Pay and Productivity in Canada: Growing Together, Only Slower than Ever

David M. Williams[1]
Business Council of British Columbia

Abstract

Pay and labour productivity growth in Canada are broadly aligned over the long run since 1961 and during the 2008-19 business cycle. The slowdown in Canada's productivity growth rate since 2000, the general stability of the labour share, and the lack of further gains in labour's terms of trade after 2008 largely explain the slowdown in workers' real pay growth over the 2008-19 business cycle. Canadians should be concerned about the country's persistently low productivity growth because it leads to low real pay growth. Canada's policymaking institutions should prioritize understanding and accelerating productivity.

This article examines the long-run relationship between growth in labour productivity, defined as real output per hour worked across the total economy ("productivity"), and growth in average workers' pay, defined as real hourly total labour compensation ("pay").[2] When both concepts are carefully measured, productivity and pay in Canada have broadly kept pace with each other in aggregate over the long run and across business cycles. The economy-wide link between growth in productivity and pay appears foundational and intact.[3]

The main contribution of this article is to present new evidence for Canada building on Sharpe *et al.* (2008a). In comparision with that study, and also Dufour and Russell (2015), Uguccioni *et al.* (2016) and the Canadian results in Harrison (2009) and Sharpe and Uguccioni (2017), this article uses: total economy average labour compensation (including supplemental labour income and the labour income of the self-employed) as the sole, comprehensive measure of nominal pay. To construct real pay,

1 Vice President of Policy at the Business Council of British Columbia. The author thanks Andrew Sharpe, Jock Finlayson, Ken Peacock and four anonymous referees for helpful comments, and Wulong Gu from Statistics Canada for providing historical data. Email: david.williams@bcbc.com.

2 Hereafter, "productivity" and "pay" refer to levels, and growth refers to their change over time. An acceleration (deceleration) in levels is an increase (decrease or slowdown) in growth rates.

3 The analysis does not consider changes in the distribution of pay across income groups, firms, regions, industries, skills, or socioeconomic characteristics. It is noteworthy that although income inequality did increase in Canada during the 1980s and 1990s, the Gini coefficients for market incomes and disposable incomes peaked in 1998 and 2004 respectively (Statistics Canada, 2021). In other words, Canada appears unlike the United States (Mishel and Gee, 2012) in that household income inequality has been declining for about two decades.

the study uses the household consumption expenditure deflator (HCE) in addition to the GDP deflator (PGDP) and the consumer price index (CPI). The study also excludes depreciation and output-based taxes from the measure of total economy output in labour productivity. Sharpe *et al.* (2008a) consider the five Canadian business cycles over 1961-2007 but the main analysis is focused on 1980-2005 which predates most of the boom in Canada's external terms of trade from 2002-08. This article examines a longer time period of 1961-2019 and includes six business cycles, including the 2008-19 cycle.

Sharpe *et al.* (2008a) concluded that hourly median real earnings of full-time workers deflated by the consumer price index (CPI) had lagged productivity by 1.26 per cent per annum during 1980-2005. They attributed about half of the gap to the incompleteness of the wage measure and an increasing gap between median and average earnings. By focusing solely on average total labour compensation (and comparing it to productivity which is also an average), this article does not consider those factors. Of the remaining gap, Sharpe *et al.* (2008a) attribute almost two-thirds to a decline in labour's terms of trade and the rest to a decline in the labour share (the ratio of nominal labour compensation to nominal output). The longer time period and measurement choices in this article provide new evidence about these relationships for Canada.

The structure of the article is as follows. The first main section surveys the literature. Section 2 sets out the neoclassical theory of the firm on the relationship between pay and productivity. Section 3 addresses measurement issues. Section 4 provides the results using annual Canadian data. Section 5 discusses the findings. Section 6 discusses the policy implications. Section 7 concludes. The Appendix provides data sources and descriptions.

Literature Review

The literature on the relationship between pay and productivity is vast. Two main strands are relevant to this article. The first considers what has happened to the labour share. Central to this question is the measurement of the numerator and the denominator, the time period, the countries considered, and whether the analysis is at the total economy, industry or firm level. The second concerns the relationship between real pay growth and labour productivity growth, which additionally must consider measures of prices and hours worked. If these relationships are stable over the long run, then the reasons for the post-2000 slowdown in productivity growth in Canada and elsewhere matter a great deal because of their implications for real pay growth and improvements in living standards.

Labour share

The stability of the labour share was once considered a "remarkable historical constancy" (Kaldor 1957:1) and "one of the most surprising, yet best established, facts in the whole range of economic statis-

tics" (Keynes 1939:48).[4] In recent decades, certain measures of the labour share have been found to be in decline in the United States (Elsby *et al.*, 2013) and across countries (Karabarbounis and Neiman, 2014), eliciting concern from international agencies (OECD, 2018; IMF, 2017; and ILO, 2015). Various hypotheses have been advanced to explain this apparent decline: falling relative capital prices (Karabarbounis and Neiman, 2014); increased capital accumulation (Piketty and Zucman, 2014); the rise of "superstar" firms and "winner takes most" competitive dynamics (Autor *et al.*, 2020); and capital-biased technical progress and automation (Acemoglu and Restrepo 2018; Martinez, 2018), among others.

Other studies question whether the aggregate labour share has declined after accounting for the measurement of self-employment labour income (Gutierrez and Piton, 2020 across countries, and to some extent Elsby *et al.*, 2013 for the United States), the capitalization of intellectual property products (Koh *et al.*, 2020 for the United States), and imputed rents from owner-occupied housing across countries (Gutierrez and Piton, 2020; Rognlie, 2015). Rognlie (2015) further argues the denominator should be net value-added at basic prices, which is the approach used in this article, rather than gross value-added at market prices. Gutierrez and Piton (2020) find that after standardizing measurements of self-employment labour income and housing imputed rents across countries, the corporate sector's labour share only declined in the United States manufacturing sector and is otherwise stable across European Union countries and the United States economy excluding manufacturing.[5]

Pay and productivity

A second strand of literature explores whether real hourly pay growth and labour productivity growth have decoupled (e.g. OECD, 2018; Schwellnus *et al.*, 2017). Due to data limitations, studies frequently define pay as: median or average wages excluding non-wage benefits paid by employers (rather than total compensation); a proxy for median compensation (since no such series exists); or employee compensation (excluding the labour income of the

4 Both quotations refer to the net labour share in the total economy, the focus of this article. Other authors define the labour share as the ratio of labour compensation to (gross or net) value-added in the corporate sector to sidestep the question of how to account for the labour income of self-employed workers – which, fortunately, is a published series in Canada, unlike in other countries such as the United States. Since the late-1970s was a peak in the labour share, the starting point of the analysis can also matter when drawing conclusions about time trends.

5 Notwithstanding debate about what has happened to the aggregate labour share in the long run, there are complex and possibly transitory dynamics at the industry and firm level, particularly between firms and to a lesser extent within firms. For example, Kehrig and Vincent (2021) find that the decline in the United States manufacturing sector's labour share since the 1980s (a pivotal industry given the findings of Gutierrez and Piton, 2020) was due to the reallocation of value-added to highly productive, low-labour-share manufacturing firms whose labour shares fell as output expanded. These firms were able to charge premium prices relative to peer firms, suggesting demand-side forces at work. However, the drop in their labour share was reversed after 5-7 years, leading the authors to characterize such firms as "shooting stars" rather than "superstars". Gouin-Bonefant (2018) produces a model of "superstar" firms with low shares and high productivity where rising productivity dispersion shields such firms from wage competition, putting downward pressure on the aggregate labour share.

self-employed). Such considerations can materially affect the results.

Feldstein (2008) highlights the importance of focusing on total compensation rather than wages, and using a common price deflator for compensation and productivity.[6] Both recommendations are adopted in this article, as are the recommendations of Rognlie (2015) to exclude depreciation and output-based taxes from the measure of output in labour productivity.[7] Stansbury and Summers (2017) using United States data for 1973-2016 and Castle and Hendry (2009) using United Kingdom data for 1860-2004 find a roughly one-for-one long-run relationship between growth in average compensation and productivity. Similarly, Pessoa and Van Reenen (2013) find few signs of what they call "net decoupling" between productivity and average compensation growth in the United Kingdom or the United States over the past 40 years. As noted earlier, Sharpe *et al.* (2008a), Harrison (2009), Dufour and Russell (2015) and Sharpe and Uguccioni (2017) provide the evidence for Canada.

The Theoretical Link Between Pay and Productivity

To assess the relationship between pay and productivity, this article applies the neoclassical theory of the firm as set out in Sharpe *et al.* (2008b). The economy's total real output is given by the Cobb Douglas production function:

$$y = \frac{Y}{P_Y} = AL^{\alpha}K^{1-\alpha} \qquad (1)$$

where y is real output and Y is nominal output. P_Y is the price of output, A is technology, L is labour (total hours worked), K is capital (hours of capital use).[8] Workers earn wages (labour compensation) while owners of the firm earn returns to capital. The shares of income earned by the factors of production sum to one and are α for workers (the labour share) and $1-\alpha$ for firm owners (the capital share).

Firms hire workers (measured in hours) up to the equilibrium at which the extra nominal revenue generated from an extra hour of labour is equal to nominal cost of that labour, W. There are two key conceptual points here. First, W includes all forms of labour compensation and benefits paid by firms. Second, W includes the labour income of the self-employed as well as employees – just as the measure of output (Y) includes the output of both employees and the self-employed.

6 Strain (2019) provides another useful discussion of measurement issues.

7 Spant (2003), Baker and Rosnick (2007) and Ross and Murray (2010) also argue that depreciation should be excluded from the measure of output.

