

Explaining the Gap between Productivity and Median Wage Growth in Canada, 1976-2014

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ABSTRACT

Canadian labour is more productive than ever before, but there is a pervasive sense among Canadians that the living standards of the 'middle class' have been stagnating. Indeed, between 1976 and 2014, median real hourly earnings grew by only 0.09 per cent per year, compared to labour productivity growth of 1.12 per cent per year. We decompose this 1.03 percentage-point growth gap into four components: rising earnings inequality; changes in employer contributions to social insurance programs; rising relative prices for consumer goods; and a decline in labour's share of aggregate income. Our main result is that rising earnings inequality accounts for half the 1.03 percentage-point gap, with a decline in labour's income share and a deterioration of labour's purchasing power accounting for the remaining half. Further analysis of the inequality component reveals that real wage growth in recent decades has been fastest at the top and at the bottom of the earnings distribution, with relative stagnation in the middle. Our findings are consistent with a 'hollowing out of the middle' story, rather than a 'super-rich pulling away from everyone else' story.

Motivation and Background

Canada's workers are more productive than ever. Between 1976 and 2014, Canada's labour productivity - the volume of goods and services produced in the average hour of work in Canada - increased by 52.5 percent, or 1.12 percent per year.

At the same time, a common view holds that Canada's 'middle class' is experiencing economic stagnation. In its 2016 budget, the Government of Canada expressed this view as follows:

[Even] though there has been economic growth over the past three decades, it hasn't much ben-

efitted the middle class. Too often, the benefits have been felt only by already wealthy Canadians, while the middle class and those working hard to join it have struggled to make ends meet. (Government of Canada, 2016)

Survey evidence confirms that this sentiment is pervasive among Canadians. Graves (2014) refers to an "almost universal public consensus that the middle class is in crisis." The share of Canadians who self-identify as 'middle class' fell from 67 per cent in the early 2000s to 47 per cent at the end of 2014 (EKOS Research, 2014). Canadian workers do not feel that their

1 James Ugucioni is a graduate student in the Department of Economics at the University of Toronto. The article was written while he was an economist at the Centre for the Study of Living Standards. He thanks Andrew Sharpe, Jasmin Thomas, Don Drummond, and Alexander Murray for comments. This article is an abridged version of Ugucioni, Sharpe and Murray (2016). Email: james.ugucioni@mail.utoronto.ca

improved productivity has raised their standard of living.

Evidence on wage growth in recent decades suggests that these workers may have a point. While cumulative growth in labour productivity over the period was 52.5 per cent, the hourly earnings of the median worker grew by only 3.3 per cent after adjusting for the rising cost of living. This disconnect between growing labour productivity and stagnant earnings for the median worker likely goes a long way toward explaining the prevailing sense of middle class malaise.

Economic history and economic theory suggest that labour productivity growth should generate rising living standards for workers over time, so the apparent disconnect between labour productivity growth and wage growth is puzzling. What factors account for it? In this article, the gap between labour productivity growth and median hourly earnings growth is decomposed into contributions from the following four sources:

- rising earnings inequality;
- changes in the importance of employer contributions to social insurance programs as a form of labour compensation;
- rising relative prices for consumer goods; and
- a decline in labour's share of aggregate income.

Each of these components has its own implications for the welfare of workers. To the extent that the productivity-earnings gap simply reflects a rising share of labour compensation being paid in the form of employer contributions to social insurance plans, for example, it is not obvious that workers are any worse off. On the other hand, rising earnings inequality or a

decline in labour's share of income represent more serious obstacles to broad-based prosperity.

If rising inequality is the leading driver of the productivity-earnings gap, is the story simply that super high-earning individuals are leaving everyone else behind? When we examine the wage data more closely, we uncover a subtler story. Wage growth in recent decades has been highest at the top and at the bottom of the wage distribution, with relative stagnation in the middle. These findings are consistent with a 'hollowing out of the middle' narrative, as one finds in the recent literature on the phenomenon of 'labour market polarization.'²

In the rest of the present section, we provide evidence on recent trends in labour productivity and in several measures of labour remuneration. Most of our results are evident in these trends, though our technical analysis later in the article will make the results quantitatively precise. We then discuss related literature. This material provides motivation and context for the more detailed analysis that follows.

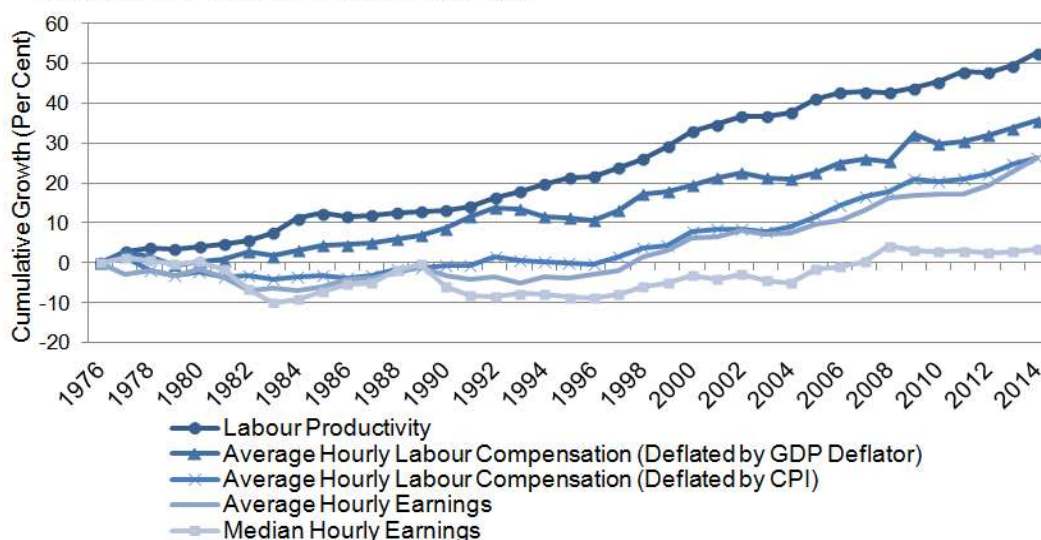
The remainder of the article is structured as follows. The second section describes our framework for decomposing the gap between labour productivity growth and median annual earnings growth into the components listed above. In the third section the results of the decomposition are presented for the full 1976-2014 period and for five sub-periods chosen based on the timing of business cycle peaks. The fourth and final section contains a concluding discussion.

Preliminary Evidence

Chart 1 depicts the prima facie evidence for the view that middle class living standards have

2 The literature on labour market polarization finds that technological change and globalization have led to a decline in middle-wage jobs in advanced economies, so that employment and wage growth occur only in high-wage and low-wage occupations. This occurs because traditional middle-wage jobs are the ones most susceptible to automation or outsourcing. See Autor and Dorn (2013), Autor *et al.* (2006) and Jaimovich and Siu (2012), among others.

