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Sectoral Contributions to Labour Productivity Growth

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EXECUTIVE SUMMARY

Addressing Canada's slow productivity growth has become a public policy priority. However, this paper argues that declines or slower growth in aggregate labour productivity should not automatically be interpreted as a deterioration in living standards. Improvements in an economy's terms of trade also play a crucial role in advancing living standards. Low rates of productivity growth may, in some cases, result from welfare-enhancing reallocations of labour into sectors with lower labour productivity.

Using the generalized exactly additive decomposition (GEAD) methodology, this study analyzes the contribution of 15 business sectors to Canada's aggregate productivity growth from 1997 to 2019. The findings show that labour productivity in Canada's business sector increased by 30.7 per cent over this period, averaging an annual growth rate of 1.2 per cent. Notably, the finance, insurance and real estate (FIRE) sector made the largest contribution to overall labour productivity growth. Conversely, the manufacturing sector was the only one to make a negative contribution due to declining relative prices and a reduced share of total labour input.

Three key takeaways emerge from this analysis:

1. **Industry-Level Focus for Productivity Growth**: A comprehensive productivity agenda should prioritize changes at the industry level to identify the sources of aggregate productivity growth effectively. Understanding sector-specific dynamics allows for more targeted policy interventions.
2. **Labour Reallocation as a Growth Strategy**: Shifting resources, particularly labour, to higher value sectors is essential for driving productivity growth. The study highlights that labour reallocation effects significantly impacted productivity trends in multiple sectors.
3. **The Role of Relative Prices in Income Growth**: The price of an industry's output influences its contribution to aggregate income growth. Panel regression models reveal that changes in relative prices indirectly affect output per hour by influencing labour allocation.

The research highlights that while overall labour productivity grew, sectoral contributions varied. The FIRE sector contributed the most, adding 8.7 percentage points to aggregate productivity growth, mainly through its within-sector productivity effects. However, this was slightly offset by negative relative price and labour reallocation effects. The mining, oil and gas extraction sector made the second largest contribution (4.7 percentage points), despite a within-sector productivity decline, as positive relative price and labour reallocation effects compensated for the loss.

In contrast, the manufacturing sector negatively impacted productivity growth by 3.6 percentage points. While it experienced within-sector productivity improvements, these were outweighed by a sharp decline in its relative price and a substantial reduction in its share of labour input.

The findings align with recent remarks by Carolyn Rogers, the senior deputy governor of the Bank of Canada, who emphasized two strategies for improving productivity: focusing on high-value industries and enhancing efficiency within existing industries. This paper underscores that achieving strong productivity growth requires a dual approach — shifting resources to more valuable sectors while also improving efficiency across the economy.

Ultimately, productivity growth is not solely about increasing output with fewer inputs. It also involves strategic shifts toward industries that contribute more significantly to national income. Recognizing the role of relative price changes and sectoral labour reallocation is crucial for crafting effective productivity policies in Canada.

1. INTRODUCTION

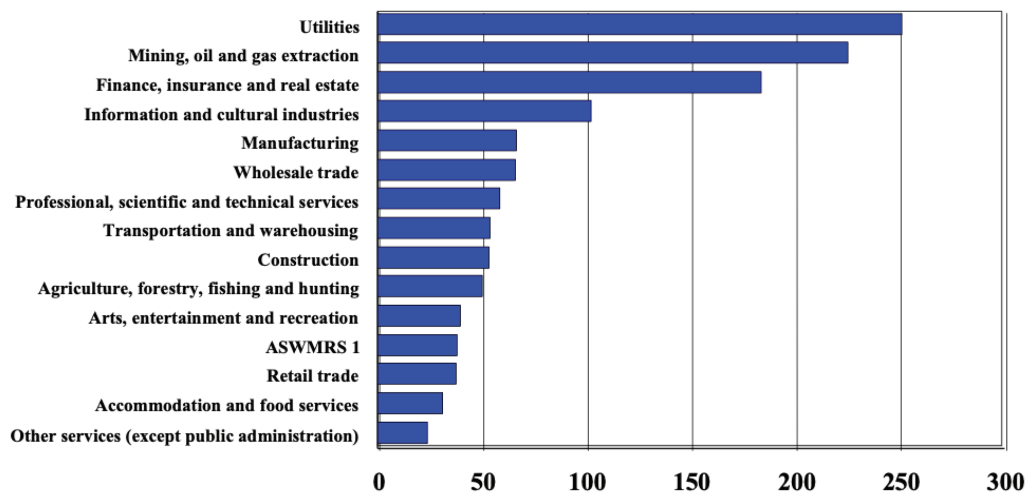
The recent wave of commentaries and reports on Canada's lacklustre productivity growth was sparked by Carolyn Rogers (2024), the senior deputy governor of the Bank of Canada, who noted that:

> Improving productivity in Canada needs to be a priority for everyone, and there are two basic strategies for doing it. One is to have the economy *focus more on the industries that add greater value than less-productive activities*. The other strategy is to keep doing the jobs we're doing but do them more efficiently. Ideally, Canada would use both strategies, leading to an economy with strong productivity growth and a large concentration of high-value industries. (Emphasis added)

Rogers' statement highlights the often overlooked role of focusing on industries of greater value as a means of boosting productivity growth. Increasing productivity means not only producing more output with the same or fewer inputs; it also means producing more outputs in industries that add more value to national income by shifting resources to those sectors. In a market economy, the sectors producing more valuable outputs are those receiving higher prices.

Figure 1 shows nominal GDP per hour of labour input in 2019 for 15 two-digit industries in the business sector. Three sectors — utilities, mining, oil and gas extraction; and finance, insurance and real estate — produced more than $175 of output per hour of labour input. With the exception of information and cultural industries, the other sectors produced less than $75 per hour of labour input. Shifting labour input to the higher valued sectors, especially the top three sectors, would generate substantial productivity gains.

Figure 1. GDP Per Hour of Labour Input in 2019



1 Administrative and support, waste management and remediation services
Source: Stat Can Tables 36-10-0401-01 and 36-10-0208-01

Utilities (especially electricity generation) are publicly owned enterprises in most provinces, and productivity gains in that sector are largely determined by governments' investment and pricing policies. Mining, oil and gas is the privately owned sector with the highest labour productivity. However, studies such as Sharpe (2010) and Sharpe and Waslander (2014) have shown that the mining, oil and gas sector has experienced declining productivity over the last 20 years. Indeed, a recent paper by Loertscher and Pujolas. (2024, 494) concluded that the lack of total factor productivity (TFP) growth in the oil sector is the main reason for Canada's slow TFP growth and that "the difference in productivity growth between Canada and the United States can be attributed entirely to the oil sector." Gordon (2024) challenged the relevance of Loertscher and Pujolas' analysis by arguing that "TFP systematically under-estimates productivity growth in non-renewable extraction industries" because it does not account for changes in "the stock of the resource remaining in the ground." Whether conventional measures of TFP, such as those published by Statistics Canada, overstate or understate actual TFP in the non-renewable resource sectors depends on the trend in the ratio of resource reserves to physical capital (see Appendix 1). The conventional measure of TFP exceeds actual TFP when the ratio of reserves to capital is increasing, and it understates actual TFP when the ratio of reserves to capital is decreasing. The latter situation tends to occur with a depleting resource base. For example, the ratio of oil and gas reserves to the capital stock in the conventional oil and gas sector in Alberta steadily declined between 1997 and 2017, with an average annual rate of decline of 5.3 per cent.[1] (Since 2017, the ratio of reserves to capital has stabilized). This means that Statistics Canada's measure of TFP for the conventional oil and gas industry has underestimated its actual TFP over that 20-year period.

Some economists have recognized that conventional measures of TFP do not accurately reflect productivity improvements in non-renewable resource industries. See Lasserre and Ouellette (1988) for asbestos mining in Canada, Mitra (2019) for U.S. copper mining, Villena and Greve (2018) for Chilean copper mining, Managi et al. (2006) for oil production in the Gulf of Mexico and Syed et al. (2015) for Australian mining. The latter study also adjusts productivity measures for the timing lag between capital investments and output in mining projects.