8 The model relies on several strict assumptions, including: A is exogenous; returns to scale are constant ([0,1]), which means that doubling labour and capital doubles output, and that for each factor the average and marginal products are equal; diminishing marginal returns to factor inputs ($\alpha < 1$), meaning that adding either more labour or more capital to the production process yields incrementally fewer gains in output; and competitive product markets and factor markets, meaning that individual firms and workers cannot affect market prices and wages. Functional forms all have strengths and weaknesses (Paul, 2019; Miller, 2008). Future research could explore the application of constant elasticity of substitution (CES) or multi-sector (e.g. housing/non-housing) production functions.

Real product wage

Wages deflated by output prices gives the "real product wage", w_{prod}, where W is nominal hourly total labour compensation, P_Y is output prices, Y_L is nominal total labour compensation and is L hours of employment.

$$w_{prod} = \frac{W}{P_Y} = \frac{W \cdot L}{P_Y \cdot L} = \frac{Y_L}{P_Y \cdot L} \tag{2}$$

Labour productivity

Because of constant returns to scale, the average and marginal products of labour are equal. Labour productivity is therefore:

$$\frac{y}{L} = \frac{Y}{P_Y \cdot L} \tag{3}$$

Note that labour productivity and the real product wage use a common price deflator, P_Y, as emphasized by Feldstein (2008). The real product wage is therefore the measure of pay that should most closely align with productivity in the long run.

Labour share

The ratio between the real product wage (Equation 2) and labour productivity (Equation 3) is the labour share (Equation 4). This is the proportion of nominal output paid to labour as a factor of production. One minus the labour share is the compensation paid to firm owners (the capital share).

$$\begin{aligned} \frac{\textit{real product wage}}{\textit{labour productivity}} &= \left(\frac{Y_L}{P_Y \cdot L}\right) / \left(\frac{Y}{P_Y \cdot L}\right) \\ &= Y_L / Y \end{aligned} \tag{4}$$

Using the notation of Sharpe *et al.* (2008b), rearranging the equation (4) and letting $\Delta\%X$ denote the percentage change in variable X, growth in the real product wage can be restated as:

$$\begin{aligned} &\Delta\%\textit{real product wage} \\ &= \Delta\%\textit{labour productivity} + \Delta\%\textit{labour share} \end{aligned} \tag{5}$$

Labour's terms of trade

Workers produce goods and services sold by firms at output prices, P_Y. Workers' output includes consumer and non-consumer goods and services, including domestic products and exports but excluding imports. Workers use their nominal wages to buy consumer goods and services, which include consumer imports, at consumer prices, P_C. The ratio between the price of workers' output and the price of consumption is labour's terms of trade (P_Y/P_C). Labour's terms of trade can shift due to changes in export prices and domestic non-consumer product prices relative to consumer import prices.

Real consumption wage

Another important measure of wages is the real consumption wage, w_{cons}. The consumption wage measures the real consumer purchasing power of hourly nominal compensation, W. Unlike the product wage (noting that w_{prod} is a function of P_Y not P_C), the consumption wage does not reflect the real capacity of firms to pay wages unless $P_Y = P_C$. The consumption wage is:

$$w_{cons} = \frac{W}{P_C} = \frac{Y_L}{P_C \cdot L} = \frac{Y}{P_Y \cdot L} \cdot \frac{Y_L}{Y} \cdot \frac{P_Y}{P_C} \tag{6}$$

where Y_L is nominal total labour com-

pensation, P_C is the price of consumption goods and services, L is total hours worked, Y is nominal output and P_Y is the price of output. Labour productivity is $Y/P_Y L$, Y_L/Y is the labour share, and P_Y/P_C is labour's terms of trade.

Again using the notation of Sharpe *et al.* (2008b), in growth terms, the relationship is simplified to:

$$\begin{aligned}
&\Delta\%\textit{real consumption wage} \\
&\quad = \Delta\%\textit{labour productivity} + \Delta\%\textit{labour share} \\
&\qquad + \Delta\%\textit{labour's terms of trade} \\
&\quad = \Delta\%\textit{real product wage} \\
&\qquad + \Delta\%\textit{labour's terms of trade}
\end{aligned} \tag{7}$$

Finally, an alternative measure of the real consumption wage is calculated by deflating hourly nominal compensation by the Consumer Price Index (CPI) instead of P_C. Whereas the household consumption deflator (P_C) in the national accounts is based on a changing basket of goods and services bought by consumers, the Laspeyres-type CPI reflects prices for a fixed basket of goods and services. If and only if $P_C = P_{CPI}$, which would imply no substitution of products by consumers in response to relative price changes, would the two measures of real consumption wages be equivalent. Furthermore, since w depends on P_Y (not P_C or P_{CPI}), if and only if $P_Y = P_C = P_{CPI}$ would measures of real consumption wages align with labour productivity.

Measuring the Link in Practice

Three key measurement issues arise in assessing the long-run relationship between growth in real pay and total economy labour productivity:

- How to measure nominal wages;
- How to measure prices used to translate nominal wages into real wages; and
- Whether the output measure used in the calculation of labour productivity should be net of non-factor production costs.

Measuring wages

The measure of nominal hourly wages, W, must be comprehensive. It should include all types of compensation paid by the firm to workers for applying their time and skills to the production process. It should include the labour compensation of both employees and self-employed workers (excluding dividends and other capital income received as business owners) because the measure of output in labour productivity includes the output of both employees and the self-employed. Similarly, it should include the compensation of workers across all industries, including both the business and non-business sectors, since all of these labour inputs contribute to total economy output. Table 1 shows the four main wage measures available in Canada and their scope.

The Labour Force Survey (LFS) and the Survey of Employment, Payrolls and Hours (SEPH) are the most commonly cited wage data sources because they are published monthly with a short lag. However, neither includes supplementary labour income (SLI, also known as employers' social contributions). National Accounts (NA) wage

Table 1: Canadian Wage Data Sources and Their Scope

Data source	All forms of income?	All forms of work?	All industries?
	Includes supplementary labour income	*Includes self-employed*	*Includes business and non-business sectors*
Productivity Accounts (PA)	Yes	Yes	Yes
National Accounts (NA)	Yes	No	Yes
Labour Force Survey (LFS)	No	No	Yes
Survey of Employment, Payrolls and Hours (SEPH)	No	No	No

Note: Although the LFS collects data on labour force status and hours worked among employees and the self-employed, earnings data are in respect of employees only. In March 2020, Statistics Canada (2020:26) added questions to the LFS about compensation for the self-employed. The data are not yet public, however.
Source: Statistics Canada

data shows that SLI has become a much larger share of employers' cost of labour over time, increasing from 9 per cent to 14 per cent of compensation between 1981 and 2019 (Chart 1).[9] [10]

The most comprehensive wage data source is the Productivity Accounts (PA), which includes SLI and an imputation for the labour income of the self-employed based on LFS and Census data (see Maynard, 2005).[11] Self-employment has played a declining role in Canada's labour market as a share of employment hours worked and all jobs since about the mid-1990s (Chart 2, Panel A).[12] Chart 2, Panel B, shows self-employment compensation as a share of PA total labour compensation rose from about 5 per cent in 1981 to a peak of almost 8 per cent in 1996 but thereafter faded to only around 4 per cent in 2019. Like NA wage data, the PA wage data covers the total economy, including both the business sector and non-business sector (i.e. government and non-profit institution serving households).

In summary, since all labour inputs con-

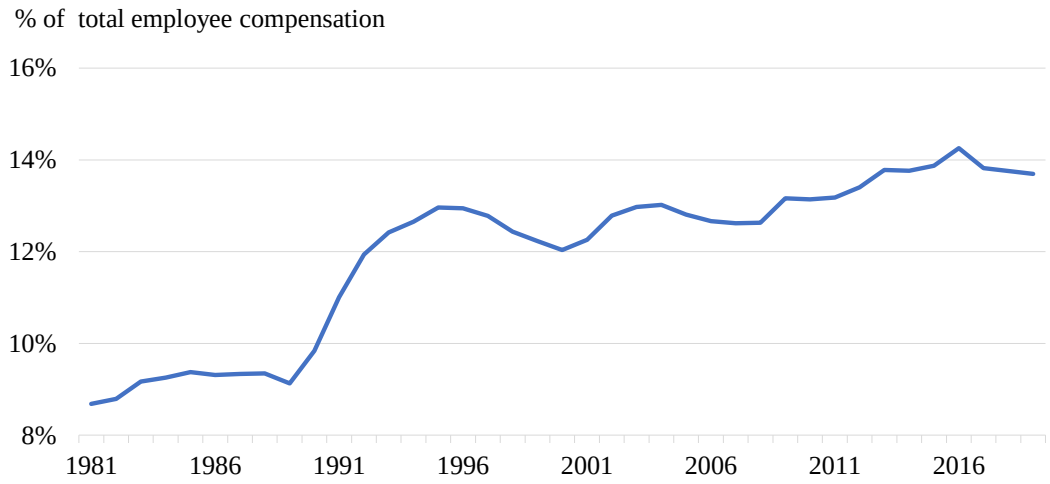
9 See definition of compensation in Statistics Canada (2016, Chapter 5). Champagne et al. (2017) highlight similar trends for the United States

10 For example, for the period 1966-86, employers contributed 1.8 per cent of their employees' income, up to the maximum annual pensionable earnings, to the Canada Pension Plan. The contribution rate was gradually increased to 4.95 per cent by 2003, and then began to increase again from 2019 and was 5.1 per cent in 2019. In inflation-adjusted 2019 dollars, the maximum annual employer contribution has increased from $615 CAD in 1966 to $2,748.90 CAD in 2019. That is a 347 per cent inflation-adjusted total increase in employers' contributions, which equates to a compound average growth rate (CAGR) of around 2.8 per cent per annum – which is well in excess of productivity growth.