Chart 1
Cumulative Growth in Labour Productivity and in Four Measures of Real Labour Remuneration, Canada, Per Cent, 1976-2014



Source: CSLS calculations, based on Statistics Canada data

been stagnant in recent decades in spite of considerable growth in labour productivity. The chart indicates that growth of labour remuneration has not kept pace with labour productivity over the 1976-2014 period. Most strikingly, while growth in labour productivity over the period was 52.5 per cent (or 1.12 per cent per year), the hourly earnings of the median worker grew by only 3.3 per cent (or 0.09 per cent per year).³ The 1.03 percentage-point gap between these annual growth rates is what we seek to explain.

How can we understand the disconnect between labour productivity growth and median earnings growth? The three remaining lines in Chart 1 provide a starting point. While median hourly earnings were stagnant, average hourly earnings grew by 26.2 per cent (or 0.61 per cent per year) over the 1976-2014 period. The difference between these two data series is that the median wage reflects the experience of workers in the middle of the wage distribution while the average wage is dragged upward by high-earn-

ing individuals. Thus, it appears that rising earnings inequality has played a significant role in the stagnation of median earnings; the gains from labour productivity growth are largely accruing to some workers, but not much is going to the median worker.

The next line in Chart 1 depicts average hourly labour compensation deflated by the consumer price index (CPI). This data series differs from average hourly earnings in that it includes employer contributions to social insurance programs on workers' behalf, in addition to the wage and salary earnings counted in the average hourly earnings data.

Average hourly labour compensation (deflated by the CPI) increased by 26.2 per cent (or 0.61 per cent per year) over the 1976-2014 period, exactly the same cumulative growth as was exhibited by average hourly earnings. This implies that employer contributions to social insurance programs played a negligible role in the productivity-earnings gap over the 1976-2014 period.

3 Following Statistics Canada (1997), earnings are defined as "the sum of wages and salaries, and net self-employment income."

The final line in Chart 1 depicts average hourly labour compensation deflated by the GDP deflator, a measure of the growth of output prices. The gap between the two average hourly labour compensation measures reflects the difference between the growth rates of the output price and the consumption goods price; that is, changes in labour's terms of trade.⁴

Average hourly labour compensation (deflated by the GDP deflator) increased by 35.6 per cent (or 0.81 per cent per year) over the 1976-2014 period, 0.2 percentage-points per year faster than CPI-deflated average hourly labour compensation or average hourly earnings. Consumer prices grew faster than output prices over the period.

Thus, two factors - rising earnings inequality and the rising relative price of consumer goods - appear to explain much of the gap between labour productivity growth and median earnings growth. But they do not explain all of the gap; there remains a substantial discrepancy between labour productivity growth and average hourly labour compensation growth (deflated by the GDP deflator). In our formal analysis in sections two and three in the article, we attribute this remaining gap to a decline in labour's share of aggregate income; a greater share of all the income generated in Canada is being paid either as compensation to other factors of production, with less left for compensation to labour.

Thus, the four factors listed above provide a complete account of the sources of the productivity-earnings gap depicted in Chart 1. Our formal analysis in the following two sections of the article brings quantitative precision to this accounting.

The fact that median earnings have not kept pace with labour productivity may be a matter of concern for workers, but should we be surprised by it? Some economists might answer this question in the negative. They would point out that, under standard assumptions, economic theory implies that labour productivity should grow at roughly the same rate as average hourly labour compensation over the long run. The standard theory is silent about the distribution of earnings. A stagnant median wage in the presence of rising labour productivity presents no inconsistency with basic economic theory; it simply implies that the wage distribution is becoming more unequal, and standard theory has never precluded that possibility.

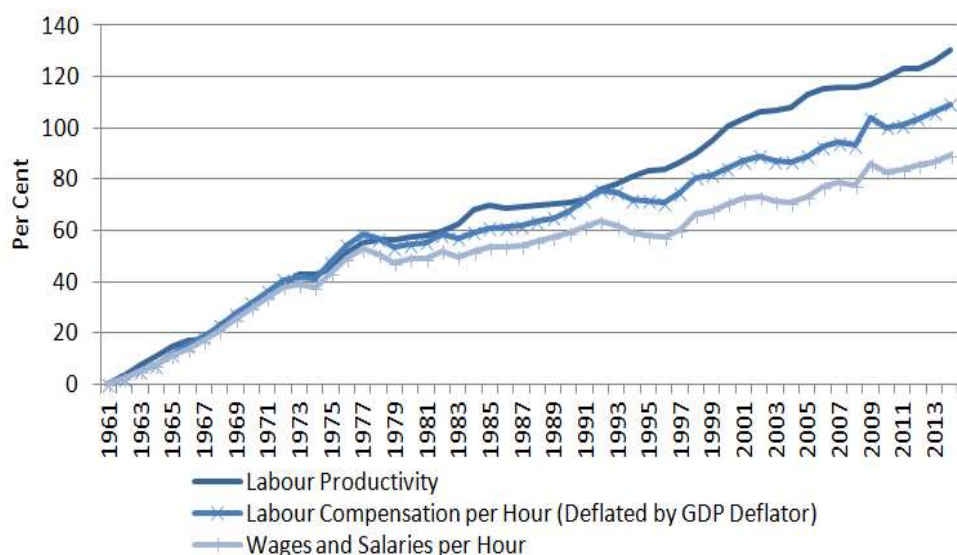
This defense of the basic theory is partly correct, but it ignores the fact that, as noted above, even *average* hourly labour compensation has not kept pace with labour productivity since 1976. This discrepancy is strongly at odds with standard economic theory. Moreover, it represents a change relative to Canada's earlier economic history. Average hourly labour compensation, deflated with the GDP deflator, grew at the same rate as labour productivity between 1961 and the mid-1970s (Chart 2).⁵ It was only after 1976 that the two series became decoupled (although average labour compensation did briefly catch up to labour productivity in the early 1990s before falling behind again). Average hourly wages and salaries also grew at the same rate as labour productivity until the mid-1970s.

Thus, recent trends in labour productivity and in labour compensation are puzzling from the perspectives of both economic theory and eco-

4 The output price index (formally called the GDP deflator) is an average price for all goods and services produced, while the Consumer Price Index is an average price for all the goods and services consumed. The evolution of the two price indexes can differ because the bundle of goods produced in Canada is not the same as the bundle of goods consumed. For example, Canada produces products for export to other countries. The prices of those goods have a greater weight in the output price index than in the Consumer Price Index.

5 'Median Hourly Earnings' could not be included in Chart 2 because that data series begins in 1976. See Ugucioni, Sharpe, and Murray (2016) for detailed discussion of data sources.