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[1] Calculations based on data from the Alberta Energy Regulator (2024a, b) and Statistics Canada (2024a).

Because Statistics Canada's measures of TFP do not account for resource depletion, in this study we focus on labour productivity — output per hour of labour input — which has a more robust interpretation than current measures of TFP. Declines in labour productivity in non-renewable resource industries are widely observed phenomena because firms initially exploit the richest and least costly reserves. With cumulative production, higher cost and lower quality reserves that require more inputs per unit of output are then exploited. Cyclical factors also play a role. Higher resource prices make it worthwhile to develop lower grade deposits, with corresponding declines in output per unit of labour input.

With this background, we see three important takeaways from Rogers' remarks concerning Canada's productivity challenges. First, a productivity agenda should focus on productivity changes at the industry level to understand the sources of aggregate productivity growth. Second, shifting resources — labour input in particular — to the more valuable sectors in an economy is an important source of productivity growth. Third, the price of an industry's output affects its contributions to aggregate income growth.

Economists and statisticians have developed tools that provide insights into how these three factors affect aggregate labour productivity. The procedures decompose, or parse, how different sectors contribute to aggregate productivity growth. The Centre for the Study of Living Standards (CSLS) has over many years produced valuable reports on the sources of productivity growth in Canada. Sharpe (2010) developed a procedure for decomposing a sector's impact on aggregate productivity growth into a change in the sector's labour productivity and its impact on aggregate productivity through changes in its share of labour input.[2] This procedure is widely used and has become known as the CSLS decomposition procedure. However, in this paper we employ the less frequently used generalized exactly additive decomposition (GEAD) procedure because it distinguishes sectors' contributions to aggregate productivity growth through relative output price changes, as well as within-sector labour productivity effects and labour reallocation effects. We use the GEAD procedure to show how 15 sectors have contributed to aggregate business sector productivity growth in Canada from 1997 to 2019.

The paper is organized as follows. Section 2 provides a brief overview of the CSLS and GEAD procedures and why the latter has been used in this study. Section 3 uses a simple two-sector model, in which one sector exhibits diminishing labour productivity, to illustrate how a relative price shock can affect aggregate labour productivity. A numerical example shows how the GEAD methodology parses a price shock into within-sector, relative price and labour reallocation effects. In Section 4, the GEAD procedure is used to show the sectoral contributions to the business sector's aggregate labour productivity growth from 1998 to 2019. Special attention is given to the contrasting contributions of the mining, oil and gas sector and the manufacturing sector to aggregate productivity growth. In Section 5, we estimate panel regression models to gauge how changes in relative prices affect the allocation of labour across sectors in the same year and how this in turn affects sectors' labour productivity. The final section contains some concluding remarks.

The key takeaways in these sections are summarized below.

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2 See also Sharpe (2010); Baldwin and Willox (2016).

1. INDUSTRY-LEVEL FOCUS FOR PRODUCTIVITY GROWTH

- One should not automatically interpret declines, or slower growth rates, in aggregate labour productivity as deterioration in living standards because changes in an economy's terms of trade are also important.[3] Low rates of productivity growth may be the result of welfare improving changes in a country's terms of trade that shift labour to sectors with declining labour productivity. In this context, it is worthwhile noting that Canada's terms of trade improved by 11.4 per cent between 1997 and 2019, largely driven by higher prices for the mining, oil and gas extraction sector's output — a sector that experienced declining output per hour of labour input.
- Labour productivity in Canada's business sector increased by 30.7 per cent between 1997 and 2019, an average annual growth rate of 1.2 per cent. Aggregate within-sector labour productivity growth, which was positive in every year except 2008 and 2009, contributed 30.6 percentage points to aggregate productivity growth.
- Finance, insurance and real estate (FIRE) made the largest contribution to aggregate labour productivity growth, 8.7 percentage points, through its large within-sector labour productivity growth effect, 11.1 percentage points, which was slightly offset by a relative price effect (-1.6) and a labour reallocation effect (-0.8).
- Manufacturing was the only sector that made a negative contribution to aggregate productivity growth. Its positive within-sector labour productivity growth effect, 6.7 percentage points, was more than offset by its relative price effect (-2.9) and labour reallocation effect (-7.4). Overall, manufacturing pulled down business sector labour productivity growth by 3.6 percentage points.
- While the within-sector decline in labour productivity in mining, oil and gas extraction reduced aggregate labour productivity growth by 2.2 percentage points, this was more than offset by its positive relative price effect (3.5 percentage points) and its labour reallocation effect (3.4 percentage points). Overall, mining, oil and gas extraction made the second largest contribution to aggregate labour productivity growth — 4.7 percentage points.
- Panel regression models based on annual data from 1998 to 2019 indicated that a change in relative prices can indirectly influence some sectors' output per hour through induced changes in labour inputs. A 10-per-cent increase in the relative price of a sector's output was associated with a 2.1-per-cent increase in its share of labour input in that year. In three resource-based sectors — agriculture, forestry, fishing and hunting; mining and oil and gas extraction; and utilities, and five service sectors — wholesale trade; transportation and warehousing; information and cultural industries; FIRE; and arts, entertainment and recreation — labour productivity declined when the share of labour input increased in that year.

[3] The terms of trade is the ratio between an index of export prices and an index of import prices.

2. PROCEDURES FOR DECOMPOSING GROWTH RATES OF AGGREGATE LABOUR PRODUCTIVITY

Tang and Wang (2004) first proposed the GEAD procedure for parsing sectors' contributions to aggregate labour productivity growth and then Diewert (2015) further developed and extended it. Appendix 2 describes the key equations in the GEAD procedure. In this section, we provide a brief description of the CSLS and GEAD formulas and how they differ.

As previously noted, the GEAD procedure breaks down a sector's impact on aggregate labour productivity growth into within-sector labour productivity changes that directly affect aggregate productivity, a real (or relative) price effect which indicates how economy-wide productivity is affected by a change in an industry's output price and a labour reallocation effect from changes in an industry's share of labour input. The CSLS formula also includes a within-industry labour productivity effect and labour reallocation effects, in which the latter are broken down into reallocation effects based on industry differences in labour productivity levels and differences in labour productivity growth rates. While there are differences in how labour reallocation effects are defined, the main difference between the two decomposition formulas is that the GEAD incorporates relative output price changes while the CSLS does not.

De Alvillez (2012, 97) compared the results of the GEAD and CSLS decompositions of the growth rates of aggregate labour productivity growth at the two-digit industry level between 2000 to 2010. He noted that one of the key differences is that the GEAD formula reflects changes in the sectors' relative output prices and therefore the "overall *economic significance* of different sectors to aggregate labour productivity" (De Alvillez 2012, 114, emphasis in the original). His analysis showed that whereas the CSLS procedure indicated that the mining, oil and gas sector reduced aggregate labour productivity between 2000 and 2010, the GEAD procedure indicated that it made a large positive contribution to aggregate labour productivity because it incorporated the increase in the prices of oil and gas and minerals over that period. De Alvillez (2012, 115) concluded that "the GEAD formula captures the fact that mining and oil and gas extraction played a fundamental role in driving economic growth in Canada in this past decade." While the manufacturing sector made a positive contribution to aggregate labour productivity growth under the CSLS formula, due to its substantial within-sector productivity improvement, the GEAD formula indicated that it had a negative impact on aggregate productivity growth because of the decline in the relative price in manufactured goods over the 2000–2010 period (De Alvillez 2012, 111, Table 7).[4] A subsequent study by Calver and Murray (2016) found that the CSLS and GEAD procedures produced similarly contrasting contributions of mining, oil and gas and manufacturing to TFP growth between 1997 to 2014. In comparing these procedures, Calver and Murray (2016, 111) concluded that:

> The CSLS decomposition may be better suited for assessing how provinces and industries are contributing to "real" productivity growth nationally. However, the ultimate goal of public policy is not to maximize physical productivity growth, but the total value of production. From this point of view, incorporating price changes may be more relevant for understanding how changes in the value of output per unit of input have contributed to rising living standards. The GEAD is better suited for this purpose.