11 Statistics Canada estimates labour compensation for self-employed workers as the sum of self-employment labour compensation by industry. Compensation in each industry is the product of the number of self-employed jobs, average annual hours worked by self-employed workers, and hourly total compensation rates. The number of self-employed jobs is estimated using quinquennial Census data that is then interpolated and projected using LFS data. Hours worked are primarily sourced from the LFS. Self-employed workers are assumed to earn the same hourly total compensation rate as employees in an industry.

12 Statistics Canada defines self-employed jobs as those held by unincorporated working owners, self-employed persons who do not have a business, and persons working in a family business without pay. Jeon and Ostrovsky (2020) highlight that close to half of tax filers citing self-employment income also report employee earnings (wages for which they received an end-of-year earnings summary, or T4 document, from their employer). For these individuals, most of their total income is employee income. In other words, for many self-employed workers, self-employment is not their main labour market activity.

Chart 1: Supplementary Labour Income (SLI) as a Share of Total Employee Compensation (excl. Self-Employed), National Accounts, Annual, Canada, 1981-2019



Note: SLI includes employers' contributions to: group or private pension plans; health, dental, life and other insurance policies; and government plans such as the Canada Pension Plan, Quebec Pension Plan, employment insurance, and workers' compensation insurance. National accounts labour compensation data exclude the self-employed.
Source: Statistics Canada Table 36-10-0221-01

tribute to output, the measure of pay should be similarly comprehensive. The PA provide the only complete source of wage data because they include all forms of labour income, all forms of work, and cover all industries. All other wage data are incomplete in some way and therefore miss important trends affecting compensation. LFS and SEPH consider money wages only and miss the rising proportion of compensation that employers pay to workers as SLI. SEPH data also exclude the non-business sector. Both PA and the NA wage data include SLI income and include all industries, but NA data excludes the labour income of the self-employed.

Measuring prices

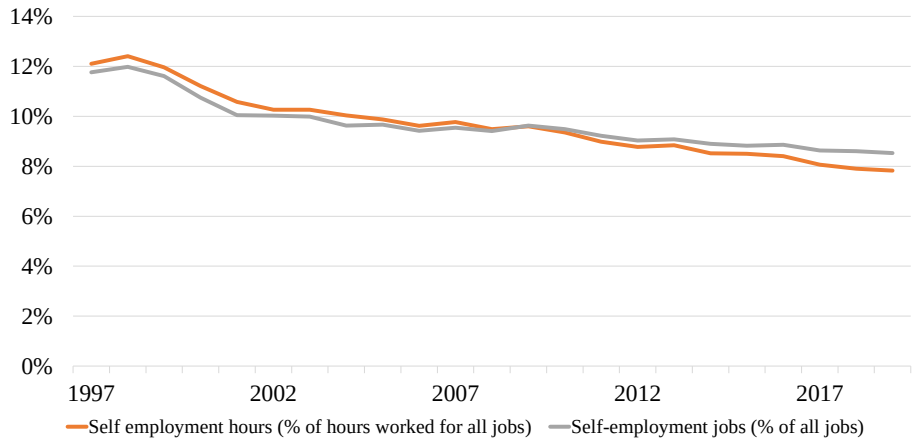
There are three possible price indices that could be used to deflate nominal wages:

- Nominal wages deflated by output prices – i.e. the Fisher-type GDP deflator from the national accounts (PGDP) – gives the real product wage.[13]
- Nominal wages deflated by consumer prices – i.e. the Fisher-type household consumption expenditure deflator (HCE) from the national accounts – gives the real consumption wage.
- Finally, an alternative version of the real consumption wage uses the Laspeyres-type consumer price index (CPI) as the deflator.

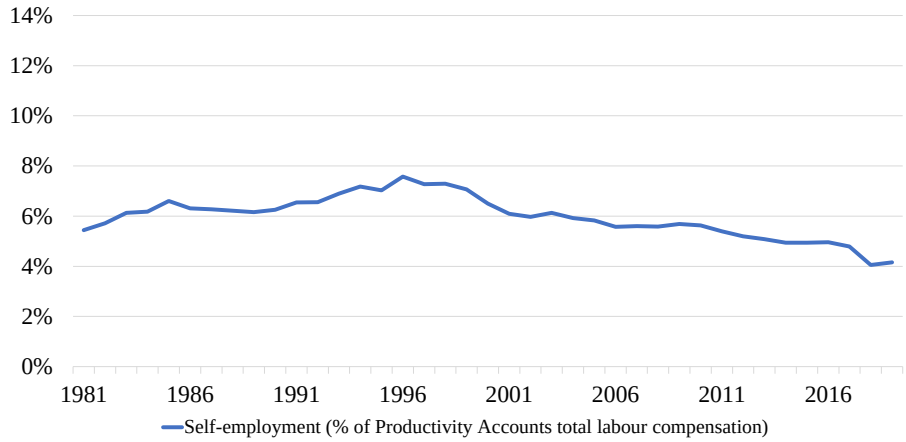
13 In 2001, Statistics Canada switched from using Paasche to Fisher indices in the National Accounts and later recalculated historical series on that basis. Under certain conditions, a Paasche index can be thought of as the lower bound on prices changes while a Laspeyres index (because of its substitution bias) is the upper bound. The Fisher index lies in between, as it is the geometric average of the two.

Chart 2: Self-Employment as a Share of Hours Worked and all Jobs and Total Labour Compensation, Annual, Canada

Panel A: Share of Hours Worked and Share of All Jobs



Panel B: Share of Total Labour Compensation



Note: Self-employed jobs are those held by unincorporated working owners, self-employed persons who do not have a business, and persons working in a family business without pay. Panel A shows Labour Statistics consistent with the System of National Accounts for 1997-2019. Panel B shows the difference between Productivity Accounts labour compensation and National accounts labour compensation, as a share of Productivity Accounts labour compensation, for 1981-2019.
Source: Statistics Canada Tables 36-10-0489-01, 36-10-0221-01, 36-10-0480-01; author's calculations

Workers produce output sold at PGDP, which affects firms' marginal revenue product. Consumer prices (HCE or CPI) are not necessarily related to firms' revenues, such as for firms that export or sell products business-to-business or business-to-government. Therefore, neither HCE nor CPI necessarily influence firms' nominal resources with which to compensate factors of production. PGDP is thus the best available price index by which to assess the relationship between growth in real wages and productivity when applying the theory of the firm.

Workers use their wages to purchase consumer products. The real consumption wage is important to workers because it indicates changes in households' welfare as measured by real income. Here, the most appropriate price measure is HCE which is a subset of PGDP. Alternatively, CPI measures price changes for a periodically-updated fixed basket of goods and ser-

Table 2: Price Indices and Terms of Trade Over Canadian Business Cycles
Compound Annual Growth Rates (CAGR, Per Cent Change Per Annum), Annual Data

Business cycle	GDP deflator	Household consumption expenditure deflator	Consumer price index	Labour's terms of trade	Alternative labour's terms of trade	External terms of trade
Years	*PGDP*	*HCE*	*CPI*	*PGDP/HCE*	*PGDP/CPI*	*PX/PM*
A	B	C	D	E = B – C	F = B – D	G
1961-1973	4.36	3.50	3.40	0.86	0.96	0.57
1973-1981	9.43	9.30	9.26	0.12	0.17	0.19
1981-1989	4.70	5.11	5.16	-0.41	-0.46	0.11
1989-2000	1.96	2.11	2.21	-0.16	-0.25	-0.21
2000-2008	2.76	1.58	2.24	1.18	0.53	2.24
2008-2019	**1.30**	**1.29**	**1.60**	**0.01**	**-0.30**	**-0.68**
Long run: 1961-2019	**3.85**	**3.57**	**3.72**	**0.27**	**0.12**	**0.30**

Note: PGDP is the GDP deflator, HCE is the household final consumption expenditure deflator, CPI is the consumer price index, PX is export prices and PM is import prices.
Source: Statistics Canada

vices.[14] It is the best-known price measure and is used by businesses and workers as an informal guide in wage and price setting, by governments to adjust tax brackets and benefits, and by the Bank of Canada in setting monetary policy.[15]

Table 2 sets out the compound annual growth rates (CAGR) for PGDP, HCE and CPI over the six Canadian business cycles from 1961-2019. Column A shows the business cycle dates as determined by the Business Cycle Council of the C.D. Howe Institute. Both 1961 and 2019 are starts and ends of business cycles, respectively. Also, the latest cycle, 2008-2019, is a complete cycle. Columns E and F show two measures of labour's terms of trade using HCE and CPI, respectively. Column G shows Canada's external terms of trade. The Appendix provides data sources. An online data appendix is available here [provide link].

Over 1961-2019, output prices rose by 3.9 per cent per annum while consumer price growth (HCE) was slightly lower, resulting in a 0.3 per cent per annum overall improvement in labour's terms of trade.[16] Notably, the 2000-08 cycle saw a strong rise

14 Statistics Canada updated the CPI basket weights in 1957, 1967, 1974, then mostly quadrennially (1978, 1982, 1986, 1992, 1996, 2001, 2005), then biennially from 2009 to 2017 (latest) based on household expenditure surveys (Statistics Canada, 2019: Appendix C). Note there is a long lag between the basket reference year and implementation of around three to six years before the 1996 update and about two years thereafter. For example, the 2015 reference basket was implemented in January 2017 and used until January 2019, when it was replaced by the 2017 basket.