Chart 2
Cumulative Growth in Labour Productivity and in Two Measures of Real Labour Remuneration, Canada, Per Cent, 1961-2014



Source: CSLS calculations, based on Statistics Canada data

conomic history. The stagnation of real earnings for the median worker while labour productivity has continued to grow appears to have generated a pervasive sense that Canada's middle class is in crisis. These facts provide the context for the analysis in this article.

Literature Review

Sharpe *et al.* (2008) decompose the divergence between real median wages and labour productivity into four overarching factors: rising inequality, deteriorating terms of trade for labour, a decrease in labour's share of income, and measurement inconsistencies.⁶ They find that from 1980 to 2005, labour productivity grew 1.26 percentage points per year faster than median real earnings. They decompose the gap into their four factors, attributing 0.35 percentage points

per year to inequality, 0.42 percentage points per year to terms of trade for labour, 0.25 percentage points per year to labour's share of income, and 0.25 percentage points per year to measurement issues.⁷ Unfortunately, because they employ census data on median real earnings, they are unable to decompose the 1980 to 2005 period into peak-to-peak sub-periods. Our analysis largely follows the method of Sharpe *et al.* but improves upon it in two respects. First, we present a more comprehensive analysis by expanding the time period from 1980-2005 to 1976-2014. Second, we analyze peak-to-peak sub-periods to discuss how the gap evolved over time.

Pessoa and Van Reenen (2012) perform a decomposition of median wage growth and productivity growth similar to the one presented in

6 The term "labour's terms of trade" refers to the ratio of consumption goods prices to producer prices, while the term "measurement inconsistencies" refers to the combined effect of employer social contributions and changes in hours of work per worker.

7 Our estimates for the 1980 to 2005 period are broadly similar to those obtained by Sharpe *et al.* (2008). For 1980 to 2005 we estimate the gap to be 1.41 percentage points per year, of which: inequality made up 0.52 percentage points; terms of trade 0.28 percentage points; labour's share of income 0.41 percentage points; and measurement inconsistencies 0.20 percentage points.

Sharpe *et al.* (2008) for the United Kingdom and the United States. They define two types of measures for the divergence - "gross decoupling" and "net decoupling". The former measures differences in growth between labour productivity and median hourly real earnings, while the latter measures differences in growth between labour productivity and average labour compensation per hour (deflated with the same deflator). Gross decoupling accounts for changes to labour's share of income, labour's terms of trade, differences between growth in median and mean hourly earnings, and the wedge between labour compensation and earnings, while net decoupling is determined by only changes to labour's share of income. Ultimately, Pessoa and Van Reenen (2012) find little evidence of net decoupling in the UK, but significant gross decoupling in the United States and UK. In the UK, gross decoupling was driven by differences between mean and median earnings and the wedge between earnings and labour compensation.

Pessoa and Van Reenen recognize that both gross decoupling and net decoupling are important policy indicators. As gross decoupling relates the "true middle" of the earnings distribution to labour productivity, it avoids issues of a skewed average and uses a more tangible income concept from the point of view of the worker (e.g. EI contributions made by the employer may not be considered income by a given worker). As gross decoupling also deflates earnings with the CPI and labour productivity with the GDP deflator, it also captures any difference in the prices faced by firms and workers. This is an important distinction to make because firms and consumers can at times face very different prices. Net decoupling, on the other hand, is important because it challenges one of the main stylized facts cited by economists - labour's stable share of income. Pessoa and Van Reenen observe that net decoupling could occur

for many reasons, including shocks which disturb the long run equilibrium, technological change-biased against labour, changes to the level of competition in the market (in the product market it results in setting higher prices, while in the labour market it results in setting lower wages), and finally changes to labour supply due to structural phenomena like globalization.

Mishel and Gee (2012) also employ Sharpe *et al.* (2008)'s methodology. Much like us, they perform an annual analysis comparing median real wage in the United States with labour productivity and find a significant gap of 1.56 percentage points per year between 1973 and 2011. Rising wage inequality accounted for 0.61 percentage points of the gap, while labour's terms of trade accounted for another 0.44 percentage points. They specifically point to the erosion of labour standards, globalization, high trade deficits, and the rising share of capital depreciation in GDP to explain both growing inequality and the changes in the distribution of income towards capital.

Empirical Framework

In this section, we formally describe the decomposition of the gap between labour productivity growth and median real hourly earnings growth, developed in Sharpe *et al.* (2008). The first subsection presents the technical details of the decomposition without much commentary. In the second subsection, we provide a conceptual discussion of each of the components of the decomposition and explain how they should be interpreted. In the final subsection, we describe the data sources we will use.

Decomposition Method

The starting point for the decomposition is the following accounting identity:

$$\frac{Y_L}{P_C \times L} = \frac{Y}{P_Y \times L} \times \frac{Y_L}{Y} \times \frac{P_Y}{P_C} \quad (1)$$

Here, Y_L is total nominal labour compensation, P_C is the price of consumption goods, and L is total hours worked. Y is total nominal output (or income) in the economy and P_Y is the price of output.

Thus, the ratio $Y_L/P_C \times L$ denotes average real hourly labour compensation in units of consumption goods (i.e. the "consumer wage"). On the right-hand side, the ratio $Y_L/P_Y \times L$ denotes real output per hour in units of output goods; that is, labour productivity. Y_L/Y is labour's share of total income in the economy. The remaining term P_Y/P_C is the relative price of output goods in terms of consumption goods; following the literature, we will refer to this as "labour's terms of trade." More will be said about this below.

For any variable X , let the notation $\Delta\%X$ denote the per cent growth rate of X . Then expressing equation (1) in growth rates, we obtain

$$\begin{aligned} \Delta\% \text{ Average Real Hourly Compensation} \\ = \Delta\% \text{ Labour Productivity} + \Delta\% \text{ Labour Share} \\ + \Delta\% \text{ Labour Terms of Trade} \end{aligned} \quad (2)$$

Our goal is to explain changes in the gap between labour productivity and median real hourly earnings. Let $\Delta\% \text{ Gap}$ denote the productivity-earnings growth gap. Formally, it is defined by

$$\Delta\% \text{ Gap} = \Delta\% \text{ Labour Productivity} - \Delta\% \text{ Median Real Hourly Earnings} \quad (3)$$

Rearranging (2) and using (3) to eliminate labour productivity growth, we obtain

$$\begin{aligned} \Delta\% \text{ Gap} = \Delta\% \text{ Average Real Hourly Compensation} \\ - \Delta\% \text{ Median Real Hourly Earnings} - \Delta\% \text{ Labour Share} \\ - \Delta\% \text{ Labour Terms of Trade} \end{aligned} \quad (4)$$

Now, the change in average real hourly earnings relative to median real hourly earnings is an indicator of the change in earnings inequality over time. Thus, we define the change in inequality as

$$\Delta\% \text{ Inequality} = \Delta\% \text{ Average Real Hourly Compensation} - \Delta\% \text{ Median Real Hourly Earnings} \quad (5)$$

Finally, we need to relate average real hourly compensation to average real hourly earnings. As we discuss in more detail below, the difference between these two measures reflects the impact of changes in employer contributions to social insurance programs:

$$\begin{aligned} \Delta\% \text{ Average Real Hourly Compensation} \\ - \Delta\% \text{ Average Real Hourly Earnings} = \Delta\% \text{ Employer Social Contributions} \end{aligned} \quad (6)$$

Substituting (5) and (6) into (4) yields the overall decomposition:

$$\begin{aligned} \Delta\% \text{ Gap} = \Delta\% \text{ Inequality} + \Delta\% \text{ Employer Social Contributions} \\ - \Delta\% \text{ Labour Terms of Trade} - \Delta\% \text{ Labour Share} \end{aligned} \quad (7)$$

Equation (7) is the final decomposition formula. Having presented the technical details of its derivation, we now proceed to discuss its interpretation.

