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Unit labour cost, wages and labour productivity in Canada: A bottom-up analysis[1]

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Unit Labour Cost, Wages, and Labour Productivity in Canada: A Bottom-up Analysis*

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Abstract

We provide a granular view of Canadian real unit labour cost growth and its two components — real wages and labour productivity — from 1997 to 2019. We develop a growth accounting framework allowing us to decompose aggregates into contributions from 19 industries across time. Our approach allows us to generate insights into the behaviour of Canada's unit labour cost, wages, and labour productivity that are not possible to obtain by using aggregate data alone.

Our main findings demonstrate that there are considerable differences in the growth of real wages and labour productivity across industries over this period, but within industries real wage and labour productivity growth are strongly correlated. As a result, within industry real unit labour cost growth is small. Our framework highlights that industry effects on the aggregate depend not only on within industry changes, but also relative levels of wages/labour productivity and the input share of each industry. If an industry has a high relative level of labour productivity/wages, then shifts in input shares can impact the aggregate even in the absence of any growth within industry.

Two important themes emerge from our paper. First, analysis of macroeconomic aggregates runs into the usual challenges that such aggregates reflect complex and often non-linear interactions, making it difficult to pinpoint the exact sources of changes in aggregate variables. One way to ameliorate these challenges is to make use of more granular data, as we do. Second, a coherent economic framework is needed to reconcile and connect granular data to aggregate information, and to draw conclusions about macroeconomic aggregates from granular data. Our work proposes such a framework within the Canadian context for real unit labour cost, real wages, and labour productivity.

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1 Introduction

Unit labour cost (ULC) — a measure of the labour cost to produce a single unit of real output — is a commonly cited metric in discussions of both short- and long-run economic outcomes in Canada. In the short-run, ULC may be informative about current and future inflationary pressures, as rising labour costs can lead businesses to pass on such costs to consumers in the form of higher prices.[1] In the long-run ULC can be useful to assess Canada's competitiveness in global markets, as lower ULC makes domestic products more attractive and increase exports (Kaci and Maynard, 2002).

ULC is defined as the ratio of the wage rate and labour productivity. Increases in ULC can then occur whenever wage growth exceeds labour productivity growth. From 1997 to 2019 real ULC in Canada decreased by roughly 3%, explained by the fact that the increase in labour productivity over this period (+30%) outpaced increases in real wages (+27%). However, it is often difficult to pinpoint the exact sources of growth in these variables as they reflect the aggregation of activity and prices across a number of industries and regions. Further, analysis from a purely aggregate standpoint potentially conceals important trends occurring at a more granular level, which can be informative about the future performance of the Canadian economy.[2]

In this paper we provide an analysis of real unit labour cost and its two components, namely real wages and labour productivity, in Canada from a granular viewpoint. We develop a growth accounting framework which allows us to decompose aggregates of these variables into contributions from each industry across time. Further, our approach allows us to distinguish between changes in aggregates resulting from growth at the disaggregated level versus changes resulting from shifts in the composition of activity/prices. Our industry-level analysis focuses on 19 different industries, corresponding to the 2-digit North American Industry Classification System (NAICS) level, over the period 1997 to 2019.[3] Our approach allows us to generate insights into the behaviour of Canada's unit labour cost, wages, and labour productivity not possible using aggregate data alone, and helps us to address questions such as: What are the industries contributing to Canada's ULC, wage, and labour productivity growth? Have the primary contributors changed over time? How

[1] See Perrier and Gu (2023) for a recent example in the Canadian context. Barlevy and Hu (2023) find that ULC does not help to forecast US inflation, but that this finding is consistent with an economy where wages adjust more slowly than prices.

[2] For example, Foerster, Hornstein, Sarte and Watson (2022) show that US sectors exhibit very disparate trends in productivity over the post-war period. Some sectors exhibit positive productivity growth, while other sectors are stagnant.

[3] The NAICS classification structure can be found at https://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVD&TVD=1181553

are the contributions distributed across industries? Is growth in these variables stagnant in some industries?

Our main findings can be summarized as follows. First, we find that across industries there are considerable differences in the growth of real wages and labour productivity over this period. Industries such as agriculture, wholesale trade, and retail trade experienced large increases in labour productivity, while others such as mining, oil, & gas, construction, and administrative & waste management services experienced low or even negative labour productivity growth over this period. In most cases real wage growth is strongly correlated with labour productivity growth at the industry-level, meaning that within industry changes in real unit labour cost are small.

Second, our decomposition highlights that within industry growth rates in isolation cannot fully determine the effect of a particular industry on aggregate outcomes. For example, the mining, oil, and gas industry averaged negative labour productivity growth and positive real wage growth over this period – implying a rise in real unit labour cost. In the aggregate however, mining, oil, and gas contributed positively to Canada's level of labour productivity and negatively to its real unit labour cost. Our framework highlights that industry effects on the aggregate depend not only on within industry changes, but also relative levels of wages/labour productivity and the input share of each industry. If an industry has a high relative level of labour productivity/wages, then shifts in input shares can impact the aggregate even in the absence of any growth within industry. In the case of the mining, oil, and gas industry, even though within industry labour productivity was falling and real unit labour cost was rising, the industry has a high relative level of labour productivity and low relative level of unit labour cost. As a result, the within industry effects are dominated by changes in the input shares, pushing aggregate labour productivity upwards and aggregate real unit labour cost downwards.