15 Four main sources of divergence between the consumption deflator and the CPI are the formulae, relative weights on comparable items, treatment of medical expenses, and treatment of housing (see Johnson, 2017; and Pessoa and van Reenen, 2013:29-30, for the United States). Sabourin (2012) highlights four potential biases in the Canadian CPI: commodity substitution; outlet substitution; new goods; and quality (the latter can also be a challenge for HCE). Although Statistics Canada endeavours to account for these issues during updates of the basket, adjustments may still be imperfect. Sabourin (2012) estimates that mean total bias in the CPI is around +0.5 percentage points per annum relative to a true cost of living index.

16 There is incomplete overlap between the external terms of trade and labour's terms of trade. The external terms of trade is the ratio of export prices to import prices in respect of tradeable consumer and non-consumer goods and services. In labour's terms of trade, the numerator (PGDP) includes the prices of all tradeable and non-tradeable goods and services produced domestically, but the denominator (HCE) includes the prices for consumer goods and services only (including those that are imported).

in labour's terms of trade in part reflecting an extraordinary – but temporary – surge in Canada's external terms of trade. The latter resulted from a commodity price super cycle propelled by an accelerating Chinese economy (Buyuksahin *et al.*, 2016).

Chart 3 plots two versions of labour's terms of trade (PGDP/HCE and PGDP/CPI) and Canada's external terms of trade using 1961 as the base year. The two versions of labour's terms of trade are similar before the early 2000s. However, after the early 2000s, PGDP/CPI shows a much more muted rise until 2008, after which it gradually declines. PGDP/CPI appears to understate the improvement in labour's terms of trade by overstating the rise in consumer prices faced by households.[17]

Measuring labour productivity

Labour productivity is hourly real output (i.e. real GDP at market prices per hour worked). The question arises as to whether GDP overstates the income from production that is actually available to firms to compensate labour and capital as factors of production. National Accounts data shows depreciation costs have risen from around 14 per cent of nominal GDP before the mid-1970s to around 17 per cent in 2019 (Chart 4). It is generally accepted that the capital stock is depreciating at a faster rate because digital assets, intangible assets, and intellectual property have shorter lives (Spant, 2003). A rising proportion of output devoted to maintaining the capital stock means fewer resources are available to increase living standards (Baker and Rosnick, 2007).

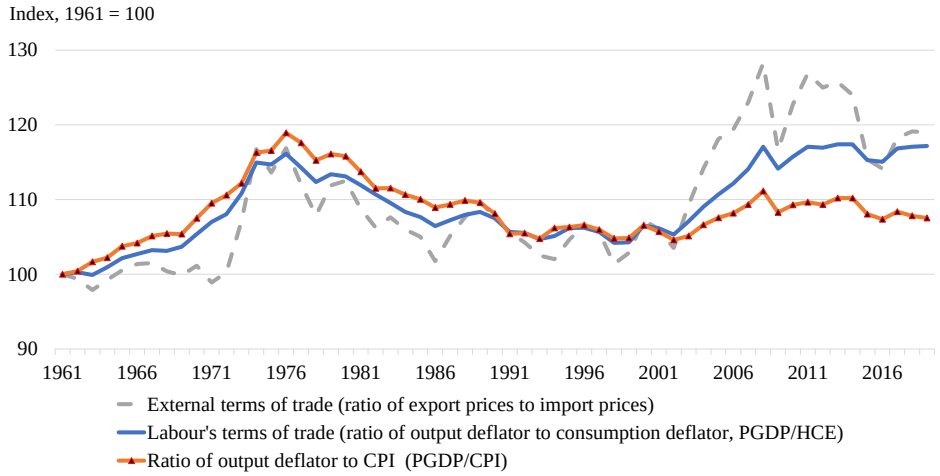
Two other non-factor production costs are "taxes less subsidies on products and imports" and "taxes less subsidies on production," which are tied to the value of output.[18]These production-based net taxes directly or indirectly influence the valuation of output, as distinct from taxes based on receiving income or possessing wealth. The sum of these taxes as a share of nominal GDP is similar in 2019 as compared to 1961, but has fluctuated widely in the interim (Chart 4). It fell sharply during the 1970s, rose significantly during the 1980s, and declined from 1993 to 2008. Since 2008, it has risen by about 1 percentage point of nominal GDP at market prices.

In total, non-factor production costs have increased from 25 per cent of GDP in 1961 to 28 per cent in 2019, with significant increases in the 1980s (partly reversed during the 1990s) and from the mid-2000s (Chart 4). The rise in non-factor pro-

17 Substitution effects missed by the CPI may have become more important from the 2000s due to the advent of cheap imports from China after its 2001 admittance to the World Trade Organization, internet shopping, e-commerce and dynamic pricing by firms. Another possibility is that there are differences in the treatment of housing in HCE and CPI that have become more important during Canada's post-2000 house price boom (Williams, 2018; Bergevin, 2012).

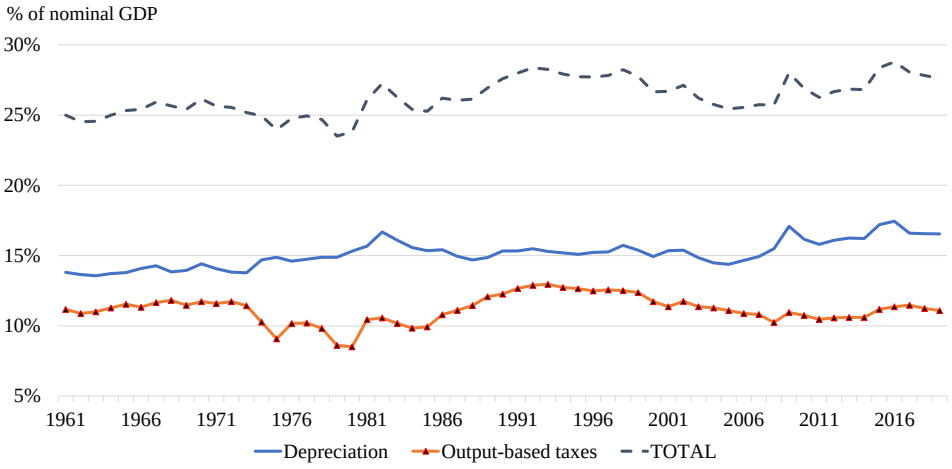
18 "Taxes less subsidies on products and imports" are collected from producers or importers directly as a percentage of the price of the traded product or as a dollar amount per physical unit. Examples include the goods and services tax (GST), harmonized sales taxes (HST) or provincial sales taxes (PST), import duties, export taxes, amusement taxes, air transportation taxes, municipal sales taxes, and environmental levies and excise on tobacco, alcohol or fuel. Taxes are remitted to the government when a product is sold: if no output is sold, no taxes are paid. "Taxes less subsidies on production" are taxes that are indirectly linked to production but must be paid by producers regardless of the level of profitability or sales. Examples include business property taxes, license fees, and taxes on pollution not linked to sales units. See Statistics Canada (2016, Chapter 4).

Chart 3: Labour's Terms of Trade and External Terms of Trade, Annual, Canada



Source: Statistics Canada Tables: 36-10-0129-01, 36-10-0130-01 and 36-10-0005-01

Chart 4: Non-Factor Production Costs, Per Cent of Nominal GDP at Market Prices, Canada, Annual, 1961-2019



Note: Depreciation is the sum of consumption of fixed capital for corporations, unincorporated businesses, and general government and institutions serving households. Output-based taxes include taxes less subsidies on products and imports, and taxes less subsidies on production.
Source: Statistics Canada Table: 36-10-0221-01

duction costs means GDP overstates the income from production firms have available to pay factors of production. An alternative nominal income measure is nominal net domestic product (NDP) at basic prices, which is defined in this paper as nominal GDP at market prices, less consumption of fixed capital, less taxes minus subsidies on products and imports, less taxes minus subsidies on production.[19] Real NDP at basic prices can only be estimated as a proxy because Statistics

19 The System on National Accounts defines output "at basic prices" as GDP at market prices less direct output-based taxes only. This paper removes both direct and indirect output-based taxes from the measure of output since neither is available to firms to compensate factors of production. For simplicity, hereafter this output concept is referred to as "at basic prices" to differentiate it from GDP at market prices.

20 An appropriate deflator for NDP at basic prices would exclude from output prices the price effects of depreciation and output-based taxes. This output price measure would be the most consistent with the theory of the

Canada does not produce a price deflator for NDP at basic prices.[20] This article relies on the GDP deflator as the price index for NDP, the same price deflator used for labour productivity and real product wages.[21]

Resolving measurement issues: Summary

In summary, the three measurement issues are resolved as followed:

- **Which measure of nominal wages?** PA data provide the only comprehensive source of nominal wage data. Other wage data sources (i.e. LFS, SEPH and NA) provide incomplete measures of total labour compensation because they do not capture SLI, the non-business sector, and/or the self-employed.
- **Which measure of prices to deflate nominal wages?** The most appropriate deflator to use in assessing the relationship between productivity and pay using the theory of the firm is the output price deflator. When assessing household well-being using the real consumption wage, the most appropriate price measure is the consumer price deflator (HCE), a subset of PGDP, while CPI is the least appropriate price measure because of substitution effects.
- **Is labour productivity the best measure of firms' income from production?** The conventional measure of output, GDP at market prices, overstates the resources firms have available to compensate labour and capital. A more appropriate measure of output is net domestic product (NDP) at basic prices which excludes depreciation costs and output-based taxes.