Interpreting the Decomposition

The object of interest to us is $\Delta\% \text{ Gap}$, the discrepancy between labour productivity growth and median real hourly earnings growth. Equation (7) expresses this gap in terms of four components, each of which has a precise economic interpretation. In this subsection, we provide a brief explanation of each of the four components. We then conclude with general comments about the decomposition.

Inequality

The inequality component is the gap between the growth rates of average and median real hourly earnings. Empirically, the Canadian distribution of earnings is positively skewed; its mean is greater than its median because the mean is dragged upward by very high earners. When earnings at the top of the distribution grow more quickly than those in the middle of the distribution, the mean rises relative to the median and earnings inequality rises. This would imply that the gains from labour productivity are flowing disproportionately to workers who were already high earners relative to the median worker, so $\Delta\%$ *Inequality* contributes positively to $\Delta\%$ *Gap*.

Employer Social Contributions

Total real compensation includes employer contributions to social insurance programs (e.g. the Canada Pension Plan or Employment Insurance) while real earnings do not. It is possible that part of the gap between labour productivity growth and median hourly earnings growth is accounted for by workers receiving a growing amount of their compensation in the form of employer contributions to social insurance programs rather than cash or in-kind earnings. Whether this makes workers better off depends on how much they value the social programs.

Labour Terms of Trade

The accounting identity in equation (1) includes two prices: the consumption goods price P_C and the output goods price P_Y . These

average prices differ because, in general, the bundle of goods consumed by consumers is not the same as the bundle of goods produced in the domestic economy.⁸

Labour productivity is defined as the volume of output goods produced per hour of work, so the relevant price is P_Y . Workers ultimately want to use their compensation to buy consumption goods, so the relevant price for measuring real labour compensation is P_C . The discrepancy between labour productivity and real labour compensation is therefore influenced by the ratio P_Y/P_C . Following the literature, we refer to this ratio as "labour's terms of trade."⁹

When $\Delta\%$ *Labour Terms of Trade* > 0 , consumer prices are falling relative to output prices. Everything else being equal, this increases workers' purchasing power relative to labour productivity, and hence reduces the gap between labour productivity growth and real earnings growth. That is why labour's terms of trade enter equation (7) with a negative sign.

Labour Share

The final term in equation (7) accounts for changes in total labour compensation as a share of aggregate income in the economy. Labour productivity measures the economy's average output per hour of labour supplied by workers, but part of that output is paid to other factors of production (primarily capital). The remaining share accrues to labour. These aggregate shares are determined by technological and institutional factors in the long run, though they can be

8 For example, Canada produces goods that are exported to other countries rather than purchased by Canadian consumers. The prices of those exports are included in the output price P_Y but not in the consumption price P_C .

9 Clearly, an analogy is being drawn between P_Y/P_C and the more common notion of "terms of trade," which is the ratio of a country's export prices to its import prices. Intuitively, P_C is the price of the goods workers buy and P_Y is the price of the goods workers produce and sell. It is to workers' advantage when the price of what they sell increases relative to the price of what they buy, just as it is to a country's advantage when the price of what it sells (its exports) increases relative to the price of what it buys (its imports).

Table 1**Decomposition of the Growth Gap between Labour Productivity and Median Real Hourly Earnings into Four Components, Canada, 1976-2014**

	Labour Productivity	Median Real Hourly Earnings	Gap	Inequality	Employer Social Contributions	Labour's Terms of Trade	Labour Share
	Growth (per cent per year)			Percentage Point Contributions to the Gap			
1976-2014	1.12	0.09	1.03	0.53	0.00	0.20	0.31
1976-1981	0.90	-0.32	1.21	-0.41	0.03	0.92	0.76
1981-1989	0.94	0.16	0.78	0.15	-0.03	0.48	0.19
1989-2000	1.51	-0.28	1.79	0.92	0.14	0.24	0.48
2000-2008	0.89	0.94	-0.05	0.20	0.01	-0.55	0.29
2008-2014	1.12	-0.14	1.26	1.52	-0.24	0.18	-0.20
	Per Cent Contributions to the Gap						
1976-2014	--	--	--	51.0	0.2	19.1	29.7
1976-1981	--	--	--	-33.9	2.5	75.8	62.3
1981-1989	--	--	--	19.5	-4.0	61.9	24.0
1989-2000	--	--	--	51.7	7.8	13.3	26.6
2000-2008	--	--	--	--	--	--	--
2008-2014	--	--	--	120.5	-19.0	14.4	-15.9

Note: Per cent contributions to the gap are not computed for the 2000-2008 period because the total gap was close to zero over that period.

Source: CSLS calculations, based on Statistics Canada data

influenced by supply and demand conditions in the short run.

When labour's share rises, the gap between labour productivity growth and labour compensation growth falls. This is why labour's share enters equation (7) with a negative sign.