Lastly, we find that the industries responsible for short-run changes in unit labour cost, wages, and labour productivity are quite different. Year-over-year changes in real unit labour cost and labour productivity growth primarily reflect developments in goods-producing sectors, while real wages reflect developments in service-producing and non-business industries.

Two important themes emerge from our paper. First, analysis of macroeconomic aggregates runs into the usual challenges that such aggregates reflect complex and often non-linear interactions, making it difficult to pinpoint the exact sources of changes in aggregate variables. One way to ameliorate these challenges is to make use of more granular data, as we do. Second, to draw conclusions about macroeconomic aggregates from granular data

requires a coherent economic framework. In some cases, as we show, the effect of within industry changes on aggregate outcomes can be counterintuitive.

The rest of the paper is organized as follows. Section 2 derives and outlines our growth accounting framework. Section 3 discusses our data and our findings. Section 4 concludes.

2 A Growth Accounting Framework

Our growth accounting framework builds on an approach proposed by Tang and Wang (2004). However, we extend their framework in three directions. First, Tang and Wang focus on industry-level labour productivity contributions to aggregate labour productivity. Our framework accounts for contributions across both industries and geographic regions. As a result our framework can be used to provide a quantitative answer to, for example, the contribution of labour productivity growth in manufacturing in Ontario to Canada's aggregate labour productivity growth.

Second, while Tang and Wang (2004) used their decomposition to examine industrial contributions to aggregate labour productivity growth, they note that such an approach is actually valid for a variety of aggregate variables (see pg. 428). We develop a similar decomposition for aggregate real wages in Canada. To our knowledge, such a decomposition has not been used to examine contributions to aggregate real wages and real unit labour cost.[4]

Third, since aggregate real unit labour cost growth reflects the difference between aggregate real wage growth and labour productivity growth, our decompositions of wages and labour productivity can be used to decompose aggregate real unit labour cost. We begin by outlining how we decompose real wages and labour productivity, which ultimately allow us to decompose real unit labour cost.

2.1 Decomposing real wages

Our decomposition begins by noting that the aggregate real wage rate, w_t, can be defined by

$$w_t = \frac{W_t H_t}{P_t H_t}, \tag{1}$$

[4] A number of papers have studied decompositions of aggregate labour productivity in Canada. E.g., see Sharpe and Bradley (2009); Sharpe (2010); Baldwin and Willox (2016); Blit et al. (2020).

where $W_t H_t$ is total nominal compensation, H_t is total hours worked, and P_t is the aggregate price level. Equation (1) can also be used to show that aggregate nominal compensation is equal to the real wage rate multiplied by the price level and hours worked. That is, $W_t H_t = w_t P_t H_t$. Further, while (1) is expressed for the aggregate economy, this relationship also holds at disaggregated levels such that $W_{i,j,t} H_{i,j,t} = w_{i,j,t} P_{i,j,t} H_{i,j,t}$, where j refers to a geographic region and i to an industry.

Let the economy be comprised of J total geographic regions and I industries. Then (1) can be expressed as

$$w_t = \frac{\sum_J \sum_I P_{ijt} H_{i,j,t} w_{i,j,t}}{P_t H_t}, \tag{2}$$

where $P_{i,j,t}$, $H_{i,j,t}$, and $w_{i,j,t}$ are the price level, number of hours worked, and real wage rate of industry i in geographic region j at time t. Next, let $s_{i,j,t} = \frac{P_{i,j,t}}{P_t} \frac{H_{i,j,t}}{H_t}$, which represents the labour input share in industry i in region j adjusted for relative output prices. Then equation (2) can be expressed in growth rates by

$$\Delta w_t = \sum_J \sum_I \frac{w_{i,j,t-1}}{w_{t-1}} \left(s_{i,j,t} \Delta w_{i,j,t} + \Delta s_{i,j,t} \right), \tag{3}$$

where Δw_t is the growth rate of the aggregate real wage rate, $\Delta w_{i,j,t}$ is the growth rate of the real wage rate in industry i in region j, $\frac{w_{i,j,t-1}}{w_{t-1}}$ is the relative level of real wage rates at the beginning of the period, and $\Delta s_{i,j,t}$ is the absolute change in the labour input share adjusted for relative output prices ($\Delta s_{i,j,t} \equiv s_{i,j,t} - s_{i,j,t-1}$).

Equation (3) shows that the growth rate of the aggregate real wage rage can be decomposed into two distinct effects from each industry in each region. The first captures what we call a *pure growth effect*, i.e., how real wage rate growth in a specific industry in a region contributes to the aggregate. The contribution to the aggregate depends on (1) the relative real wage rate at the beginning of the period; and (2) the labour input share adjusted for relative output prices.