Results

Overview

Table 3 presents the results of the analysis using annual data for the six Canadian business cycles from 1961-2019. Chart 5 plots productivity growth and pay growth over the six Canadian business cycles corresponding to Columns A to F from Table 3. As noted earlier, the Appendix provides data sources and variable construction. An online data appendix is available here [provide link].

Long-run results

The bottom row of Table 3 shows the results for 1961 to 2019. Pay growth and productivity growth have roughly matched each other over the long run. Over 58 years, labour productivity growth averaged 1.7 per cent per annum and net labour productivity growth was 1.5 per cent per an-

firm (i.e. P_Y in equations 1-4 earlier) and in principle should be used to calculate net labour productivity and real product wages. In practice, a NDP deflator does not exist, so the GDP deflator is used as the measure of output prices. If overall price growth for depreciation and output-based taxes is slower (faster) than the GDP deflator, growth in net labour productivity and real product wages could be overstated (understated).

21 Ross and Murray (2010:25) also generate a proxy for real NDP (although theirs is at market prices). From real GDP at market prices they subtract an estimate of real depreciation (i.e. nominal depreciation deflated by an investment price deflator that they construct). However, this approach is problematic because Canadian real GDP data are chain-linked so are not additive.

Table 3: Productivity and Pay Growth Over Canadian Business Cycles
Compound Annual Growth Rates (CAGR, Per Cent Change Per Annum), Annual Data

Business cycle	Labour productivity	Net labour productivity	Real product wage	Real consumption wage	Alt. real consumption wage	Labour's terms of trade	Gross labour share	Net labour share
Years	*Real GDP at market prices /hour worked*	*Real NDP at basic prices /hour worked*	*Hourly compensation /PGDP*	*Hourly compensation /HCE*	*Hourly compensation /CPI*	*PGDP/HCE*	*Nominal compensation /Nominal GDP at mkt prices*	*Nominal compensation /Nominal NDP at basic prices*
A	B	C	D	E	F	G=E–D	H=D–B	I=D–C
1961-1973	3.11	3.30	2.97	3.83	3.93	0.86	-0.14	-0.33
1973-1981	1.80	0.59	1.50	1.62	1.67	0.12	-0.30	0.91
1981-1989	1.09	0.87	0.83	0.42	0.37	-0.41	-0.26	-0.04
1989-2000	1.56	1.65	1.23	1.07	0.97	-0.16	-0.33	-0.42
2000-2008	0.92	1.06	0.67	1.85	1.19	1.18	-0.25	-0.39
2008-2019	**0.99**	**0.69**	**1.05**	**1.06**	**0.75**	**0.01**	**0.06**	**0.36**
Long run: 1961-2019	**1.65**	**1.47**	**1.46**	**1.73**	**1.59**	**0.27**	**-0.19**	**-0.01**

Note: All data are for the total economy. Nominal net domestic product (NDP) at basic prices is nominal GDP at market prices less depreciation and output-based taxes. Real NDP is nominal NDP deflated by the GDP deflator (PGDP). HCE is the household final consumption expenditure deflator and CPI is the consumer price index. Total labour compensation and hours worked are from the Productivity Accounts, where compensation includes supplementary labour income and the labour income of the self-employed.
Source: Statistics Canada; author's calculations

num. Growth in real wages was similar: 1.5 per cent per annum for real product wage growth and 1.7 per cent per annum for real consumption wage growth. For the CPI-based real wage measure, growth was between at 1.6 per cent per annum.

Labour's terms of trade improved by 0.3 per cent per annum, indicating that worker's welfare improved as the prices of goods and services consumed by workers rose less than the prices of goods and services they produced. The gross labour share declined by 0.2 per cent per annum, indicating that workers received a slightly decreasing share of national income compared to capital providers. However, after accounting for non-factor production costs, which rose over the period, the net labour share was unchanged.

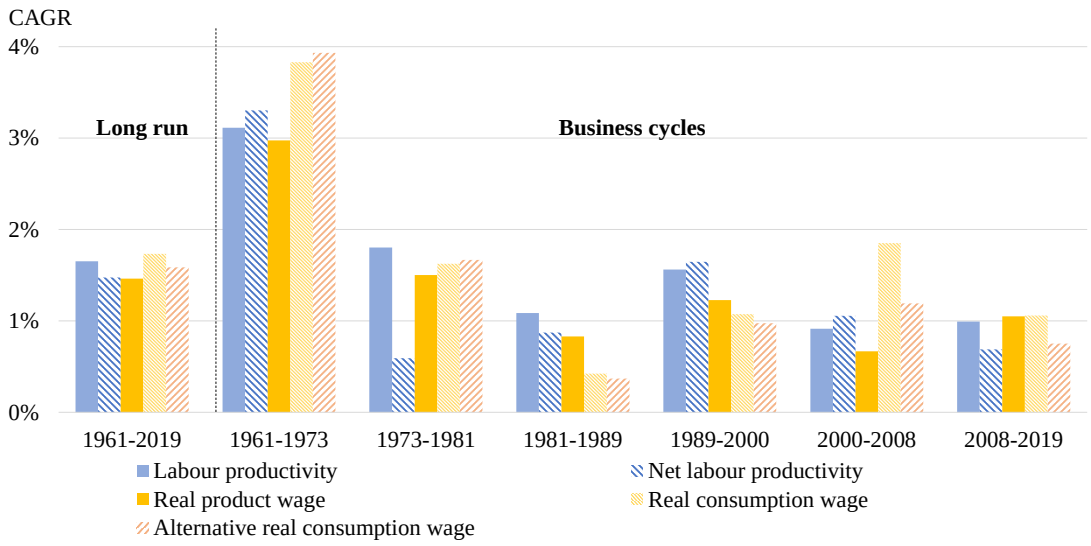
The 2008-2019 business cycle

The most recent business cycle from 2008-19, along with the 2000-08 cycle, saw the slowest productivity growth since records began in 1961. Labour productivity growth was 1.0 per cent per annum, while net labour productivity growth was even lower at 0.7 per cent per annum due to the increase in non-factor production costs.

Growth in productivity and pay was slow. Both the real product wage and the real consumption wage averaged around 1.1 per cent per annum, in line with labour productivity growth and slighty faster than net labour productivity growth. The CPI-based real wage measure was slightly lower at 0.8 per cent per annum, reflecting that the CPI rose faster than PGDP and HCE over the period.

The 2008-19 business cycle saw no change in labour's terms of trade, in stark contrast to the 2000-08 cycle when output prices significantly outpaced consumer prices. The gross labour share improved slightly by 0.1 per cent per annum. The net labour share improved by about 0.4 per cent per annum, reversing the decline that occurred over 2000-08. Overall, the main difference between the 2008-19 and 2000-09 business cycles is that households' real in-

Chart 5: Measures of Labour Productivity and Real Hourly Total Labour Compensation, CAGR (Per Cent Change Per Annum), Canada, 1961-2019



Note: Labour productivity is real GDP at market prices per hour worked. Net labour productivity is real NDP at basic prices per hour worked, where output excludes depreciation and output-based taxes. Total compensation per hour worked includes supplementary labour income and the labour income of the self-employed. Labour productivity, net labour productivity and the real product wage use the same price measure, PGDP. The real consumption wage and alternative real consumption wage use HCE and CPI, respectively.
Source: Statistics Canada and author's calculations

come was no longer aided by improvements in labour's terms of trade.

Discussion

Has pay kept up with productivity?

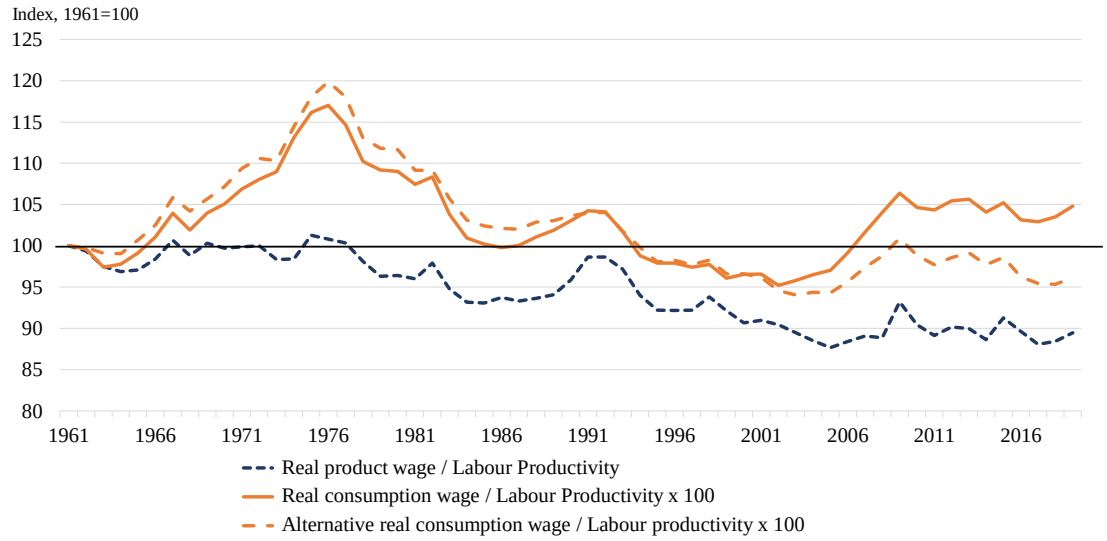
The question as to "whether pay growth has kept up with productivity growth in Canada" hinges to a large degree on measuring both concepts appropriately. Real product wages have lagged the conventional measure of labour productivity (Chart 6, Panel A). However, they tracked net labour productivity fairly well over 1961-2019 (Chart 6, Panel B). This is an important result. Consistent with the long run predictions of the theory of the firm, it suggests that workers received the full benefits of labour productivity gains after adjusting output for the rise in depreciation costs and output-based taxes.