General Comments

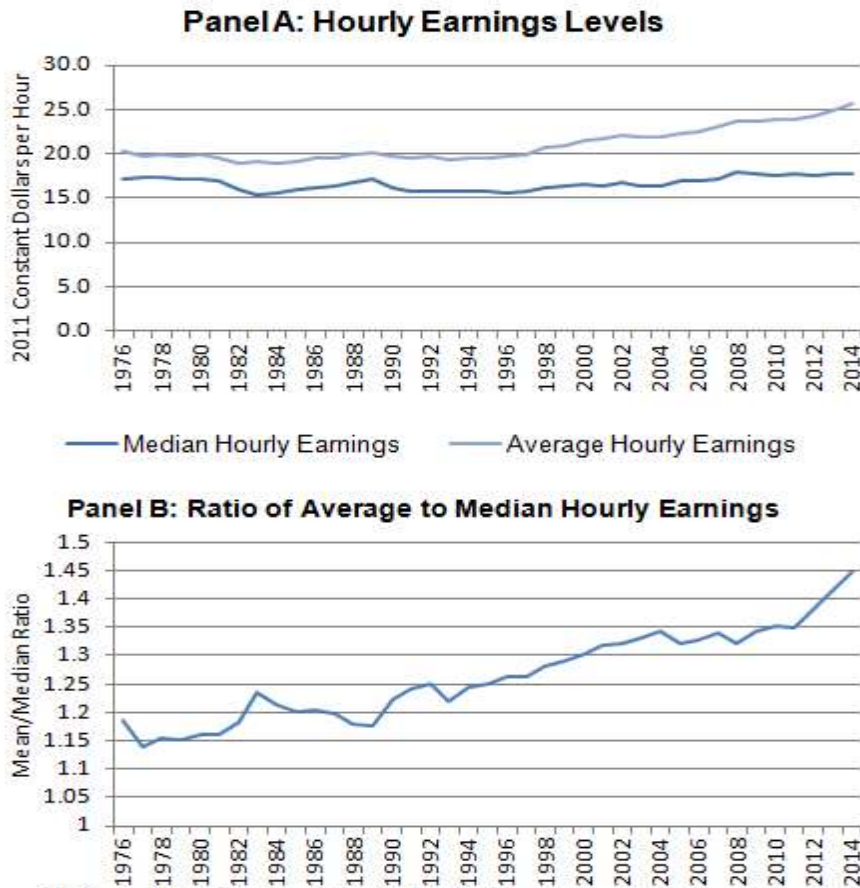
The decomposition in equation (7) represents an accounting exercise and does not, on its own, justify any statements about cause and effect. Did the gap between labour productivity and median real annual earnings increase because earnings inequality increased for some reason? Or did measured earnings inequality increase because the productivity-earnings gap increased

for some reason? An accounting decomposition cannot answer a question like this.¹⁰ To address such questions would require a structural model that explains why each of the components changed the way it did.

Nevertheless, we think the accounting approach is useful. It draws our attention to the relationships between the productivity earnings gap and several other economic phenomena - rising earnings inequality, the changing impact of laws governing employer contributions to social insurance programs, and so on. It lends a disciplined, quantitative characterization to those relationships. It suggests areas for future research that might clarify the causal mechanisms at play.

10 Similar questions can be asked about the other components as well. Did earnings grow more slowly than productivity because labour's share of income declined? Or did labour's share of income decline because earnings grew more slowly than labour productivity?

Chart 3
Average and Median Real Hourly Earnings, Canada,
2011 Constant Dollars per Hour, 1976-2014



Data¹¹

The analysis employs the Survey of Labour and Income Dynamics (SLID) and System of National Accounts (SNA) data, though we do supplement the SLID data with Labour Force Survey (LFS) microdata. The SNA data allow us to relate average hourly real compensation growth with labour productivity growth for all workers in the economy from 1961 to 2014. The SLID data allow us to investigate the distribution of earnings growth and compare it with our estimates of labour productivity growth. The SLID data cover 1993 to 2011 and were extended back to 1976 using the Survey of Consumer Finance data. The hourly wage variable

from the LFS microdata, deflated with the CPI, was used to extend the SLID data to 2014.

Decomposition Results

This section presents and discusses the decomposition results. We begin with an overall summary of the results. We then devote one subsection to detailed analysis of each of the four components: earnings inequality, employer social contributions, labour's terms of trade, and labour's share of income.

Summary of Results

The decomposition results are summarized in Table 1. Over the 1976-2014 period, the growth

11 For a detailed discussion of data sources, see Ugucioni, Sharpe and Murray (2016). All data used in the article are posted at <http://csls.ca/reports/csls2016-16-DataAppendix.pdf>.

Table 2
Inequality Component and its Determinants,
Canada, 1976-2014

	Average Real Hourly Earnings	Median Real Hourly Earnings	Inequality Component
	A	B	C = A - B
1976-2014	0.61	0.09	0.53
1976-1981	-0.73	-0.32	-0.41
1981-1989	0.31	0.16	0.15
1989-2000	0.65	-0.28	0.93
2000-2008	1.14	0.94	0.20
2008-2014	1.38	-0.14	1.53

Growth rates are in per cent per year.

Source: CSLS calculations, based on Statistics Canada data

gap between labour productivity and median real hourly earnings was 1.03 percentage points per year. Of that gap, rising earnings inequality accounted for 0.53 percentage points, or 51 per cent of the total gap. A declining labour share of aggregate income accounted for the next largest component: 0.31 percentage points, or 30 per cent of the gap. A deterioration of labour's terms of trade - that is, an increase in consumer prices relative to output prices - accounted for the remaining 0.20 percentage points, or 19 per cent of the total gap. Employer social contributions were a non-factor.

In addition to the results for the full 1976-2014 period, Table 1 contains results for six sub-periods. The cut-off dates are business cycle peaks (except for the first and last years, which are determined by data availability). The analysis reveals that the proximate sources of the productivity-earnings gap differ from sub-period to sub-period. In 1976-1981, the productivity-earnings gap was large (1.21 percentage points per year) in spite of declining inequality. The gap in that period was driven by a large deterioration in labour's terms of trade and a large decline in the labour share of income. The contribution of inequality has tended to increase

over time (except for the 2000-2008 period, which was an unusual period in that the overall productivity-earnings gap was essentially zero). That of labour's terms of trade has tended to decline as consumer price inflation and output price inflation have both stabilized at a similar level (around the Bank of Canada's two per cent annual inflation target). The contribution of labour's share has varied from period to period, while that of employer social contributions has in general been small.

In the most recent period, 2008-2014, the 1.52 percentage-point contribution of rising inequality accounts for more than 100 per cent of the 1.26 percentage-point productivity-earnings growth gap.

Earnings Inequality

Thomas and Ugucioni (2016) show that economic inequality has risen considerably in Canada in recent decades, particularly in the 1990s. Our data also show growing inequality in Canada as mean and median hourly real earnings have diverged. Between 1976 and 2014, median real hourly earnings increased 0.09 per cent per year (from \$17.1 to \$17.7 in 2011 dollars) while mean hourly earnings increased 0.61 per cent

Table 3
Distribution of Real Hourly Wage Growth by Percentile, Canada, Per Cent per Year, 1997-2014

Real hourly earnings	1997-2014	2000-2008	2008-2014
Mean	0.75	0.82	0.81
Percentile			
1 st	1.73	1.26	2.37
10 th	0.75	0.74	1.44
20 th	0.60	0.72	0.64
30 th	0.85	0.78	0.68
40 th	0.63	0.39	0.83
50 th	0.47	0.55	0.34
60 th	0.61	0.59	0.75
70 th	0.66	0.58	0.84
80 th	0.82	0.97	0.86
90 th	0.94	1.19	0.73
99 th	1.02	1.18	0.75

Percentiles constructed using Labour Force Survey microdata.