Our choice of the GEAD formula is then based on our view, consistent with Rogers' remarks, that we need to "focus more on the industries that add greater value than less-productive activities."

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[4] Reinsdorf (2015, 11) noted that the GEAD formula has some technical advantages over the CSLS formula but argued hat the latter is more consistent with "the conceptual definition of productivity growth as an outward movement in the production possibility frontier caused by improvements in technology or in the organization of production."

2. THE IMPACT OF RELATIVE PRICES ON AGGREGATE LABOUR PRODUCTIVITY

This section shows how a relative price shock can affect aggregate labour productivity based on a simple two-sector economy in which one sector exhibits diminishing labour productivity. For concreteness, we can think of this sector as mining and oil and gas extraction and the other sector with constant returns to scale, as manufacturing. This illustrative example should help readers interpret the decomposition results for the 15 business sectors in Section 4.

How a relative price shock can affect aggregate productivity is shown using a simple (introductory economics level) diagram and a numerical example which show how the GEAD procedure treats the shock's productivity effects. Figure 2 illustrates this basic model.[5] Labour is the only variable input used in the two sectors. The total labour input for the economy is fixed at H, the length of the horizontal axis. Sector 1 exhibits a diminishing marginal product of labour. Its labour input is measured from left to right on the horizontal axis and denoted by L_1. Sector 2 exhibits constant returns to scale. Its labour input is the difference between H and L_1. The output prices of both sectors are exogenously determined on world markets, and in the initial situation both prices are equal to one. The value of the marginal product of labour, VMPL, is the marginal product of labour multiplied by the output price. Initially, the value of the marginal product of labour in sector 1 is the $VMPL_{10}$ curve and the VMPL curve of sector 2 is the horizontal line. In a competitive economy, wage rates are equal to the value of the marginal product of labour. Competition in the labour market means the VMPLs are equalized across the sectors. Accordingly, in the initial situation, labour input in sector 1 is L_{10} and $(H - L_{10})$ in sector 2. While the VMPLs are equalized, the average product of labour, the APLs, are not. Because sector 1 exhibits a diminishing marginal product of labour, its average product of labour exceeds its marginal product. Thus, in the initial situation, the average product of labour in sector 1, APL_{10}, is greater than the average product of labour in sector 2. This means that aggregate labour productivity is a weighted average of the APLs in the two sectors, where the weights are, for example, their shares of the value of aggregate output.

Now consider a permanent increase in the relative price of sector 1's output. (One could think of this as an increase in the world oil price). In Figure 2, this change in relative prices is reflected in an upward shift in sector 1's VMPL curve. The labour market adjusts so that sector 1's labour input increases until the VMPL's equality is restored. Consequently, employment in sector 1 increases to L_{11}, and there is a corresponding decline in employment in sector 2. The increase in employment in sector 1 means that its average product of labour declines to APL_{11} in keeping with the decline in its marginal product of labour. In contrast, while employment in sector 2 declines, its APL remains constant. Aggregate labour productivity, the weighted average of the APLs in the two sectors, will be lower after the increase relative to price sector 1's output. Thus, a predicted consequence of an increase in the relative output price of a sector, such as mining and oil and gas extraction that exhibits diminishing marginal productivity, is a decline in aggregate labour productivity.

This prediction needs to be qualified because the model assumes the other sector's average product of labour remains constant as output and labour input decline. However, a more realistic model recognizes that within a sector, labour productivity varies across firms. The least productive firms with the lowest output per hour could be expected to cut back production more than the more efficient firms, thereby raising the sector's average output per hour of labour. This adjustment would offset the prediction of the simple two-sector model that an increase in

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5 I am grateful to Trevor Tombe for suggesting the use of this type of diagram.

the relative price of a sector with diminishing labour productivity would result in a decline in aggregate labour productivity.

Figure 2. Relative Price Changes and Labour Productivity

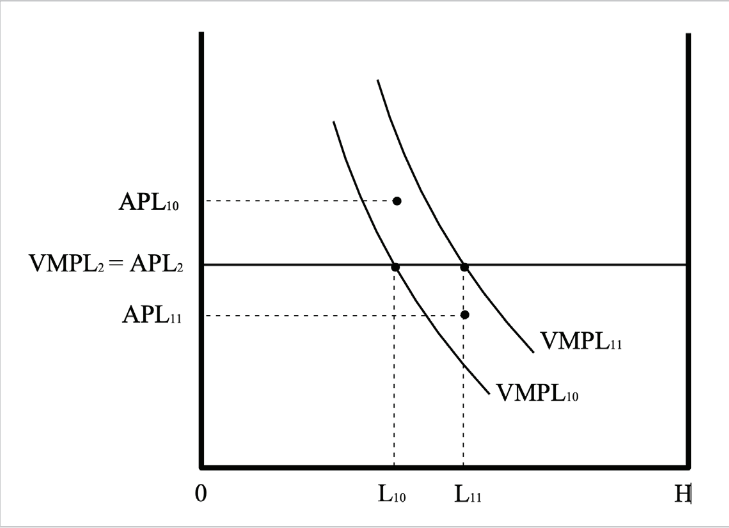

Table 1 shows a numerical example based on the two-sector model described above (see Appendix 3 for the model's equations). Here, we will only note that the parameters of sector 1's production function were chosen so that they generated the relative shares of labour input and nominal GDP in the mining, oil and gas (MOG) sector and the manufacturing (MFG) sector in 1997.[6] The second column shows the base case values of the key variables, with P_i the nominal output price, Y_i real output, x_i average productivity and sl_i the share of labour input in sector i. NGDP is nominal GDP, i.e., GDP measured at current prices. RGDP is real GDP measured at the base case prices. IPI is the implicit price index used to convert NGDP to RGDP. (In the base case, with both prices set equal to one, RGDP is the same as NGDP and the IPI is one). For simplicity, it is assumed that there are H = 100 units of labour in the economy. X is aggregate labour productivity, with X = RGDP/H. It is important to note that in the base case, average labour productivity in sector 1 is 3.359 times higher than in sector 2. This was the relative labour productivity level of the MOG and MFG sectors in 1997.

The third column shows how an increase in sector 1's relative output price affects this economy's allocation of labour between the two sectors, the changes in labour productivity in the two sectors and how the GEAD procedure decomposed these productivity effects into within-sector effects, relative price effects and labour reallocation effects. We begin by noting that although nominal prices of both sectors' outputs increase, the relative price of sector 1's output virtually doubles. Consistent with the model in Figure 2, the output of sector 1 increases and its share of labour increases 7.1 per cent to 18.7 per cent. The output of sector 2 declines in proportion to its decline in labour input, but its average labour productivity remains constant. By contrast, average labour productivity in sector 1 declines by almost 50 per cent. Real GDP (measured at base case prices) and aggregate labour productivity decline by 3.1 per cent.

6 The parameter values imply that sector 1's supply elasticity is 0.425 and the elasticity of substitution of production (a measure of the responsiveness of the ratio of the sectors' outputs to a change in relative output prices) is 0.256.

The bottom section of the table shows how the GEAD procedure breaks down the change in aggregate labour productivity into three components in each sector. It is important to interpret each of these components as the effect they would have on aggregate labour productivity in the absence of a change in the other components. First, the within-sector labour productivity changes are denoted by the Δx_i. In the absence of relative price and labour reallocation effects, the decline in sector 1's labour productivity would have reduced aggregate labour productivity by 24.2 per cent. As there was no change in sector 2's labour productivity, it had no effect on aggregate labour productivity. Second, the relative price effects are denoted by Δp_i. Again, in the absence of within-sector productivity changes and changes in the industries' shares of labour input, the increase in the relative price of sector 1's output would increase aggregate labour productivity by 14.6 per cent, while the decrease in the relative price of sector 2's output would reduce it by 16.1 per cent. Thus, the relative price effects in the two sectors are largely offsetting. The total relative price effect reduced aggregate productivity by 1.4 per cent because sector 2 represented a larger share of GDP in the base case. Third, the increase in the share of labour employed in sector 1 would have increased aggregate labour productivity, in the absence of within-sector and relative price effects, by 31.4 per cent. The corresponding reduction in sector 2's labour input share would have reduced aggregate labour productivity by 8.9 per cent. The combined labour input reallocation effects would have increased aggregate labour productivity by 22.5 per cent. The 3.1-per-cent reduction in aggregate labour productivity in this example is equal to the sum of the within-sector labour productivity effect (-24.2), relative price effect (-1.4) and labour reallocation effect (22.5).

