing industries, it makes up 40%.

The Atlantic region has the largest overall productivity disadvantage relative to Ontario (26%). Two-thirds of this difference arises from 'real' differences. These differences are found across almost all sectors, particularly the Core and Secondary Manufacturing and High Wage Services sectors. The sum of the 'real' components in services is equal to 36% of the total difference for the region as a whole and the sum of the 'real' disadvantages for manufacturing account for 28% of the total overall difference.

In summary, the 'old' economy continues to be a major player in the Canadian economy. The Natural Resources sector serves as an anchor in the west of Canada, enabling Alberta to elevate its overall productivity level above that of Ontario. In Saskatchewan, the Natural Resource sector allows this province to offset weaker 'new' economy industries such as Core Manufacturing and High Wage Services. Differences in the productivity of the new high-knowledge sectors do exist. But they are relatively small compared to the differences in the Natural Resources sector.

The regression analysis confirms these findings. Once industry effects and the peculiar position of the Natural Resources sector are accounted for—Ontario, Alberta, British Columbia and Saskatchewan and Quebec are not significantly different from one another. But the Atlantic region and Manitoba lag the others. The regression analysis further reinforces the findings of the decomposition analysis, revealing the high productivity present in the new economy sectors such as High Wage Services, Core Manufacturing and old economy sectors, specifically Natural Resources and the Secondary Manufacturing sectors.

There is one last caveat that needs to be added to the findings of this paper. It pertains to the caution that should be applied to the interpretation of interprovincial differences that have been outlined herein. Labour productivity differences arise from a large number of factors. They can differ because of differences in capital intensity. They can occur because the same industry is at a different stage in the industrial process—where there is a different level of materials processing. They can differ because plants are of different sizes and thus more able to exploit economies of scale. They can differ because some industries are more technologically advanced

than others. They can differ because some industries are more efficient than others. A simple examination of productivity differences cannot separate out which of these causes is the most important.

Appendix A: The Measurement of Productivity

Multifactor and labour productivity

Productivity is one of several key indicators of the economic health of an economy. It provides a measure of the productive capability of the economy—how much output an economy produces for a specific amount of resources that go into production.

Twenty years ago, Statistics Canada relied only on a single measure of productivity—the amount produced per hour-worked. This measure of productivity, often referred to as labour productivity, is sensitive to the amount of capital that is provided to workers, where capital refers to the investment made in machinery, equipment and buildings. Plants that have more capital tend to have a higher output per hour-worked.

For some purposes, it is important to know whether changes in output per hour worked just reflect changes in the amount of capital being provided to workers. As a result, the Statistics Canada productivity program also produces what has become known as a multifactor productivity measure. It bundles together both labour and capital, along with materials, in a single input measure. Other than that it is identical to the simpler measure of labour productivity. It represents the amount of output produced by a standardized input bundle that is made of labour, capital, and materials.

Statistics Canada's main estimates of productivity concentrate on measures of growth in productivity rather than on productivity levels. Why do we look at growth rather than level? We do so because changes in productivity capture our progress in improving our capability to produce output as we increase our inputs. Knowing whether you are getting more for less tells you something about the net effect of a host of factors—changes in technology, organizational reorganizations, and the extent to which economies of scale are being more fully exploited.

Statistics Canada's measure of labour productivity growth tracks changes in output per worker while its measure of multifactor productivity growth captures increases in output due to improvements in the production process less any increases in the bundle of inputs. For example, if output increases by 6% while combined inputs increase by 5%, we have a net increase of 1% in multifactor productivity.

What does the multifactor productivity growth measure give us? Some have referred to increases in multifactor productivity as being the "free lunch" that improvements in knowledge and in production techniques provide us. Improvements in productivity arise from real events. These events occur on the shop floor. Plants become larger and exploit scale economies, or use labour of higher quality, or adopt more advanced technology, or introduce better quality products—all of which can lead to productivity gains.

Despite the difficulties in determining the exact source of productivity growth, its measurement is seen to be important since it captures the extent to which our production efficiency has increased. And increases in this variable are normally reflected in measures like Gross Domestic

Product (GDP) per capita which people use to evaluate whether we are improving our standard of living. Aggregate multifactor productivity captures the sum total of all gains, measured at the plant level, that occur in all privately-owned plants across all industries in the economy.