Source: CSLs calculations, based on Statistics Canada data

per year (from \$20.3 to \$25.7) (Chart 3, Panel A). Thus, average earnings exceeded median earnings by 19 per cent in 1976 and by 45 per cent in 2014 (Chart 3, Panel B). Average earnings began to pull away from median earnings in the late 1980s, and earnings inequality grew quickly throughout the 1990s. Inequality stabilized in the early 2000s, but appears to have begun another steep increase after 2010. Table 2 summarizes the inequality component and its determinants - the growth rates of median and average real hourly earnings - for the 1976-2014 period and for the six sub-periods.

Growing inequality is not simply a matter of comparing mean and median workers, but rather a matter of widening the distribution of earnings on the whole. Using Labour Force Sur-

vey microdata obtained from Statistics Canada, we construct hourly real earnings for all workers by deflating nominal hourly earnings with the CPI. Our data only cover 1997 to 2014, but still allow us to glean important insights into the evolution of inequality in the 2000 to 2008 and 2008 to 2014 periods. The results are presented in Table 3.¹²

First and foremost, in Table 3 we see the divergence between median (50th percentile) and average hourly real earnings which our inequality component of the gap measures in all three periods. Just like the inequality component, average hourly real earnings grew much quicker than median hourly real earnings from 2000 to 2008 and from 2008 to 2014.

12 Although the annual growth rates of median hourly earnings in the SLID and the LFS are similar for the 1997-2011 period (at 0.44 per cent and 0.53 per cent, respectively), Table 2 and Table 3 reveal substantial differences between the growth rates implied by the two data series for sub-periods. This reflects a combination of sampling error and definitional differences (e.g. the LFS "earnings" data exclude bonuses and stock options). It may also reflect error arising from our assumption that the change in annual hours worked has been the same for all workers. Nevertheless, we think the analysis of differences in wage growth across the wage distribution - which the LFS makes possible - remains informative in spite of the existence of some discrepancies between the two data sources.

Earners in the 99th percentile (the "top one per cent") experienced stronger hourly real earnings growth than any of the deciles from 1997 to 2014 and in the 2000 to 2008 peak to peak period, though the 1st percentile's hourly real earnings grew quicker than the 99th percentile's from 1997 to 2014. From 2008 to 2014, real earnings growth for the 99th percentile was in line with growth throughout the middle of the distribution. The highest growth rates were actually experienced by earners in the bottom decile of the distribution during the 2008-2014 period.

The U-shaped distribution of real earnings growth means that our use of the term 'inequality' to refer to the slow growth of median earnings relative to average earnings may be slightly misleading. If real earnings for those who earn the least grow at broadly the same rate as those who earn the most, then inequality in Canada (as measured, say, by a 90-10 ratio) is more or less stable. However, as those in the middle lag behind in growth, they are being caught by those who earn the least. The story is less about overall earnings inequality than it is about a 'hollowing out' of the middle of the wage distribution.

Overall, the inequality component contributed 0.53 percentage points per year to the gap between productivity growth and median hourly earnings growth over the 1976-2014 period, making it the largest contributor of any of the components. What explains the stagnation of earnings in the middle of the wage distribution in recent decades? The two forces that have received the most attention in the literature are globalization and technological change.

The world's increased openness to international flows of goods and capital has created opportunities for advanced economies' capital

to seek high returns around the world and, at the same time, has brought advanced economies' workers into competition with the workers of relatively low-wage countries. Recent research suggests that the effect on advanced economies' employment levels and wages resulting from trade with low-wage countries may be larger and more persistent than economists once thought.¹³ We would expect these effects to be largest in industries with the greatest direct trade exposure, such as manufacturing - industries that traditionally accounted for many jobs in the middle part of the wage distribution.

Technological change also affects the distribution of earnings. Traditionally, economists have focused on the notion of skill-biased technological change; that is, the idea that advanced technologies tend to raise the wages of highly skilled workers relative to the wages of comparatively unskilled workers. More recently, some economists have pointed out that computer technology is increasingly able to automate the kinds of routine tasks once performed by middle-wage workers in clerical or middle-management occupations. This is on top of the continuing automation of factory jobs, which also used to comprise part of the middle of the wage distribution. The result of these technological forces is 'labour market polarization,' a phenomenon whereby the middle of the wage distribution is 'hollowed out' and workers' labour market outcomes are increasingly bifurcated between highly skilled, high-wage 'winners' and low-wage 'losers.'¹⁴ Our findings on the U-shaped distribution of real earnings growth are consistent with a story like this.

As noted in the introduction to this report, economic theory implies that labour productivity and average real hourly labour compensation should grow at roughly the same rate over the

13 See Acemoglu *et al.* (2016), Autor *et al.* (2013a), Autor *et al.* (2016) and Autor *et al.* (2014), among others.

14 See Autor *et al.* (2006), Autor and Dorn (2013), Autor *et al.* (2013b), Autor *et al.* (2015), and Jaimovich and Siu (2012), among others.

Table 4
Labour's Terms of Trade and Its Determinants, Canada,
1976-2014

	Output Price (GDP Deflator)	Consumption Price (CPI)	Change in Labour's Terms of Trade
	A	B	C = A - B
1976-2014	3.54	3.73	-0.20
1976-1981	8.82	9.74	-0.92
1981-1989	4.81	5.30	-0.48
1989-2000	2.00	2.24	-0.24
2000-2008	2.81	2.26	0.55
2008-2014	1.38	1.56	-0.18

Growth rates are in per cent per year.

Source: CSLS calculations, based on Statistics Canada data

long term. In terms of how middle class people feel about their economic situation, however, median hourly earnings is arguably a more important measure than average hourly compensation. The fact that earnings inequality accounts for 51 per cent of the gap between labour productivity growth and median real hourly earnings growth implies that the theoretical link between labour productivity and labour compensation may not have broken down as much as it might seem at first glance. Labour productivity is still leading to earnings growth for workers, but that earnings growth is benefiting workers at the top and at the bottom of the earnings distribution while the median worker - the representative of the 'middle class' - has benefited hardly at all.

That being said, economic theory has not been vindicated yet. After accounting for earnings inequality, 49 per cent of the productivity-earnings gap remains to be explained. We now proceed to the next step in our decomposition.

Employers' Social Contributions

In addition to wages and salaries and taxable in-kind benefits captured on T4 tax forms, workers take part of their compensation in the form of government-mandated employer con-

tributions to social insurance programs (e.g. the Canada Pension Plan and Employment Insurance). These contributions are included in real hourly labour compensation, but not in real hourly earnings. Thus, part of the gap between labour productivity growth and median hourly earnings growth should in principle be accounted for by growth of employers' social contributions.

In practice, Table 1 reveals that employers' social contributions made a negligible contribution to the productivity-earnings growth gap over the 1976-2014 period.