Real consumption wages outpaced labour productivity for much of the 1961-2019 period (Chart 6, Panel A). They also significantly outpaced net labour productivity for almost the whole period (Chart 6, Panel B).[22] Both results reflect favourable movements in labour's terms of trade. Shifts in labour's terms of trade explain why real consumption wages rose faster than real product wages during 1961-73 and 2000-08. Nonetheless, changes in labour's terms of trade and the external terms of trade are generally temporary. Productivity growth is the only sure path to sustained gains in real pay and living standards over the long run.

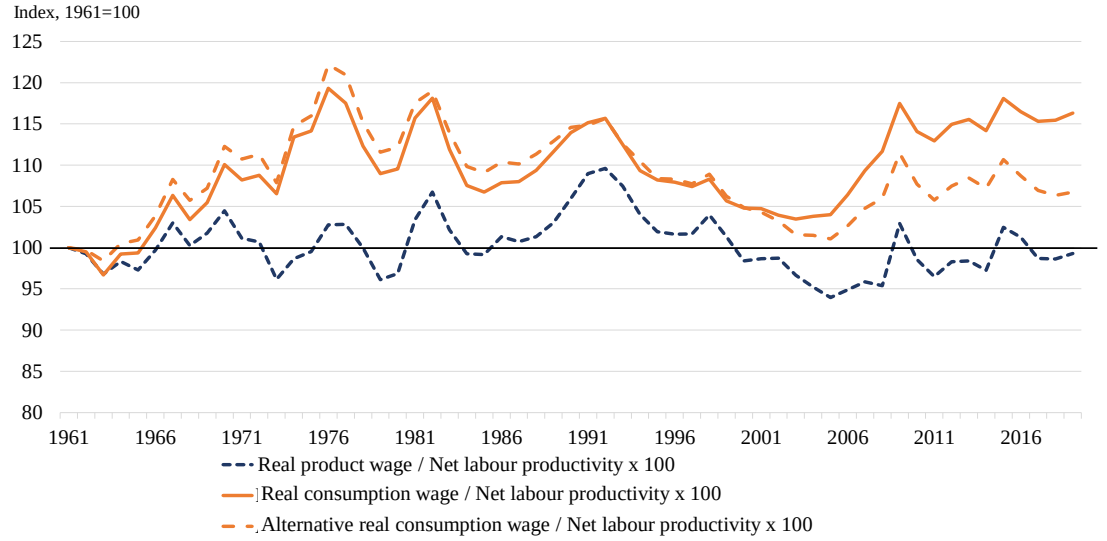
22 The alternative real consumption wage (based on CPI) lagged labour productivity from the 1990s (Chart 6, Panel A). However, it exceeded net labour productivity for almost the whole period, albeit by a lesser margin than the HCE-based real consumption wage (Chart 6, Panel B).

Chart 6: Ratio of Real Hourly Total Labour Compensation to Labour Productivity and Net Labour Productivity, Annual, Canada, 1961-2019

Panel A: Gross Productivity

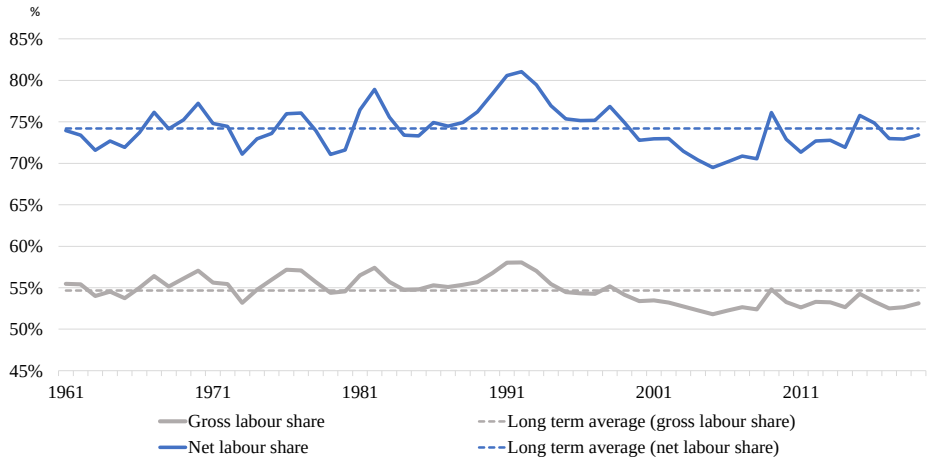


Panel B: Net Productivity



Note: Labour productivity is real GDP at market prices per hour worked. Net labour productivity is real NDP at basic prices per hour worked, where output excludes depreciation and output-based taxes. Total compensation per hour worked includes supplementary labour income and the labour income of the self-employed. Labour productivity, net labour productivity and the real product wage use the same price measure, PGDP. The real consumption wage and alternative real consumption wage use HCE and CPI, respectively.
Source: Statistics Canada and author's calculations

Chart 7: Gross and Net Labour Shares, Annual, Canada, 1961-2019



Note: Gross labour share is nominal total labour compensation / nominal GDP at market prices, where compensation includes supplementary labour income and the labour income of self-employed workers. Net labour share is nominal total labour compensation / nominal NDP at basic prices, where the denominator is nominal GDP less depreciation and output-based taxes.
Source: Statistics Canada and author's calculations

Has labour's terms of trade changed?

Canadian workers benefited from a significant 0.9 per cent per annum improvement in labour's terms of trade (PGDP/HCE) over the 1961-73 business cycle and a slight improvement over the 1973-81 cycle (Table 3, Column G). There was then a substantial deterioration over the 1981-89 cycle and to a lesser extent the 1989-2000 cycle. The 2000-08 cycle saw a strong 1.2 per cent per annum increase in labour's terms of trade, and then no change at all over the 2008-19 cycle. Both the 1961-73 and 2000-08 increases in labour's terms of trade were associated with increases in Canada's external terms of trade driven by commodity price booms (see Chart 3 and Table 2 earlier). Over the 2008-19 cycle, there were no further gains in labour's terms of trade and the surge in the external terms of trade began to unwind.

Has the labour share changed?

Chart 7 shows the gross and net labour shares. The net labour share was mostly above its long-run average over the two decades prior to 2000 and was mostly below it thereafter. By 2019, the net labour share was close to its long-run average and its 1961 level. Overall, the share of net income paid to labour appears little changed. Canadian data suggests that structural influences on the aggregate net labour share may play a minor role or cancel each other out in the long run, notwithstanding fluctuations across business cycles and complex dynamics at the firm and industry level.

Policy Implications

Since in the long run the net labour share appears broadly stable, and pay growth and net productivity growth are broadly aligned, it follows that Canada's productivity growth performance has important implications for living standards. Canada's productivity growth rate fell by about half after 2000 as did growth in real product wages (Table 4). Had real product wages during 2000-2019 grown at the

same pace as net productivity growth over 1961-2000 (i.e. 1.8 per cent per annum instead of 0.9 per cent per annum), pay would have been around 21 per cent higher by 2019. In current dollars, this means Canadian workers' average total compensation in 2019 would have been around $8 CAD per hour higher in 2019, or about $13,550 CAD per annum.[23]

Most advanced countries also saw labour productivity growth slow significantly after 2000 to around 1.2 per cent per annum on average among G7 and OECD countries as seen in Table 4 below and in Sharp and Tsang (2018).[24] Gordon (2012) argues that information and communications technology (ICT) innovations during the third industrial revolution from about 1960-2005, and digital innovations in the fourth industrial revolution now underway, do not have the same potential to generate large, continuous gains in living standards compared to the "great inventions" of the second industrial revolution from 1870-1970. Brynjolfsson and McAfee (2011) and Mokyr (2014) are more optimistic that the recent productivity slowdown is temporary. Nevertheless, Canada's labour productivity growth performance ranked 21st out of 23 OECD countries (for which data are available) over 1970-2000 and 25th out of 36 OECD countries over 2000-19, according to OECD statistics. By 2019, on a purchasing power parity basis, the level of Canadian real GDP per hour worked was about 27 per cent lower than the United States, 21-22 per cent lower than France and Germany, and 10 per cent lower than the United Kingdom. Notwithstanding debates about the technological frontier, there would appear to be ample scope to raise Canada's productivity growth by adopting innovations already deployed by leading countries and firms (i.e. through capital investment, technological diffusion and "catch up").[25]

Schumpeterian models emphasize the role of innovation, competition and creative destruction and are central to understanding productivity growth and the economic growth process (Aghion and Howitt, 2006). Andrews *et al.* (2016) finds that after 2000 there was increasing productivity among global frontier firms (the top 5 per cent most productive firms in the world) but rising productivity dispersion between them and non-frontier firms. They suggest that a rise in "winner takes most" competition and slower diffusion of innovations from leading to non-leading firms, due to regulatory restrictions on competition, could be responsible for the post-2000 global pro-

23 These calculations are relative to actual total compensation of $37.35 CAD per hour (current dollars) and 1691 annual hours worked per job in 2019 from the Productivity Accounts.

24 By industry, the manufacturing sector appears to be a key contributor to the productivity slowdown in the U.S (Kehrig and Vincent, 2021 and Gutierrez and Piton, 2020) and Canada (Sharpe and Tsang, 2018).