The current flurry of public policy commentaries have universally interpreted declines (or slow growth) in labour productivity as synonymous with poor economic performance. But does this hold true when a decline in average labour productivity is caused by an increase in the relative price of a sector that exhibits diminishing marginal productivity? The answer depends on whether the economy is a net exporter or importer of the goods whose prices have increased. An increase in the relative price of an economy's exports represents an improvement in its terms of trade. This means it can consume more of its imported goods, while giving up less of its exported goods in return. Households' consumption possibilities thus improve with an increase in an economy's terms of trade. This example therefore illustrates why we should not simply associate declines, or slower growth rates, in aggregate labour productivity with a deterioration in living standards. Changes in an economy's terms of trade can be as important as changes in aggregate labour productivity in determining a country's living standards. In this context, it is worthwhile noting that while Canada's annual growth rate of business sector labour productivity was only 1.2 per cent between 1997 and 2019, our terms of trade improved by 11.4 per cent over that period,[7] largely driven by an improvement in mineral, oil and gas prices.[8] Conesa and Pujolas (2019) show that improvements in Canada's terms of trade from 2002 to 2014 were more important than TFP for the growth of gross domestic income (GDI) and helped narrow the gap in GDI growth between the United States and Canada.

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7 Calculations based on data in OECD (2022).

8 See Finlayson and Williamson (2024) on the importance of exports of oil and gas for Canada's balance of payments and maintaining Canadians' standard of living.

Table 1. Decomposition of Labour Productivity Changes from a Relative Price Change

	Base Case	An Increase in the Relative Price of Sector 1's Output
P_1	1	2.5
P_2	1	1.3
Y_1	23.8	31.8
Y_2	92.9	81.3
x_1	3.4	1.7
x_2	1.0	1.0
sl_1	0.1	0.2
sl_2	0.9	0.8
NGDP	116.7	183.2
RGDP	116.7	113.1
IPI	1.0	1.6
X	1.2	1.1
Percentage Change in Aggregate Labour Productivity		-3.1
Decomposition of Aggregate Labour Productivity Change (%)		
Δx_1		-24.2
Δx_2		0.0
$\Sigma \Delta x_i$		-24.2
Δp_1		14.6
Δp_2		-16.1
$\Sigma \Delta p_i$		-1.4
Δsl_1		31.4
Δsl_2		-8.9
$\Sigma \Delta sl_i$		22.5

3. SECTORAL CONTRIBUTIONS TO AGGREGATE LABOUR PRODUCTIVITY, 1998 TO 2019

With this background, we now consider sectoral contributions to the business sector's aggregate labour productivity growth from 1998 to 2019. This time period is dictated by the available data. Consistent sectoral data on labour productivity are only available since 1997 and nominal GDP data are only available up to 2020.[9] The pandemic had large and widely varying impacts on production and employment across sectors and these distorted measures of labour productivity. Accordingly, we only consider changes in labour productivity up to 2019.

Figure 3. Components of the Business Sector Labour Productivity Growth, 1998 to 2019

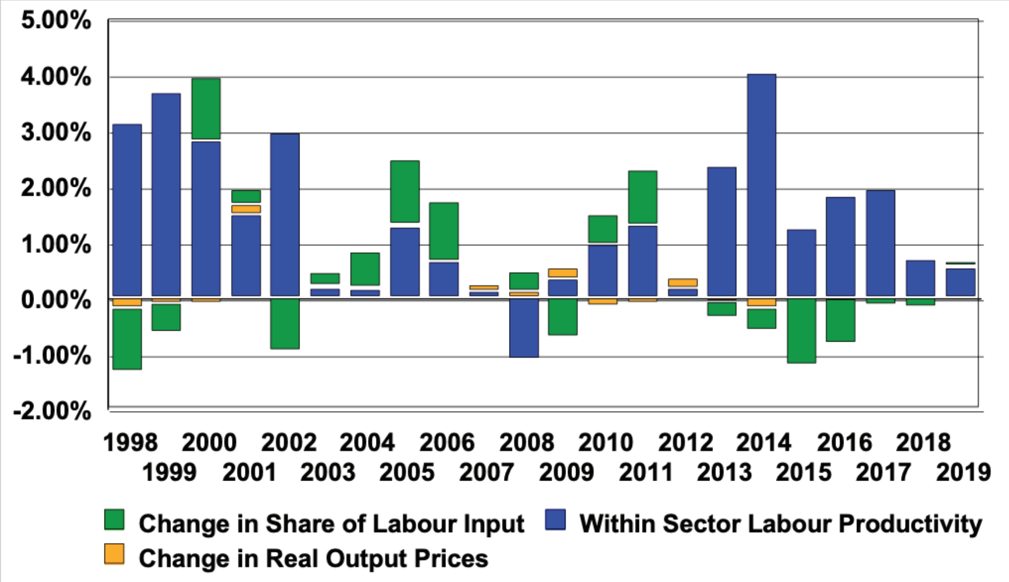
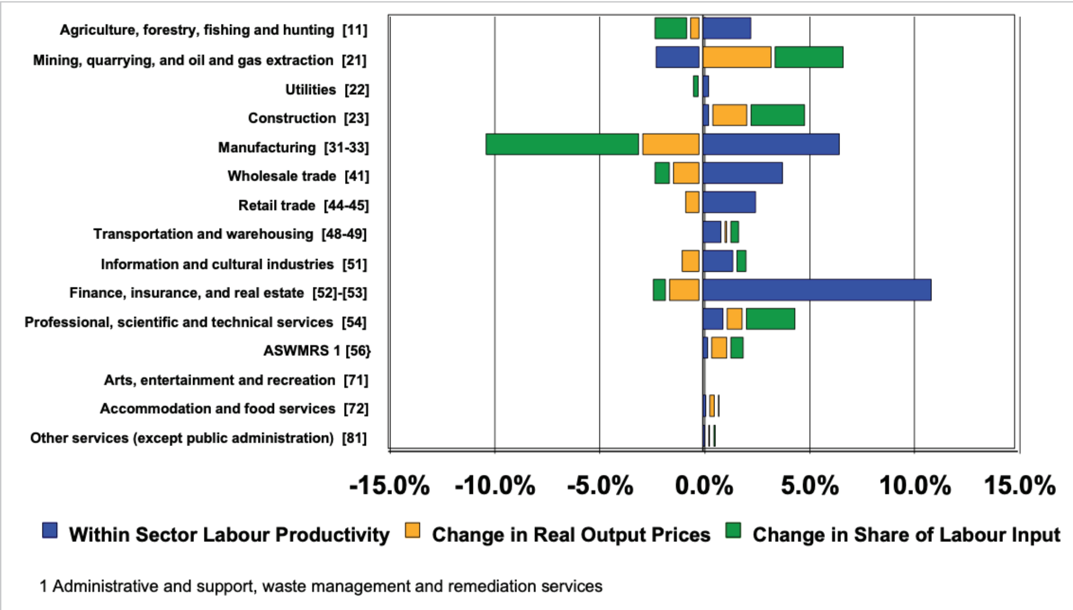


Figure 3 shows how within-sector labour productivity growth, changes in relative output prices and changes in labour input shares have contributed to annual business sector labour productivity growth. To get the total percentage change in business sector labour productivity, we add the within-sector labour productivity increases from 1998 to 2019 (the blue bars), add the changes in the sector's shares of labour input (the green bars) and the changes in the sector's real (or relative) output prices (the salmon-coloured bars) — 30.7 per cent, or an average annual growth rate of 1.2 per cent. Aggregate within-sector labour productivity growth, which was positive in every year except 2008 and 2009, contributed 30.6 percentage points to aggregate productivity growth. Changes in labour input shares made positive contributions to aggregate labour productivity growth in 10 of the 22 years under study, largely coinciding with the periods of increasing oil and gas prices. While the impacts of changes in labour input shares were relatively large in some years, with an average absolute value of 0.6 percentage points, the net contribution to aggregate labour productivity growth over the entire period was only 0.06 percentage points. Relative output price changes made only small contributions to aggregate labour productivity growth in most years because, as our numerical example above illustrates, the effects of increases in relative prices of some sectors are offset, at least to some extent, by declines in other sectors.