This result is somewhat surprising because employer social contributions as a share of employees' compensation increased from 8 per cent in 1976 to 13.9 per cent in 2014. A possible explanation for these findings is that they reflect the influence of the self-employed. Another possibility is that the effect of employer social contributions is masked by measurement error in the average real hourly earnings data.¹⁵

Labour Terms of Trade

As we explained in section two, the term "labour's terms of trade" refers to the ratio of the output price P_Y to the consumer price P_C . These average prices differ because, in general,

15 See Ugucioni, Sharpe, and Murray (2016) for discussion of these explanations.

Table 5
Growth of the Implicit Price Indexes for Components of GDP, Canada, Per Cent per Year, 1981-2014

	Final Consumption Expenditure	General Governments Final Consumption Expenditure	Gross Fixed Capital Formation	Exports of Goods and Services	Imports of Goods and Services
1981-2014	2.83	3.41	2.10	1.48	1.09
1981-1989	5.33	5.56	3.43	1.50	1.35
1989-2000	2.27	2.74	1.02	1.91	2.14
2000-2008	2.02	2.98	2.53	1.75	-0.52
2008-2014	1.66	2.41	1.75	0.31	0.98

Growth rates in terms of per cent per year.

Source: CSLS calculations, based on Statistics Canada data

the bundle of goods consumed by consumers is not the same as the bundle of goods produced in the domestic economy. Workers produce and sell output, then use the proceeds (i.e. their labour compensation) to buy consumer goods. If consumer prices rise relative to output prices, workers' purchasing power decreases. We would refer to this as a deterioration in labour's terms of trade. Since labour productivity is measured in output units while real earnings are measured in units of consumer goods, a deterioration in labour's terms of trade decreases workers' real earnings relative to labour productivity, and hence increases the productivity-earnings gap.

Over the 1976-2014 period, worsening terms of trade for labour accounted for 0.20 percentage points (or 19 per cent) of the gap between labour productivity growth and median real hourly earnings growth (Table 1). For the 1976-2014 period and for the six sub-periods, Table 4 shows how changes in output prices (measured by the GDP deflator) and consumption prices (measured by the consumer price index, or CPI) led to the changes in labour's terms of trade shown in Table 1.¹⁶

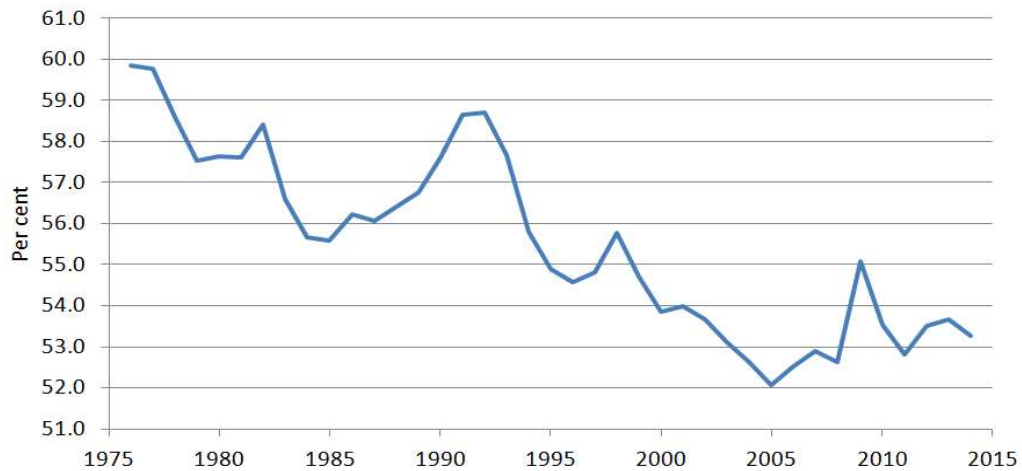
In every sub-period except 2000-2008, consumer price inflation exceeded output price inflation and, hence, labour's terms of trade deteriorated. Labour's terms of trade made its largest contributions the gap in the 1976 to 1981 and 1981 to 1989 periods, adding 0.92 percentage points per year and 0.48 percentage points per year in each period respectively. The CPI's growth slowed relative to the GDP deflator's growth as time went on, so much so that from 2000 to 2008 it actually decreased the gap by 0.55 per cent per year. This in part reflected the impact of cheap imports from countries such as China. From 2008 to 2014, GDP deflator growth fell more than CPI growth, resulting in terms of trade contributing 0.18 percentage points per year to the gap.

Table 5 shows the implicit price indexes of the various components of GDP from 1981 to 2014. The CPI should roughly track the implicit price index of household final consumption expenditure, and comparison of Table 4 and Table 5 confirms that the two price indexes grew at similar rates in each sub-period. The GDP deflator, however, is affected by the implicit price indexes

¹⁶ The labour terms of trade numbers in Table 4 and in Table 1 have opposite signs because labour's terms of trade enters the decomposition (equation (7)) with a negative sign. Thus, the negative terms of trade values in Table 4 show up in Table 1 as positive contributions to the productivity-earnings gap.

Chart 4

Labour Compensation as a Share of GDP, Canada, Per Cent, 1976-2014



Source: CSLS calculations, based on Statistics Canada data

of the other constituent parts of GDP. Implicit price indexes of imports and exports are driven by changes in the exchange rate of the Canadian dollar against foreign currencies, as well as commodity prices and the differences in inflation rates between Canada and its trade partners. While the growth rates of export and import prices were well below the growth rate of final consumption expenditure prices, overall their net weight in GDP is small, so their effect on the GDP deflator's growth is likely minimal.

A second explanation for the deterioration of labour's terms of trade lies in capital equipment prices. The price index for gross fixed capital formation grew at a much lower rate than that of household final consumption expenditure throughout the 1980s and 1990s. This likely explains most of the difference in growth between the CPI and GDP deflator in that time period. The major difference between the consumption and investment prices over these two periods was the falling price of investment in information and communication technology (ICT) equipment. As ICT investment prices fell, they pulled down the implicit price index of gross fixed capital formation and, with it, the overall GDP deflator.

Labour Share of Income

We began with the growth gap between labour productivity and median real hourly earnings. After adjusting for earnings inequality, employer social contributions and labour's terms of trade, we are left with the growth gap between labour productivity and average real hourly labour compensation, both inflation-adjusted using the output price index. Standard economic theory suggests that this gap should be zero over the long term because labour market competition should force firms to raise wages in line with productivity growth.

Our empirical decomposition shows that earnings inequality, employer social contributions and labour's terms of trade together account for 70.3 per cent of the productivity-earnings gap. That part of the gap may have substantial implications for middle class Canadians' subjective sense of their own economic welfare, but it poses no challenge to economic theory. The remaining 29.7 per cent of the gap, however, does represent a breakdown of the traditional view that labour productivity and average labour compensation should grow together.