While this is a brief summary of what a productivity measure captures, it is important to stress what it does not, as some have confused productivity growth with growth in other important economic measures.

Productivity growth does not measure changes in profits or wages. A businessman knows that he can increase efficiency, but if the price for his product falls, he may see his profits actually decline and he may be forced to pay his workers less if he is to remain in business. The same can happen for a nation. Productivity can go up, but less can be left for workers if the prices of their outputs have fallen. We can produce resources like oil or nickel more efficiently than anyone else in the world, but if no one wants to pay much for commodities, profits and wages may fall over time. Productivity can increase at the same time the standard of living is declining.

Measure of GDP per worker

As already noted, Statistics Canada's main productivity program measures growth in productivity rather than its level. Levels, however, are of interest especially for comparisons across regions or between countries. GDP per capita is simply the product of GDP per worker multiplied by the participation rate (the number of workers divided by the population). Most of the differences in GDP per capita across regions and across countries occurs because of differences in GDP per worker. And the latter is just a type of labour productivity measure.

GDP per worker measures involve both a price and quantity component since GDP is the sum of the dollar measures of the output of individual commodities or the output of individual industries, depending on whether GDP is measured from the expenditure side or from the industry side. Cross-country measures of GDP per worker involve a comparison of $\sum_i p_i Q_i / \sum_i L_i$ where Q_i is the unit of output i, p_i is its price and L_i is the number of workers producing output i.

If prices are the same across regions, as they would be if trade equates prices, then comparisons of GDP per worker yield comparisons of output per worker in constant dollars. The term constant dollars simply means that the prices that are used to aggregate the quantities are the same across countries. If prices are not the same, then the comparison can either use the prices of one country, or the prices of the other country, or some average of the two.

Many cross-country comparisons make use of a price ratio to try and correct for differences in prices across two countries. This is done by assuming that all prices are equal except for an exchange rate correction, or by measuring the price of each member of a bundle of final products or industries, and then by creating a relative price ratio that uses final demand weights in each country to aggregate individual prices. Then this relative price measure—sometimes called a purchasing parity price (PPP)—is used to correct the ratio of nominal GDP per capita to calculate what is referred to as relative real GDP. The latter is of course 'real' only in the sense that it uses a similar set of prices to weight all the outputs of each country.

Statistical agencies usually collect far more detailed data for the purposes of calculating individual price changes over time in order to estimate rates of change over time in real GDP than they do for calculating price relatives between countries for PPP estimation purposes. As such, productivity growth rates between two countries more accurately capture trends in relative productivity. But there will always be a demand for a measure of relative productivity that tries to correct for differences in prices between countries. And these are provided. However, it should be recognized that the number of prices that goes into the calculation of PPPs is generally much less than goes into the calculation of real growth rates within countries. Comparisons of relative GDP per worker across regions will therefore suffer from inaccuracy if the prices in the different regions differ and if the estimates of their differences are not very accurate.

Comparisons of GDP per worker must also be aware of the many factors that affect differences. The tendency to equate differences in these measures with just technical efficiency should be avoided. Differences in the levels of GDP per worker are affected by the same set of variables that determine differences in the *growth* in labour productivity. Regions may differ in capital intensity, in the quality of their workforce, or even in the rate of capacity utilization.

In this paper, we take the first step in comparing productivity across Canadian regions. Our comparison uses nominal GDP per worker without correcting for interprovincial price differences. This may not be a big problem if internal trade equates prices on average. The comparisons use only data from two years (1996-97) and thus may reflect the peculiarities of the economic cycle of each province. And no attempt has been made to correct for differences in capital intensity across provinces.

Future work will address some of these issues. The analysis will be extended to include data from the early 1990s, which will then be compared against the 1996-97 results. We also intend to produce data for 1998 and to develop provincial estimates of capital stock that are compatible with our labour estimates.

Appendix B: Concordance Between Working Level Industrial Classifications and Industrial Sectors

Appendix B includes the working level industrial codes and descriptions of each of the W level industries that are included in the aggregate industrial sectors that are used in this paper.