[9] Based on Statistics Canada (2024b, c, 2025) data for real GDP, nominal GDP and for hours of labour input by sector.

Figure 4. Sectoral Components of Labour Productivity Growth, 1998 to 2019 (Percentage Points)



The impact of changes in labour input shares and relative input prices on aggregate labour productivity emerges when we examine their contributions at the sectoral level. As shown in Figure 4, finance, insurance and real estate (FIRE) made the largest contribution to aggregate labour productivity growth, 8.7 percentage points, through its large within-sector labour productivity growth effect, 11.1 percentage points, which was slightly offset by a relative price effect (-1.6) and labour reallocation effect (-0.8). Manufacturing was the only sector that made a negative contribution to aggregate productivity growth. Its positive within-sector labour productivity growth effect, 6.7 percentage points, was more than offset by its relative price effect (-2.9) and labour reallocation effect (-7.4). Overall, manufacturing pulled down business sector labour productivity by 3.6 percentage points.[10]

By contrast, while the within-sector decline in labour productivity in mining, oil and gas extraction reduced aggregate labour productivity growth 2.2 percentage points, this was more than offset by its positive relative price effect (3.5 percentage points) and its labour reallocation effect (3.4 percentage points). Overall, mining, oil and gas extraction made the second largest contribution to aggregate labour productivity growth, 4.7 percentage points. As Tombe (2024) pointed out, declining within-sector productivity in the oil and gas sector "is a consequence of a strong and growing resource sector — with corresponding benefits for Canada's economy — not the reverse."

To get a better appreciation of the sources of the divergent experiences of mining, oil and gas extraction and manufacturing, Figures 5 and 6 show the year-by-year decomposition of their contributions to aggregate labour productivity growth.

[10] This result contrasts with the Sharpe (2010) and Baldwin and Willox (2016) studies which found that manufacturing made positive contributions to labour productivity during periods that overlap with this study. Their studies used the CLSL methodology and did not include the relative price effect. Conesa and Pujolas (2019) found that manufacturing had a positive TFP growth, but that measure does not include the negative relative price and reallocation effects on labour productivity.

Figure 5. Components of the Mining, Oil and Gas Sector's Contributions to Business Sector Labour Productivity Growth Rates

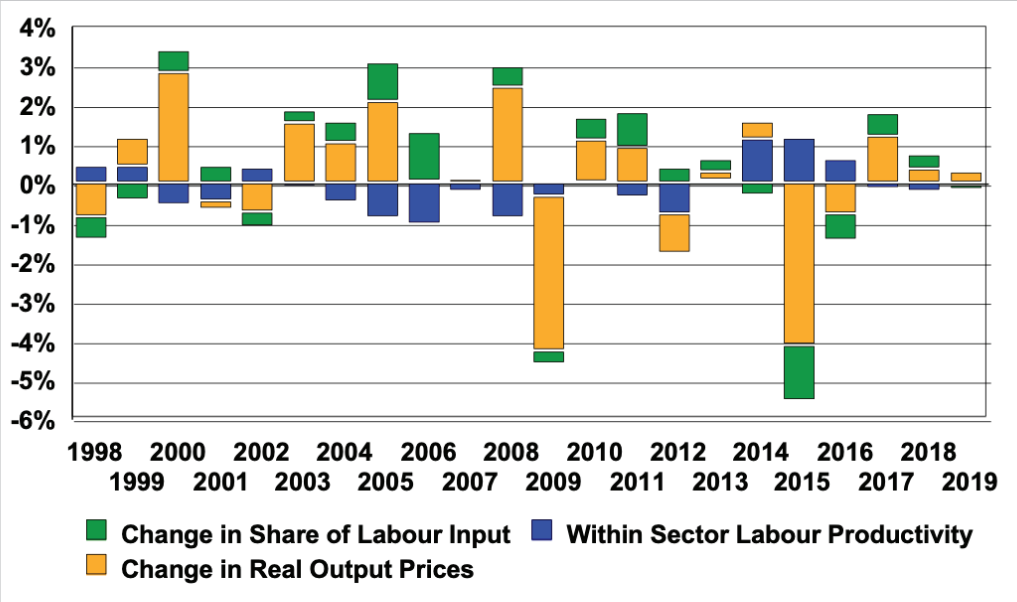
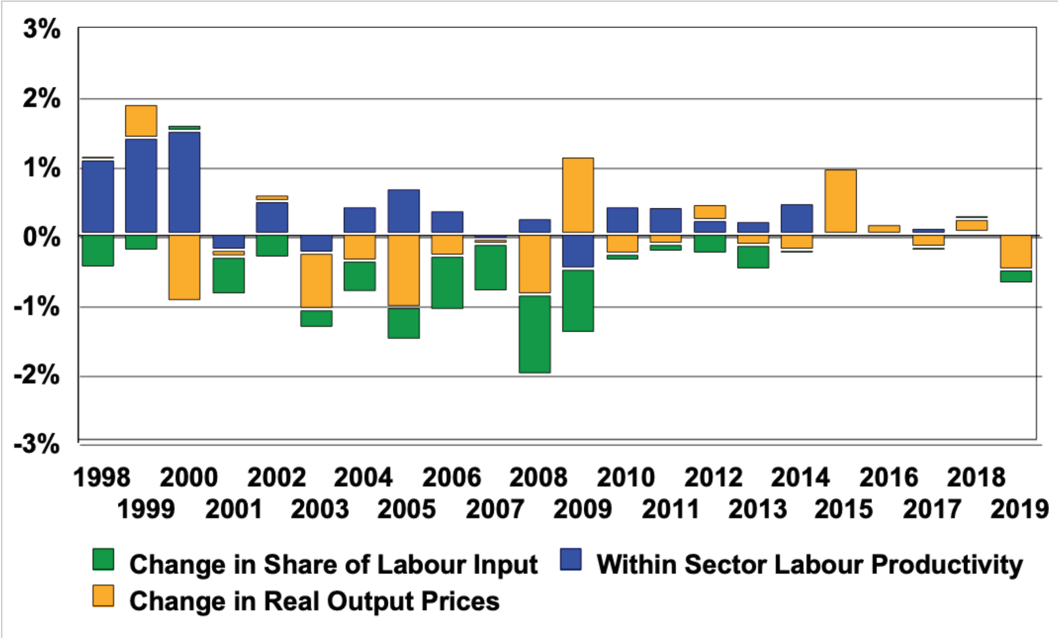


Figure 5 shows that within-sector labour productivity declined in the MOG sector in 14 of the 22 years between 1998 and 2019. The only period of consistent within-sector labour productivity improvements was 2014–2016. Those were years in which MOG's share of the employment declined, as shown by the negative green bars in those years, driven by the layoffs in the oil and gas sector with the collapse in world oil prices in 2015, as evidenced by the -4.1 percentage point relative price effect. A decline in world oil prices in 2009 had a similar negative relative price effect on aggregate labour productivity. MOG's relative price effects made a positive contribution to business sector labour productivity growth in 15 years while its labour reallocation effect had a total positive effect in 13 years. As noted above, the MOG sector made a large positive contribution to the increase in business sector labour productivity from 1998 to 2019 because the total relative price effects (3.5 percentage points) and the labour reallocation effect (3.4 percentage points) more than offset the decline in within-sector labour productivity (-2.2 percentage points).