25 What if Canada had matched the OECD's productivity growth after 2000 instead of lagging it? OECD net labour productivity growth could have been about 1.10 per cent per annum over 2000-19 assuming the same growth in non-factor production costs as in Canada over the period (i.e. 1.21 per cent less 0.12 per cent equals 1.10 per cent). If Canadian real product wages had similarly grown at 1.10 per cent per annum over 2000-2019 (instead of 0.84 per cent per annum), they would have been about 5 per cent higher by 2019. In current dollars, this means Canadian workers' average total compensation in 2019 would have been higher by around $1.70 CAD per hour or $2,900 CAD per annum.

Table 4: Post-2000 Slowdown in Productivity and Pay Growth
Annual Data, Canada and G7/OECD Countries

Measure	Compound annual growth rate (CAGR, % change per annum)		
Canada	**1961-2000**	**2000-2019**	**(2000-2019) - (1961-2000)**
Labour productivity	1.99	0.96	-1.03
Net labour productivity	1.78	0.84	-0.94
Real product wage	1.74	0.89	-0.85
Real consumption wage	1.90	1.39	-0.51
Alternative real consumption wage	1.90	0.94	-0.96
Other advanced countries	**1970-2000**	**2000-2019**	**(2000-2019) - (1970-2000)**
G7 labour productivity	2.38	1.16	-1.22
OECD labour productivity	n/a	1.21	-

Note: Labour productivity is real GDP at market prices per hour worked. Net labour productivity is real NDP at basic prices per hour worked, where output excludes depreciation and output-based taxes. Total compensation per hour worked includes supplementary labour income and the labour income of the self-employed. Labour productivity, net labour productivity and the real product wage use the same price measure, PGDP. The real consumption wage and alternative real consumption wage use HCE and CPI, respectively.
Source: Statistics Canada; OECD Statistics; author's calculations

ductivity slowdown. Gu (2019) considers Canadian micro-data on firm-level productivity and splits the data into the top 10 per cent most productive Canadian firms by industry and the rest. He finds the post-2000 productivity growth slowdown was due to a decline in innovation at Canada's top firms (which could indicate slower innovation diffusion from global frontier firms), a decline in innovation diffusion from Canada's most productive firms to other firms, and a decline in resource reallocation and business dynamism.

Canadian policy discussions on economic growth tend to be preoccupied with increasing GDP through labour supply. Increased immigration, population and labour supply do increase GDP but they have negligible overall impact on GDP per capita (Riddell *et al.*, 2016) and do not materially alter the age structure of the population over time (Robson and Mahboubi, 2018, Chart 4). In contrast, higher productivity has the advantage of raising workers' real incomes and GDP per capita. Thus, an economic growth strategy centred on raising productivity growth would be a better strategy than one focused on expanding the labour supply because it would generate the extra resources to support retired workers and fund other enhancements to the social safety net (such as in Green *et al.*, 2020).

Curing the productivity-related maladies weighing on Canada's economic performance both before and after 2000 will require policymakers to consider structural policy settings that encourage or discourage product market competition and innovation diffusion, business dynamism and creative destruction, resource reallocation, investment in capital and skills, and economies of scale. An institutions-based approach to solving Canada's productivity growth malaise could involve establishing an Australian-style national Productivity Commission as an independent government agency tasked with conducting public inquiries on microeconomic problems and reforms (Williams and Finlayson, 2021; Capeluck, 2016) or establishing a United Kingdom-style university-based Productiv-

ity Institute (van Ark and Venables, 2020). The public benefits of such an institution would easily exceed its costs.

Conclusion

The slowdown in real product wage growth in Canada since 2000 reflects the slowdown in net labour productivity growth over the same period. In and of itself, this might have given Canadian workers cause for alarm in respect of their standard of living. However, during 2000-08, there was an extraordinary but temporary rise in labour's terms of trade, in part reflecting a surge in Canada's external terms of trade. Workers' welfare as measured by real incomes actually improved over the 2000-08 business cycle because real consumption wages accelerated, even as productivity and real product wages decelerated. This unusual confluence of forces may have obscured and (for a little while) dulled the full ramifications of Canada's post-2000 productivity growth slowdown on workers' pay.

Over the 2008-19 business cycle, the chickens came home to roost. The absence of further improvements in labour's terms of trade to raise real consumption wages laid bare Canada's productivity growth problem. The post-2000 slowdown in real product wage growth does not reflect a decline in the labour share after accounting for the increase in non-factor production costs. In fact, the net labour share increased over 2008-19 and was little changed overall between 1961 and 2019.

Fundamentally, Canada's serially weak productivity growth, the general stability of the net labour share, and the lack of further gains in labour's terms of trade after 2008 mean there is little to drive long term growth in either real product wages or real consumption wages. To generate higher average real pay and living standards, Canada's policymaking institutions will need to prioritize understanding and accelerating productivity.

References

Acemoglu, D. and P. Restrepo (2018) "Modeling Automation," *AEA Papers and Proceedings*, Vol 108, pp. 48-53.

Aghion, P. and P. Howitt (2006) "Appropriate Growth Policy: A Unifying Framework," *Journal of the European Economic Association*, Vol. 4, No. 2-3, pp. 269–314.

Andrews, D., Criscuolo, C. and P. Gal (2016) "The Global Productivity Slowdown, Technology Divergence and Public Policy: A Firm Level Perspective," Hutchins Centre Working Paper 24, Brookings Institute

Autor, D., Dorn, D., Katz, L., Patterson, C. and J. van Reenen (2020) "The Fall of the Labor Share and the Rise of Superstar Firms," *The Quarterly Journal of Economics*, Vol. 135, No. 2, pp. 645-709.

Baker, D. and D. Rosnick (2007) "Productivity and Sustainable Consumption in OECD Countries, 1980-2005," *International Productivity Monitor*, No. 15, pp. 41-54.

Bergevin, P (2012) "Housing Bubbles and the Consumer Price Index: A Proposal for a Better Indicator," C.D. Howe Institute Commentary, No. 362.

Brynjolfsson, E. and A. McAfee (2011) *Race Against the Machine: How the Digital Revolution is Accelerating Innovation, Driving Productivity, and Irreversibly Transforming Employment and the Economy*, Digital Frontier Press.

Buyuksahin, B., Mo, K. and K. Zmitrowicz (2016) "Commodity Price Supercycles: What Are They and What Lies Ahead?" *Bank of Canada Review*, Autumn, pp. 35-46.

Capeluck, E (2016) "A Comparison of Australian and Canadian Productivity Performance: Lessons for Canada," CSLS Research Report, No. 2016-07, Centre for the Study of Living Standards, http://www.csls.ca/reports/csls2016-07.pdf.

Castle, J. and D. Hendry (2009) "The Long-Run Determinants of UK Wages, 1860-2004," *Journal of Macroeconomics*, Vol. 1, No. 31, pp. 5-28.

Champagne, J., Kurmann, A. and J. Stewart (2017) "Reconciling the Divergence in Aggregate U.S. Wage Series," *Labour Economics*, Vol. 49, pp. 27-41.

Dufour, M. and E. Russell (2015) "Why Isn't Productivity More Popular? A Bargaining Power Approach to the Pay/Productivity Linkage in Canada," *International Productivity Monitor*, No. 28, Spring, pp. 47-62.

Elsby, M., Hobijn, B. and A. Sahin (2013) "The Decline of the U.S. Labor Share," *Brookings Papers on Economic Activity*, Vol. 22, No. 2, Fall, pp. 1-63.

Feldstein, M (2008) "Did Wages Reflect Growth in Productivity?" *Journal of Policy Modeling*, Vol. 30, No. 4, pp. 591–594.

Gordon, R (2012) "Is U.S. Economic Growth Over? Faltering Innovation Confronts the Six Headwinds," NBER Working Papers 18315, National Bureau of Economic Research

Gouin-Bonenfant, E (2018) "Productivity Dispersion, Between-Firm Competition, and the Labor Share," 2018 Meeting Papers 1171, Society for Economic Dynamics.

Green, D.A., Kesselman, J.R. and L.M. Tedds (2020) "Covering the Basics: Reforms for a Just Society," Final Report of the British Columbia Expert Panel on Basic Income, December.

Gu, W (2019) "Frontier Firms, Productivity Dispersion and Aggregate Productivity in Canada," *International Productivity Monitor*, No. 37, pp. 96-119.

Gutierrez, G. and S. Piton (2020) "Revisiting the global decline of the (non-housing) labor share," *American Economic Review: Insights*, Vol. 2, No. 3, pp. 321-338.

Harrison, P (2009) "Median wages and productivity growth in Canada and the United States," CSLS Research Note 2009-02, Centre for the Study of Living Standards, http://www.csls.ca/events/cea2009/sharpe-etal.pdf.

International Labour Organisation (2015) "The Labour Share in G20 Economies," Employment Working Group, Antalya, Turkey, February, pp. 26-27.

IMF (2017) "Understanding the Downward Trend in Labor Income Shares," in: *World Economic Outlook: Gaining Momentum?* International Monetary Fund.

Jeon, S.-H. and Y. Ostrovsky (2020) "Self-Employed Individuals, Self-Employment Income and the Post-COVID-19 Financial Strain," Statistics Canada Catalogue, No. 45280001.

Johnson, N (2017) "A Comparison of PCE and CPI: Methodological Differences in U.S. Inflation Calculation and Their Implications," U.S. Bureau of Labor Statistics.

Kaldor, N (1957) "A Model of Economic Growth," *Economic Journal*, Vol. 67, No. 268, pp. 591-624.

Karabarbounis, L. and B. Neiman (2014) "The Global Decline of the Labour Share," *The Quarterly Journal of Economics*, Vol. 129, No. 1, pp. 61-103.