Agriculture, Fishing and Trapping:

W code	***Description***
1	Livestock farms
2	Field crop farms
3	Service industries incidental to agriculture
4	Fishing and trapping industries

Natural Resources:

W code	***Description***
5	Logging industry
6	Forestry services industry
7	Gold mines
8	Other metal mines
9	Iron mines
10	Asbestos mines
11	Potash mines
12	Salt mines
13	Other non-metal mines (except coal)
14	Coal mines
15	Crude petroleum and natural gas industries
16	Quarry and sand pit industries
17	Services industry incidental to mineral extraction

Core Manufacturing:

W code	***Description***
91	Power boiler and heat exchanger industry
92	Pre-engineered metal building industry (ex. portable)
93	Fabricated structural metal products industry not elsewhere classified
94	Ornamental and architectural metal productivity industry
95	Stamped, pressed and coated metal productivity industry
96	Wire and wire products industries
97	Hardware, tool and cutlery industries
98	Heating equipment industry
99	Machine shop industry
100	Other metal fabricating industries
101	Agricultural implement industry
102	Commercial refrigeration and air conditioning equipment industry
103	Compressor, pump, turbine & other equipment industry
104	Construction, mining & handling machinery industry
105	Sawmill, woodwork & other M&E industry not elsewhere classified
121	Small electrical appliance industry
122	Major appliance industry (electric and non-electric)
123	Electric lighting industries
124	Record player, radio and television receiver industry
125	Telecommunication equipment industry
126	Electronic parts and components industry
127	Other communication and electronic equipment industry
128	Electronic computing and peripheral equipment industry
129	Electronic & other office, store & business mach. industry
130	Electrical transformer industry
131	Switchgear, protection & other electrical industry equipment industry
132	Communications and energy wire and cable industry
133	Battery industry
134	Miscellaneous electrical products industries
143	Refined petroleum products industries
144	Other petroleum and coal products industries
145	Industrial inorganic chemical industries not elsewhere classified
146	Industrial organic chemical industries not elsewhere classified
147	Agricultural chemical industries
148	Plastic and synthetic resin industry
149	Pharmaceutical and medicine industry
150	Paint and varnish industry
151	Soap and cleaning compounds industry
152	Toilet preparations industry
153	Other chemical products industries

Secondary Manufacturing:

W code	***Description***
38	Tire and tube industry
39	Rubber hose and belting industry
40	Other rubber products industries
41	Natural fibres processing and felt products industry
42	Foamed and expanded plastic products industry
43	Plastic pipe and pipe fittings industry
44	Plastic film and sheeting industry
45	Plastic bag industry
46	Other plastic products industries not elsewhere classified
83	Ferro-alloys industry and steel foundries
84	Other primary steel industries
85	Steel pipe and tube industry
86	Iron foundries
87	Non-ferrous metal smelting and refining industry
88	Aluminum rolling, casting and extruding industry
89	Copper and copper alloy roll., cast. and extr. industry
90	Other roll., cast & extr. non-ferrous met. prod. industry
106	Aircraft and aircraft parts industry
107	Motor vehicle industry
108	Truck and bus body and trailer industries
109	Motor vehicle engine and engine parts industry
110	Motor vehicle wiring assemblies industry
111	Motor vehicle stampings industry
112	Motor vehicle steering and suspension parts industry
113	Motor vehicle wheel and brake industry
114	Plastic parts and access. for motor vehicles industry
115	Motor vehicle fabric accessories industry
116	Other motor vehicle accessories, parts & assembly industry
117	Railroad rolling stock industry
118	Shipbuilding and repair industry
119	Boatbuilding and repair industry
120	Other transportation equipment industries
135	Clay products industries
136	Hydraulic cement industry
137	Concrete products industries
138	Ready-mix concrete industry
139	Glass and glass products industries
140	Abrasives industry
141	Lime industry
142	Other non-metallic mineral products industries

Other Manufacturing:

W code	***Description***
18	Meat and meat products industry (except poultry)
19	Poultry products industry
20	Fish products industry
21	Fruit and vegetable industries
22	Dairy products industries
23	Cereal grain flour, flour mixes, & cereal food industry
24	Feed industry
25	Vegetable oil mills (except corn oil)
26	Biscuit industry
27	Bread and other bakery products industry
28	Cane and beet sugar industry
29	Chewing gum, sugar and chocolate confectionery industry
30	Tea and coffee industry
31	Other miscellaneous food products industries
32	Soft drink industry
33	Distillery products industry
34	Brewery products industry
35	Wine industry
36	Leaf tobacco industry
37	Tobacco products industry
47	Leather tanneries
48	Footwear industry
49	Miscellaneous leather and allied products industry
50	Man-made fibre and filament yarn industry
51	Other spun yarn and woven cloth industries
52	Wool yarn and woven cloth industry
53	Broad knitted fabric industry
54	Canvas and related products industry
55	Other textile products industries
56	Carpet, mat and rug industry
57	Men's and boys' clothing industries
58	Women's clothing industries
59	Children's clothing industry
60	Miscellaneous clothing and apparel industries
61	Hosiery industry
62	Sawmill, planing mill and shingle mill prod. Industry
63	Veneer and plywood industries
64	Prefab. wood. build., kitchen cabinet & vanity industry
65	Wooden door, window and other millwork industry
66	Wooden box and pallet industry
67	Coffin and casket industry
68	Particle and wafer board industries
69	Wood preservation & other wood industry n.e.c
70	Household furniture industries

71 Office furniture industries
72 Other furniture and fixture industries
73 Pulp industry
74 Newsprint industry
75 Paperboard, building board and other paper industry
76 Asphalt roofing industry
77 Paper box and bag industries
78 Other converted paper products industries
79 Commercial printing industries
80 Publishing industries
81 Combined publishing and printing industries
82 Platemaking, typesetting and bindery industry
154 Indicating, recording and controlling instrument Industry
155 Other scientific and professional equipment industry
156 Jewellery and precious metal industries
157 Sporting goods industry
158 Toys and games industry
159 Sign and display industry
160 Floor tile, linoleum and coated fabric industry
161 Musical instrument and sound recording industry
162 Miscellaneous manufactured products industry not elsewhere classified

Construction:

W code	***Description***
163	Repair construction
164	Residential construction
165	Non-residential building construction
166	Road, highway and airport runway construction
167	Gas and oil facility construction
168	Electric power, dams and irrigation construction
169	Railway, and telecommunication construction
170	Other engineering construction
171	Construction, other activities

Services –Medium Wage:

W code	***Description***
172	Air transport and related service industries
173	Railway transport and related service industries
174	Water transport and related services industries
175	Truck transport industries
176	Urban transit systems industry
177	Interurban and rural transit systems industry
178	Taxicab and other transportation industries
179	School and other bus operations industries
180	Other service industry incidental to transportation
185	Radio and television broadcasting industries
186	Cable television industry
187	Telecommunication carriers industries
188	Postal and courier service industries
202	Computer and related services
203	Accounting and legal services
204	Architectural, eng., & oth. scientific & tech. serv.
205	Advertising services
206	Miscellaneous business service industries

Services –High Wage:

W code	***Description***
181	Natural gas pipeline transport industry
182	Crude oil and other pipeline transport industries
183	Grain elevator industry
184	Other storage and warehousing industries
189	Electric power systems industry
190	Gas distribution systems industry
191	Water systems and other utility industries not elsewhere classified
192	Wholesale trade industries
194	Central bank
195	Banks and other deposit accepting intermediary
196	Credit unions and caisses populaires
197	Other financial intermediary industries
198	Real estate operator industries
199	Insurance and real estate agent industries
200	Insurance industries

Services –Low Wage:

W code	***Description***
193	Retail trade industries
210	Accommodation service industries
211	Food and beverage service industries

Omitted Working Level Industries:

W code	***Description***
201	Owner occupied dwellings
208	Other health and social service industries
209	Health practitioners & medical laboratories industry
224	Operating supplies
225	Office supplies
226	Cafeteria supplies
227	Laboratory supplies
228	Travel & entertainment
229	Advertising & promotion
230	Transportation margins
231	N.B. - P Religious organizations
232	N.B. - P Welfare organizations
233	N.B. - P Sports & recreation clubs
234	N.B - P Educational institutions
235	N.B. - P Other organizations
236	N.B. - G Hospitals
237	N.B. - G Residential care facilities
238	N.B. - G University education
239	N.B. - G Other educational serv.
240	N.B. - G Defence services
241	N.B. - G Other municipal govt.
242	N.B. - G Other provincial & territorial govt.
243	N.B. - G Other federal govt.

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