Figure 6 shows the annual components of the manufacturing sector's contributions to business sector productivity growth. Within-sector labour productivity increased in 16 of the 22 years under study, but there were negative relative price effects in 14 years and negative labour reallocation effects in 20 years. The latter reflects the 18.4-per-cent decline in total hours worked in the manufacturing sector while total hours worked in the business sector increased by 28.2 per cent.

Figure 6. Components of the Manufacturing Sector's Labour Productivity Growth Rates



4. THE LINKS BETWEEN RELATIVE PRICE CHANGES, LABOUR REALLOCATION AND LABOUR PRODUCTIVITY GROWTH RATES

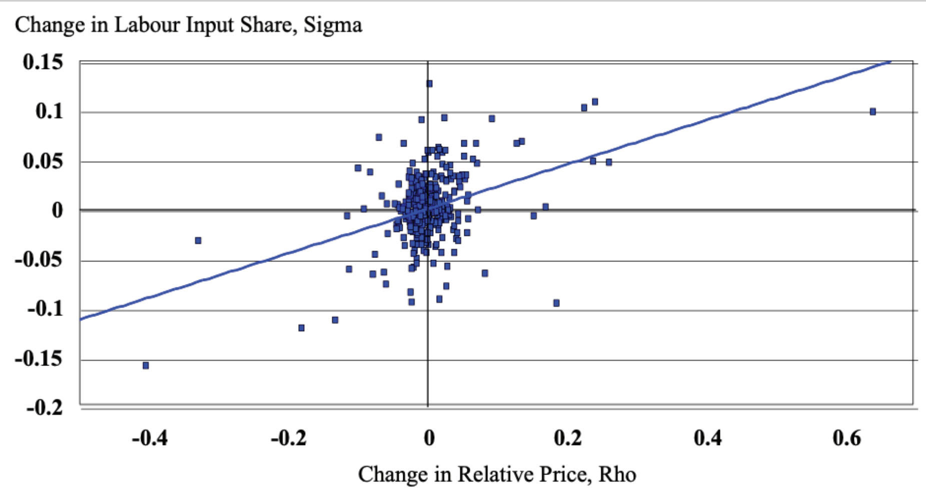
The GEAD is an accounting procedure for parsing sectoral contributions to aggregate business sector labour productivity growth. It is based on identities and therefore it is true by definition. What such accounting identities cannot do is explain the causal links between relative price changes, labour reallocations and changes in labour productivity at the sectoral level. As economists often say, "in an economy everything depends on everything else," which means that labour productivity, the allocation of labour and relative prices are jointly determined. However, as Canada is a small open economy, it is reasonable to assume that relative prices are largely determined on world markets. As the simple model in Section 3 suggests, changes in relative prices have their immediate or short-term impact through changes in the allocation of labour in the economy, as sectors receiving higher prices have an incentive to expand output by hiring more labour. Conversely, sectors with declining relative prices may contract and reduce labour input. The reallocation of labour between sectors then affects labour productivity in the short run before major adjustments in capital investments occur. Accordingly, we can postulate that in the short run, changes in relative prices drive changes in the allocation of labour in the economy, which in turn affects sectors' labour productivity.

Some very general impressions about these relationships can be garnered from Figure 4. There is a rather clear-cut positive correlation between relative price changes and changes in labour input shares. In 13 sectors, an increase (decrease) in the sector's relative price was associated with an increase (decrease) in the sector's labour input share. In other words, in all sectors (except information and cultural industries and retail trade) changes in employment shares were positively related to the change in the relative price of the sector's output. There is a more ambiguous relation between a sector's labour share and its change in labour productivity. In seven sectors, the blue bars and the green bars are on opposite sides of the zero line. In these sectors, within-sector labour productivity increases (decreases) were associated with reductions (increases) in the sector's labour input share. But in the other eight sectors, the opposite relationship holds.

The only study of the effects of relative price change on Canadian productivity that we are aware of is Dolega, Dupuis and Pichette (2010), which estimated a three-sector VAR model. They concluded that the increase in the relative price of primary products and the appreciation in the Canadian dollar had “a detrimental impact on labour productivity growth in the primary sector, a positive impact on manufacturing labour productivity growth, and a marginally negatively impact on labour productivity in the non-tradable sector” (Dolega, Dupuis and Pichette 2010, 13).

To provide a more formal analysis of the short-run impact of relative price changes on the allocation of labour and within-sector labour productivity, a regression model was estimated on panel data for 15 two-digit sectors based on annual data from 1998 to 2019. The regression results, which are shown in Figure 7 and Table 2, indicate that a sector’s share of labour input increases with its relative price. In other words, labour input was reallocated to sectors when their output became more valuable. The coefficient estimate, which is statistically significant with a t statistic of 7.89, indicates that a 10-per-cent increase in the relative price of a sector’s output was associated with a 2.1-per-cent increase in its share of labour input in that year. Sectors with declining relative prices faced corresponding declines in their shares of labour input.

Figure 7. Annual Changes in Labour Input Share and Changes in Relative Prices



Note: 330 observations on 15 sectors over 22 years;

Table 2. Panel Regression Model for Labour Input Shares

	Dependent Variable: Rate of Change in Sector i's Share of Labour Input in Year t $sigma_{it}$
Rate of Change in the Relative Output Price in Sector i in Year t rho_{it}	0.2133803
	(0.0270354)
Constant	0.0000303
	(0.0078559)

R^2 = 0.1888, 330 observations on 15 sectors over 22 years.

Fixed-effects regression model with year dummy variables (estimated coefficients not shown).
Robust estimates of standard errors shown in parentheses.

Table 3 shows the panel regression results for changes in a sector's output per hour. Both the sector's relative price change and the change in its share of labour input in year t are included as explanatory variables. The regression results indicate that an increase in a sector's share of labour input was associated with a decline in a sector's labour productivity in the same year. The coefficient estimate, which is statistically significant, implies that a 10-per-cent increase in a sector's share of labour input was associated with a 6.0-per-cent decline in its output per hour in that year. The coefficient of relative price changes is not statistically significant at the 95-per-cent confidence level. This is not surprising because, holding the share of labour input constant, the other market adjustments, such as changes in capital investments, resulting from a change in relative prices, are unlikely to be meaningful in the same year. However, if we combine the estimated coefficient estimate of an increase in relative prices on labour market shares with the latter's impact on a sector's labour productivity, we can infer that a 10-percentage-point increase in a sector's relative price is associated with a 1.3-per-cent decline in its output per hour of labour in that year. In summary, the regression models indicate that changes in relative prices can indirectly influence output per hour through the changes they induce in labour input across sectors.

Table 3. Panel Regression Model for Within-Sector Labour Productivity Growth Rates

	Dependent Variable: Rate of Change in Sector i's Output per Hour in Year t $gamma_{it}$
Rate Change in the Relative Output Price in Sector i in Year t rho_{it}	-0.0394118
	(0.0245901)
Rate of Change in Sector i's Share of Labour Input in Year t $sigma_{it}$	-0.6030652
	(0.048254)
Constant	0.00932
	(0.0046383)

R^2 = 0.5035, 330 observations on 15 sectors over 22 years.

Fixed-effects regression model with year dummy variables (estimated coefficients not shown).
Robust estimates of standard errors shown in parentheses.