Kehrig, M. and N. Vincent (2021) "The Micro-Level Anatomy of the Labor Share Decline," *The Quarterly Journal of Economics*, Vol. 136, No. 2, pp. 1031-1087.

Keynes, J (1939) "Relative Movements of Labour and Capital," *Economic Journal*, Vol. 49, No. 193, pp. 34-51.

Koh, D., Santaeulalia-Llopis, R. and Y. Zheng (2020) "Labor Share Decline and Intellectual Property Products Capital," *Econometrica*, Vol. 88, No. 6, pp. 2609-2628.

Martinez, J (2018) "Automation, Growth and Factor Shares," 2018 Meeting Papers, No. 736, Society for Economic Dynamics.

Maynard, J.-P (2005) *Annual measure of the volume of work consistent with the SNA: the Canadian experience*, Catalogue no. 11F0026MIE, No. 005, Statistics Canada.

Miller, E (2008) "An Assessment of CES and Cobb-Douglas Production Functions," U.S. Congressional Budget Office, June.

Mishel, L. and K.-F. Gee (2012) "Why Aren't Workers Benefiting From Labour Productivity Growth in the United States?," *International Productivity Monitor*, No. 23, pp. 31-43.

Mokyr, J (2014) "The Next Age of Invention: Technology's Future is Brighter Than Pessimists Allow," *City Journal*, Vol. 24, No. 1, pp. 12-20.

OECD (2018) "Decoupling of Wages From Productivity: What Implications for Public Policies?" *OECD Economic Outlook*, Vol. 2018, No. 2, pp. 51–65, OECD Publishing.

Paul, S (2019) "A Skeptical Note on the Role of Constant Elasticity of Substitution in Labour Income Share Dynamics," Asian Development Bank Institute Working Paper, No. 944, Tokyo.

Pessoa, J. and J. van Reenen (2013) "Decoupling of Wage Growth and Productivity Growth? Myth and Reality," CEP Discussion Paper, No. 1246, Centre for Economic Performance

Piketty, T. and G. Zucman (2014) "Capital is Back: Wealth-Income Ratios in Rich Countries 1700-2010," *The Quarterly Journal of Economics*, Vol. 129, No. 3, pp. 1255-1310.

Riddell, W., C. Worswick, and D. Green (2016) "How Does Increasing Immigration Affect the Economy?" *Policy Options*, Institute for Research Public Policy, November.

Robson, W.B.P. and P. Mahboubi (2018) "Inflated Expectations: More Immigrants Can't Solve Canada's Ageing Problem on Their Own," C.D. Howe Institute E-brief, No. 274.

Rognlie, M (2015) "Deciphering the Fall and Rise in the Net Capital Share: Accumulation or Scarcity," Brookings Papers on Economic Activity, Spring, pp. 1-54.

Ross, C. and A. Murray (2010) "Aggregate Measures of Income and Output in Canada and the United States: Implications for Productivity and Living Standards," *International Productivity Monitor*, No. 19, pp. 20-39.

Sabourin, P (2012) "Measurement Bias in the Canadian Consumer Price Index: An Update," *Bank of Canada Review*, Summer, pp. 1-11.

Schwellnus, C., Kappeler, A. and P.-A. Pionnier (2017) "The Decoupling of Median Wages From Productivity in OECD Countries," *International Productivity Monitor*, No. 32, pp. 44-60.

Sharpe, A., Arsenault, J.-F. and P. Harrison (2008a) "Why Have Real Wages Lagged Labour Productivity Growth in Canada?" *International Productivity Monitor*, No. 17, pp. 16-27.

Sharpe, A., Arsenault, J.-F. and P. Harrison (2008b) *The relationship between labour productivity and real wage growth in Canada and OECD countries*, Centre for the Study of Living Standards, http://www.csls.ca/reports/csls2008-8.pdf.

Sharpe, A. and J. Tsang (2018) "The Stylized Facts About Slower Productivity Growth in Canada," *International Productivity Monitor*, No. 35, Fall, 52-72.

Sharpe, A. and J. Uguccioni (2017) "Decomposing the productivity-wage nexus in selected OECD countries, 1986-2013," *International Productivity Monitor*, No. 32, pp. 25-43.

Spant, R (2003) "Why Net Domestic Product Should Replace Gross Domestic Product as a Measure of Economic Growth," *International Productivity Monitor*, No. 7, pp. 39-43.

Stansbury, A. and L. Summers (2017) "Productivity and Pay: Is the Link Broken?" National Bureau of Economic Research, No. w24165.

Statistics Canada (2021) "Canadian Income Survey, 2019," The Daily, March 23.

Statistics Canada (2020) "Guide to the Labour Force Survey," Catalogue no. 71-543-G, April 9.

Statistics Canada (2019) "The Canadian Consumer Price Index Reference Paper," Catalogue no. 62-553-X, February 27.

Statistics Canada (2016) "User Guide: Canadian System of National Accounts," Catalogue no. 13-606-G, May 31.

Strain, M (2019) "The Link Between Wages and Productivity is strong," *Expanding Economic Opportunity for More Americans*, The Aspen Institute.

Uguccioni, J., Sharpe, A. and A. Murray (2016) *Labour Productivity and the Distribution of Real Earnings in Canada, 1976-2014,* CSLS Research Report, No. 2016-15, Centre for the Study of Living Standards, http://www.csls.ca/reports/csls2016-15.pdf.

van Ark, B. and A. Venables (2020) "A Concerted Effort to Tackle the UK Productivity Puzzle," *International Productivity Monitor*, No. 39, Fall, pp. 3-15.

Williams, D (2018) "How do House Prices Affect the Consumer Price Index?" Insights, Business Council of British Columbia, April 24.

Williams, D. and J. Finlayson (2021) *What Canada Can Learn From Australia to Boost Our Dismal Productivity Growth,* Globe and Mail, February 1.

Appendix: Data Sources and Variable Construction

Concept	Definition	Construction	Source
PRODUCTIVITY			
Labour productivity	Real GDP at market prices per hour worked, all industries	Actual, 1997-	Productivity accounts, Statistics Canada, Table: 36-10-0480-01 (formerly CANSIM 383-0033), annual, 1997- *Accessed: 18/8/2020*
		Backcast to 1961 using historical series growth rate	Statistics Canada historical series, provided by request, annual, 1961- *Accessed: 11/8/2019*
Net labour productivity	Net domestic product (NDP) at basic prices per hour worked, all industries (see note)	Nominal GDP at market prices less consumption of fixed capital less taxes minus subsidies on products and imports, less taxes minus subsidies on production, 1981-	National accounts, Statistics Canada, Table: 36-10-0221-01 (formerly CANSIM 384-0037), annual, 1981- *Accessed: 18/8/2020*
		Backcast nominal component series to 1961 using growth rates of annualized data	Table: 36-10-0103-01 (formerly CANSIM 380-0063), quarterly, 1961Q1- *Accessed: 1/12/2020*
	/ GDP deflator (as a proxy for NDP at basic prices deflator, which Statistics Canada does not produce)	See below	See below
	/ Hours worked for all jobs, all industries	See below	See below
TOTAL LABOUR COMPENSATION (NOMINAL)			
Total labour compensation per hour worked **(Productivity accounts)**	Total labour compensation for all jobs, all industries, nominal	Actual, 1997-	Productivity accounts, Table: 36-10-0480-01 (formerly CANSIM 383-0033), annual, 1997- *Accessed: 18/8/2020*
		Backcast level to 1961 using historical series growth rate	Statistics Canada historical series, provided by request, annual, 1961- *Accessed: 11/8/2019*
	/ Hours worked for all jobs, all industries	Actual, 1997-	Productivity accounts, Table: 36-10-0480-01 (formerly CANSIM 383-0033), annual, 1997- *Accessed: 18/8/2020*
		Backcast level to 1961 using historical series growth rate	Statistics Canada historical series, provided by request, annual, 1961- *Accessed: 11/8/2019*
PRICES			
GDP deflator (PGDP)	Implicit price deflator for GDP at market prices (Fisher-type price index)	Actual	National accounts, Table: 36-10-0130-01 (formerly CANSIM 380-0102), annual, 1961- *Accessed: 26/4/2021*
Household final consumption expenditure deflator (HCE)	Implicit price deflator for household final consumption expenditure (Fisher-type price index)	Actual	National accounts, Table: 36-10-0130-01 (formerly CANSIM 380-0102), annual, 1961- *Accessed: 26/4/2021*
Consumer price index (CPI)	CPI, all items (Laspeyres-type price index)	Actual	Table: 18-10-0005-01 (formerly CANSIM 326-0021), annual, 1961- *Accessed: 26/4/2021*
External terms of trade	Ratio of export prices to import prices	Actual	Table: 36-10-0129-01 (formerly CANSIM 380-0101), annual, 1961- *Accessed: 5/5/2021*

Appendix: Continued

Concept	Definition	Construction	Source
TOTAL COMPENSATION (REAL)			
Real product wage (PGDP-based)	Total labour compensation per hour / PGDP	N/a	N/a
Real consumption wage (HCE-based)	Total labour compensation per hour / HCE	N/a	N/a
Alternative real consumption wage (CPI-based)	Total labour compensation per hour / CPI	N/a	N/a

Note: The System of National Accounts defines output "at basic prices" as GDP at market prices less direct output-based taxes only (i.e. taxes minus subsidies on products and imports). This paper removes both direct and indirect output-based taxes from the measure of output since neither is available to firms to compensate factors of production. For simplicity, this paper refers to this output concept as "at basic prices" to differentiate it from gross or net output at market prices.