That traditional view is based on the assumption that labour's share of aggregate income

remains approximately constant over time.¹⁷ If instead the structure of the economy changes in a way that reduces labour's aggregate income share, then such a change would show up in the data as a wedge between labour productivity growth and average real hourly labour compensation growth. That is precisely what we observe in the Canadian data. Thus, we attribute the remaining 29.7 per cent of the productivity-earnings gap to a decline in labour's share.

Labour income's share of total income has decreased from 59.9 per cent in 1976 to 53.3 per cent in 2014 (Chart 5). Broadly speaking the decline of labour's share of income was steady, with minor blips of improvement from 1986 to 1993 and 2005 to 2009. Those temporary improvements reflect the fact that returns to capital are more volatile than wages over the business cycle, so that labour's share of income tends to rise during recessions and fall during the early parts of booms. The effects of recessions are transitory, however; the long-term trend in labour's share is downward.

Overall, labour's share of income fell 0.31 per cent per year from 1976 to 2014. As shown in equation (7), changes in labour's share of income contribute inversely to the gap, meaning a fall in the former contributes growth to the latter and vice versa. Consequently, labour's share of income added 0.31 percentage points per year to the gap from 1976 to 2014 - the second-largest contribution of any component. Labour's share of income fell the most during the 1976 to 1981 period, adding 0.76 percentage points per year to the gap.

Labour's lost share of income is largely accounted for by an increase in the income share of gross operating surplus.¹⁸ From 1981 to 2014, the net operating surplus of corporations as a share of aggregate income in Canada increased from around 23.7 per cent to 27.5 per cent. Over the same period, labour's share of income fell by almost 4 percentage points (Chart 4). As net operating surplus reflects payments to capital net of depreciation, an increase in net operating surplus reflects increased profits.

In a recent report, the OECD (2012) tried to explain the falling income share of labour from 1990 to 2007. In theory, it could simply be a matter of labour movement from labour-intensive sectors to relatively capital-intensive sectors. However, the OECD argues that developments within sectors have been more important than changes between sectors. They find that total factor productivity growth and capital deepening explain up to 80 per cent of the falling share of labour. Traditionally, total factor productivity growth has worked as a complement to employment, but the OECD posits that the technological developments of recent decades are entirely different than the technological developments which relied on workers in the past. Specifically, investment in information and communication technologies in the last two decades have boosted productivity across the board, but have also led to the automation of repetitive jobs. This is closely related to the literature on labour market polarization, which we mentioned in our discussion of earnings inequality above.

17 This assumption was initially based on historical observation, and it led to the development of theories in which the income shares of factors of production remain constant over time because of the nature of production technology in the economy.

18 Gross operating surplus is the income of corporations, governments, households, and non-profit institutions serving households accruing to the capital factor of production from the production of goods and services. Its increased share was driven by increased net operating surplus of corporations (i.e. capital remuneration) and a slight uptick in capital consumption by corporations (likely due to the increased importance of ICT capital investments, which depreciate quicker than conventional capital equipment due to obsolescence).

The OECD (2012) also finds that globalization accounted for at least 10 per cent of the fall of labour's share of income in advanced economies. Consistent with Dufour and Russell (2015), they argue that the effects of globalization operate on labour's share through bargaining power both because of increased domestic competition (reduced transportation costs allow for delocalized supply chains) and increased international competition (the threat of offshoring and import competition).

Finally, the OECD (2012) proposes other more minor determinants of labour's share of income worth considering. They argue that the privatization of state major owned firms in many advanced economies in the early 1990s led to significant productivity gains, in part from shedding unproductive labour. Indeed, in the Canadian case Ugucioni (2016) found that the privatization of Canadian National Railway in 1995 was followed by significant cuts to labour at the firm. The OECD also argue that the coverage and structure of bargaining institutions also affect the extent of the fall of labour's share of income by affecting bargaining power. Minimum wages could also affect labour's share, although the direction of the effect is ambiguous; a minimum wage increase raises some workers' wages directly but may also incite employers to exploit opportunities for automation (especially because minimum wage workers are predominantly low skilled).

Conclusion

Over the 1976-2014 period, labour productivity in Canada grew by 1.12 per cent per year. Over the same period, median real hourly earnings were stagnant; they grew only 0.09 per cent per year. This means that while Canadian labour was growing more productive over time, middle-class workers did not feel that their living standards were rising.

In this article, we have decomposed the 1.03 percentage-point gap between labour productivity growth and median real hourly earnings growth into four components: earnings inequality, employer social contributions, labour's terms of trade, and labour's share of aggregate income. Our main accounting result is that rising earnings inequality accounts for half the 1.03 percentage-point gap, with a decline in labour's income share and a deterioration of labour's terms of trade accounting for the remaining half. Employer social contributions played no role.

If the increased income generated by labour productivity growth has not flowed to the median worker in the form of higher earnings, where has it gone? Our analysis suggests a two-part answer to this question:

1. **Higher earnings at the top and bottom of the earnings distribution:** Much of the increase in labour productivity over the 1976-2014 period did flow to Canadian workers - just not to the median worker. In recent decades, the fastest real wage growth has occurred at the top and at the bottom of the earnings distribution. Earnings in the middle of the distribution have been relatively stagnant.

2. **Higher incomes for capital owners:** Between 1976 and 2014, labour's share of aggregate income declined and capital's share increased.

Our accounting decomposition does not reveal the reasons for these developments, but in our discussion we related our findings to existing research that, we suspect, provides part of the explanation. Globalization has allowed capital to seek the highest returns globally and, at the same time, has brought workers in Canada's traded goods sector into competition with the workers of low-wage countries such as China and India. At the same time, technological developments in robotics and computer software have increased the scope for capital-labour

substitution in the performance of routine production tasks. Such tasks - production-line work, repetitive white-collar work, and so on - formerly provided jobs with wages in the middle of the earnings distribution. Institutional factors, such as the decline of unionization, may have been an additional contributing factor.

As these forces play out, labour market outcomes for Canadian workers are increasingly bifurcated. Highly skilled workers (e.g. people who can design new computer software) enjoy high earnings growth. Their increased demand for services may deliver spillover benefits in the form of higher wage growth in low-wage occupations. But in the middle, earnings do not grow.

Our findings do not imply that labour productivity growth has not been beneficial for Canadian workers, nor does it imply that policy efforts to raise productivity growth would be misplaced. Labour productivity growth has increased the compensation of Canadian workers, just not in the 'middle class.' To the extent that Canadians are unhappy with the way in which income growth has been distributed in recent decades, policy can be used to adjust that distribution. Productivity growth makes this easier, not harder; it is easier to ensure that everyone gets a larger slice of the pie when the pie itself is growing over time.

That being said, the forces that are likely causing the stagnation of middle-class earnings are unlikely to disappear in the near future. If anything, the possibilities for further substitution of capital for labour are likely to expand with the advent of self-driving vehicles, self-service technology in retail, automated fast food preparation, and so on. At some point, policymakers will have to grapple with the implications of these changes for the living standards of the middle class.

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