The regression model in Table 3 is restrictive in the sense that changes in relative output prices and shares of labour input have the same effects in all sectors. As previously noted, the mining, oil and gas sector's labour productivity may decline with an increase in primary product prices, while the manufacturing sector's labour productivity may rise. To capture these differential effects, we re-estimated the model with an interactive sector dummy variable on the sector's share of labour input. The estimated equation has the following form:

$$gamma_{i,t} = a_0 + a_1 \cdot rho_{i,t} + a_2 \cdot sigma_{i,t} + \sum_{i=1}^{14} \alpha_i \cdot d_i \cdot sigma_{i,t} + \sum_{i=1}^{14} \beta_i \cdot d_i$$

where $gamma_{it}$ is the rate of change in within-sector labour productivity change, rho_{it} is the rate of change in sector i's relative price, $sigma_{it}$ is the rate of change in sector i's share of labour input and d_i is a dummy variable for sector i. Table 4 shows the results. We have highlighted the eight sectors where the sum of the coefficients $(a_2 + \alpha_i) < 0$ and the null hypothesis that the sum of the coefficients is equal to zero is rejected by Chi squared test. In other words, in these eight sectors the statistical results indicate that labour productivity declines when its share of labour input increases in that year. Note that this holds in both the resource sectors, agriculture et al., mining, oil and gas extraction and some service sectors such as transportation and warehousing, information and cultural industries, FIRE and arts, entertainment and recreation. What is also interesting is that in the other seven sectors, including manufacturing, the sum of the coefficients $(a_2 + \alpha_i)$ is not significantly different from zero.

5. CONCLUDING REMARKS

Canada's lacklustre labour productivity growth, especially compared to the United States, is a cause for concern because productivity growth is a key determinant of rates of increase in wages and salaries and ultimately, standards of living (see Williams 2021 and Dahlby 2024). However, low rates of productivity growth may be the result of welfare improving changes in a country's terms of trade that shift labour to sectors with declining labour productivity, such as the resource sector. Many commentators associate productivity improvements with technological innovations, with much recent attention on robotics and AI, and this is undoubtedly true over the long term. But little attention is paid to productivity improvements that arise from shifting resources — land, labour and capital — to sectors with more value output based on international prices. This essay has highlighted this over-neglected avenue to productivity growth and improvements in Canadians' standard of living.

Table 4. Panel Regression Model for Within-Sector Labour Productivity Growth Rates

	gama	Coef.	Std. Err.	z	P>z	[95% Conf	Interval]
	rho	-0.00421	0.027594	-0.15	0.879	-0.05829	0.049873
Sectors	sigma	-0.80364	0.289386	-2.78	0.005	-1.37083	-0.23645
Agriculture, forestry, fishing and hunting [11]	d1s	0.428967	0.335235	1.28	0.201	-0.22808	1.086015
Mining, quarrying, and oil and gas extraction [21]	d2s	-0.00873	0.29764	-0.03	0.977	-0.59209	0.574638
Utilities [22]	d3s	-0.1145	0.333746	-0.34	0.732	-0.76863	0.539627
Construction [23]	d4s	0.586962	0.34682	1.69	0.091	-0.09279	1.266717
Manufacturing [31-33]	d5s	1.188215	0.39242	3.03	0.002	0.419086	1.957345
Wholesale trade [41]	d6s	-0.08728	0.48009	-0.18	0.856	-1.02824	0.853685
Retail trade [44-45]	d7s	0.501254	0.440937	1.14	0.256	-0.36297	1.365474
Transportation and warehousing [48-49]	d8s	-0.14956	0.394039	-0.38	0.704	-0.92186	0.622745
Information and cultural industries [51]	d9s	0.249109	0.344984	0.72	0.47	-0.42705	0.925265
Finance, insurance, and real estate [52]-[53]	d10s	0.007065	0.417968	0.02	0.987	-0.81214	0.826267
Professional, scientific and technical services [54]	d11s	0.694942	0.385912	1.8	0.072	-0.06143	1.451315
Administrative and support, waste management and remediation services [56]	d12s	0.540704	0.353167	1.53	0.126	-0.15149	1.232898
Arts, entertainment and recreation [71]	d13s	0.057146	0.321512	0.18	0.859	-0.57301	0.687297
Accommodation and food services [72]	d14s	0.646951	0.433806	1.49	0.136	-0.20329	1.497196
Agriculture, forestry, fishing and hunting [11]	d1	0.024723	0.009294	2.66	0.008	0.006508	0.042939
Mining, quarrying, and oil and gas extraction [21]	d2	0.001038	0.00792	0.13	0.896	-0.01449	0.016561
Utilities [22]	d3	-0.00571	0.007891	-0.72	0.469	-0.02118	0.009756
Construction [23]	d4	-0.00221	0.008433	-0.26	0.793	-0.01874	0.01432
Manufacturing [31-33]	d5	0.015038	0.009482	1.59	0.113	-0.00355	0.033622
Wholesale trade [41]	d6	0.0137	0.008147	1.68	0.093	-0.00227	0.029667
Retail trade [44-45]	d7	0.010868	0.007844	1.39	0.166	-0.00451	0.026243
Transportation and warehousing [48-49]	d8	0.004272	0.007909	0.54	0.589	-0.01123	0.019772
Information and cultural industries [51]	d9	0.013654	0.007979	1.71	0.087	-0.00199	0.029293
Finance, insurance, and real estate [52]-[53]	d10	0.011673	0.007841	1.49	0.137	-0.00369	0.027041
Professional, scientific and technical services [54]	d11	0.000891	0.009085	0.1	0.922	-0.01691	0.018697
Administrative and support, waste management and remediation services [56]	d12	0.000832	0.008288	0.1	0.92	-0.01541	0.017077
Arts, entertainment and recreation [71]	d13	-0.00812	0.007874	-1.03	0.303	-0.02355	0.007314
Accommodation and food services [72]	d14	-0.00248	0.007924	-0.31	0.755	-0.01801	0.013054
	cons	0.009231	0.005632	1.64	0.101	-0.00181	0.02027

R^2 = 0.5257, 330 observations on 15 sectors over 22 years. Robust estimates of standard errors estimates.

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APPENDIX 1:
TOTAL FACTOR PRODUCTIVITY IN THE RESOURCE SECTOR

A resource industry's aggregate output in year t, Q_t, is a function of the labour input, L_t, capital inputs, K_t and established reserves, R_t. A Cobb-Douglas production function is assumed with constant returns to scale in labour, capital and reserves. Accordingly, the exponents on the inputs sum to one. Ω_t measures total factor productivity (TFP) in year t.

(1) $$Q_t = \Omega_t \cdot L_t^{\alpha} \cdot K_t^{\beta} \cdot R_t^{\gamma} \quad \alpha + \beta + \gamma = 1$$

γ is the economic rent from the resource as a share of the value of production.

The log of TFP is given by:

(2) $$ln(\Omega_t) = ln(Q_t) - (\alpha \cdot ln(L_t) + \beta \cdot ln(K_t) + \gamma \cdot ln(R_t))$$

The conventional measure of TFP does not include reserves in the production function for a resource industry. Instead, the conventional approach assumes the production function has the following form:

(3) $$Q_t = M_t \cdot L_t^{\alpha} \cdot K_t^{(1-\alpha)}$$

where M_t is conventional measure of TFP or what Statistics Canada refers to as multifactor productivity (MFP). Implicitly, this approach attributes the marginal product of reserves to capital.

Taking logs of (3) with (1 - α) = (β + γ)

(4) $$ln(M_t) = ln(Q_t) - \alpha \cdot ln(L_t) - (\beta + \gamma) \cdot ln(K_t)$$

Subtracting (2) from (4), we obtain a measure of the bias in the conventional measure of TFP for a resource industry.

(5) $$ln(M_t) - ln(\Omega_t) = \gamma \cdot ln\left(\frac{R_t}{K_t}\right)$$

The conventional measure of TFP in the resource sector exceeds the actual TFP when the ratio of reserves to capital is increasing, and it understates actual TFP when the ratio of reserves to capital is decreasing. The latter situation tends to occur with a depleting resource base. For example, the ratio of oil and gas reserves to the capital stock in the conventional oil and gas sector in Alberta steadily declined from 1997 until 2017, with an average annual rate of decline of 5.3 per cent. (Since 2017, the ratio of reserves to capital has stabilized). This means that Statistics Canada's MFP for conventional oil and gas industry has underestimated its actual TFP over that 20-year period.

APPENDIX 2:
EQUATIONS FOR THE GENERALIZED EXACT ADDITIVE DECOMPOSITION OF LABOUR PRODUCTIVITY

The following is based on the Diewert (2015) decomposition of economy-wide labour productivity X.

Y_{it} is output; L_{it} is labour input $X_{it} = \frac{Y_{it}}{L_{it}}$ is labour productivity in industry i in year t

X_t is aggregate labour productivity P_{it} is the price of output of sector i

P_t is the aggregate output price index $L_t = \sum_{i=1}^{n} L_{it}$ economy-wide labour input

$X_t = \sum_{i=1}^{n} \frac{P_{it} \cdot Y_{it}}{P_t} \cdot \frac{1}{L_t}$ $p_{it} = \frac{P_{it}}{P_t}$ is the relative output price of sector i

$X_t = \sum_{i=1}^{n} \frac{P_{it}}{P_t} \cdot \frac{Y_{it}}{L_{it}} \cdot \frac{L_{it}}{L_t} = \sum_{i=1}^{n} p_{it} \cdot sl_{it} \cdot X_{it}$ sl_{it} is the share of labour input in industry i in year t

$sy_{it} = \frac{P_{it} \cdot Y_{it}}{\sum_{i=1}^{n} P_{it} \cdot Y_{it}}$ sy_{it} is industry i's share of nominal GDP in year t

$$\frac{X_t}{X_0} = \frac{\sum_{i=1}^{n} \left(\frac{p_{it}}{p_{i0}}\right) \cdot \left(\frac{sl_{it}}{sl_{i0}}\right) \cdot \left(\frac{X_{it}}{X_{i0}}\right) \cdot \left(\frac{p_{i0} \cdot Y_{i0}}{L_0}\right)}{\sum_{i=1}^{n} \frac{p_{i0} \cdot Y_{i0}}{L_0}} = \sum_{i=1}^{n} \left(\frac{p_{it}}{p_{i0}}\right) \cdot \left(\frac{sl_{it}}{sl_{i0}}\right) \cdot \left(\frac{X_{it}}{X_{i0}}\right) \cdot sy_{i0}$$

$$\Gamma_t = \left(\frac{X_t}{X_0}\right) - 1 \qquad \gamma_t = \left(\frac{X_t}{X_0}\right) - 1 \qquad \rho_t = \left(\frac{p_t}{p_0}\right) - 1 \qquad \sigma_t = \left(\frac{sl_t}{sl_0}\right) - 1$$

$$\Gamma_t = \sum_{i=1}^{n} sy_{i0} \cdot \left(\left(1 + \gamma_i\right) \cdot \left(1 + \rho_i\right) \cdot \left(1 + \sigma_i\right) - 1 \right)$$

"Aggregate labour productivity growth is a quadratic function in the industry growth rates for labour productivity, real output price growth rates, and industry labour input share growth rates" Diewert (2015, 369).

$$\Delta x_i = sy_{i0} \cdot \gamma_i \cdot \left(1 + \frac{\rho_i}{2} + \frac{\sigma_i}{2} + \frac{\rho_i \cdot \sigma_i}{3}\right)$$

$$\Delta p_i = sy_{i0} \cdot \rho_i \cdot \left(1 + \frac{\gamma_i}{2} + \frac{\sigma_i}{2} + \frac{\gamma_i \cdot \sigma_i}{3}\right)$$

$$\Delta sl_i = sy_{i0} \cdot \sigma_i \cdot \left(1 + \frac{\gamma_i}{2} + \frac{\rho_i}{2} + \frac{\gamma_i \cdot \rho_i}{3}\right)$$

$$\Gamma_t = \sum_{i=1}^{n} \Delta x_i + \sum_{i=1}^{n} \Delta p_i + \sum_{i=1}^{n} \Delta sl_i$$

This is an exact expression for aggregate labour productivity growth.

Γ depends on real price growth rate in sector i because an increase in the real price of sector i's output increases the importance of the output of industry i in the economy-wide aggregate output index.

APPENDIX 3:
A TWO-SECTOR MODEL OF THE IMPACT OF RELATIVE PRICE CHANGES ON AGGREGATE LABOUR PRODUCTIVITY

Sector 1 exhibits diminishing marginal productivity of labour while the marginal product of labour in sector 2 is constant. Their respective production functions are:

$$Y_1 = A \cdot L_1^{\alpha} \qquad A > 0 \qquad 0 < \alpha < 1 \qquad Y_2 = B \cdot L_2 \qquad B > 0 \qquad L_1 + L_2 = H$$

$$x_1 = \frac{Y_1}{L_1} \qquad MPL_1 = \alpha \cdot A \cdot L_1^{\alpha - 1} = \alpha \cdot \frac{Y_1}{L_1} = \alpha \cdot x_1 \qquad x_1 = \frac{1}{\alpha} \cdot MPL_1 \qquad x_2 = \frac{Y_2}{L_2} = B$$

$$L_1 = \left(\frac{Y_1}{A}\right)^{\frac{1}{\alpha}} \qquad Y_2 = B \cdot \left(H - L_1\right) \qquad sl_1 = \frac{L_1}{H}$$

$$Y_2 = B \cdot \left(L - \left(\frac{Y_1}{A}\right)^{\frac{1}{\alpha}}\right)$$

This is the equation for the production possibilities curve.

$$MRT = \frac{dY_2}{dY_1} = \frac{MPL_2}{MPL_1} = \frac{-B}{\alpha \cdot A} \cdot \left(\frac{Y_1}{A}\right)^{\frac{1-\alpha}{\alpha}}$$

MRT is the marginal rate of transformation, the slope of the production possibility curve.

$$\frac{P_1}{P_2} = MRT = \frac{-B}{\alpha \cdot A} \cdot \left(\frac{Y_1}{A}\right)^{\frac{1-\alpha}{\alpha}}$$

This is the condition determining outputs of the sectors.

$$Y_1 = \left(\frac{\alpha}{B}\right)^{\frac{\alpha}{1-\alpha}} \cdot A^{\frac{1}{1-\alpha}} \cdot \left(\frac{P_1}{P_2}\right)^{\frac{\alpha}{1-\alpha}}$$

The elasticity of supply of sector 1 output is $\eta = \alpha/(1 - \alpha)$.

$$E = \frac{dln\left(Y_2\right)}{dln\left(Y_1\right)} = \frac{-1 \cdot \frac{sl_1}{sl_2} \cdot \frac{1}{1-\alpha}}{\frac{\alpha}{1-\alpha}} = -1 \cdot \frac{1}{\alpha} \cdot \frac{sl_1}{1 - sl_1}$$

This is the elasticity of substitution of production.

$$\alpha := 0.298 \qquad sl_1 := 0.071$$

$$E := -1 \cdot \frac{1}{\alpha} \cdot \frac{sl_1}{1 - sl_1} \qquad E = -0.256 \qquad \eta := \frac{\alpha}{1-\alpha} \qquad \eta = 0.425$$

About the Author

Bev Dahlby attended St. Peter's College, the University of Saskatchewan, Queen's University, and the London School of Economics. He was Professor of Economics at the University of Alberta from 1978 to 2012 and Distinguished Fellow in Tax and Economic Growth at the School of Public Policy at the University of Calgary from 2012 to 2020. Prof. Dahlby has published extensively on tax policy and fiscal federalism. He has served as an Associate Editor of *Canadian Public Policy* and a member of the editorial board of the *Canadian Tax Journal*. He has been a member of the Executive Council of the Canadian Economics Association and the National Statistics Council. Prof. Dahlby has also served as a policy advisor to the federal and provincial governments. He was a member of the Technical Committee on Business Taxation (Mintz Committee), the Expert Panel on Federal Support to Research and Development (Jenkins Panel), and the Ecofiscal Commission. In July 2016, he was appointed Chair of the British Columbia Commission on Tax Competitiveness by the BC Minister of Finance. In May 2019, he was appointed by the Government of Alberta to the Blue-Ribbon Panel to review the province's finances. His international experience includes advisory work on tax reform for the IMF in Malawi, for the Thailand Development Research Institute, and for the World Bank in Brazil and Mexico.

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