The second effect captures what we call a *reallocation effect*. An increase in the labour input share or an increase in relative output prices can lead to changes in the aggregate even in the absence of real wage growth. Whether this change increases or decreases the aggregate real

wage rate depends on the relative real wage rate in that industry/region.

The above decomposition has a few important properties worth mentioning. First, the decomposition is valid for chained-Fisher indices, for which most of our data is based on. Second, it is exact over long time periods, which is important considering we examine contributions over more than 20 years.

2.2 Decomposing labour productivity

The decomposition of aggregate labour productivity is similar to that of wages. To start, let the level of aggregate labour productivity be defined as the ratio of aggregate nominal value added (Q) divided by the aggregate price level (P) and the number of hours worked (H)

$$LP_t = \frac{Q_t}{P_t H_t}. \tag{4}$$

Since nominal value added is measured in common units across regions and industries, aggregate nominal value added is simply the sum of value added across regions J and industries I

$$Q_t = \sum_J \sum_I Q_{i,j,t}. \tag{5}$$

Further, the expression for labour productivity in equation (4) also holds at the disaggregated level. Then it is straightforward to express aggregate nominal value added as

$$Q_t = \sum_J \sum_I P_{i,j,t} H_{i,j,t} LP_{i,j,t}, \tag{6}$$

where $P_{i,j,t}$, $H_{i,j,t}$, and $LP_{i,j,t}$ are the price level, number of hours worked, and labour productivity in industry i in region j at time t. Substituting this expression for aggregate nominal value added into equation (4) gives

$$LP_t = \frac{\sum_J \sum_I P_{i,j,t} H_{i,j,t} LP_{i,j,t}}{P_t H_t}. \tag{7}$$

Let $s_{ijt} = \frac{P_{ijt}}{P_t} \frac{H_{ijt}}{H_t}$ again be the labour input share adjusted for relative output prices in industry i in region j at time t. The growth rate of aggregate labour productivity can then be expressed as

$$\Delta LP_t = \sum_J \sum_I \frac{LP_{i,j,t-1}}{LP_{t-1}} \left(s_{i,j,t} \Delta LP_{i,j,t} + \Delta s_{i,j,t} \right), \tag{8}$$

where ΔLP_t is the growth rate of aggregate labour productivity, $\Delta LP_{i,j,t}$ is the growth rate of labour productivity in industry i in region j, $\frac{LP_{i,j,t-1}}{LP_{t-1}}$ is the relative level of labour productivity, and $\Delta s_{i,j,t}$ is the absolute change in the labour input share adjusted for relative output prices.

Equation (8) has an identical interpretation to the decomposition for wages. There are two effects, a pure growth effect and a reallocation effect. Labour productivity growth at the industry-level influences aggregate labour productivity growth with weights given by the relative level of labour productivity and the labour input share adjusted for relative output prices. Changes in the labour input share adjusted for relative output prices lead to reallocation effects. If the reallocation is towards industries in regions with high relative levels of labour productivity, then the aggregate will increase even in the absence of labour productivity growth at the industry-level.

2.3 Decomposing unit labour cost

Unit labour cost, which represents the labour cost per unit of real output, is most commonly expressed as the ratio of total labour income and real value added. But this is equivalent to the ratio of the wage rate and labour productivity. That is

$$ULC_t = \frac{W_t H_t}{Y_t} \equiv \frac{W_t}{LP_t}, \tag{9}$$

where ULC is aggregate nominal unit labour costs, W is the nominal wage rate, H is hours worked, Y is real value added, and LP is labour productivity. Unit labour cost can be ex-

pressed in real units by using a price deflator to convert the nominal wage rate to a real wage rate. This gives

$$ulc_t = \frac{w_t}{LP_t}, \tag{10}$$

where ulc is real unit labour cost and w is the real wage rate. This relationship can be expressed approximately in growth rates by

$$\Delta ulc_t \approx \Delta w_t - \Delta LP_t, \tag{11}$$

which states that at the aggregate level the growth rate in real unit labour costs is equal to the growth rate in aggregate real wages minus the growth rate in aggregate labour productivity. Using equations (3) and (8), we can express aggregate real unit labour cost growth as contributions coming from each industry in each region. This yields

$$\Delta ulc_t \approx \sum_I \sum_J \frac{w_{i,j,t-1}}{w_{t-1}} \left(s_{i,j,t} \Delta w_{i,j,t} + \Delta s_{i,j,t}\right) - \frac{LP_{i,j,t-1}}{LP_{t-1}} \left(s_{i,j,t} \Delta LP_{i,j,t} + \Delta s_{i,j,t}\right). \tag{12}$$

Equations (3), (8), and (12) are used for the analysis in the rest of the paper.

3 Decomposing ULC, Wages, and Labour Productivity

3.1 Data

All of the data used in the following section (unless otherwise stated) was obtained from Statistics Canada Table 36-10-0480-01.[5] The table provides industry level information at a annual frequency for nominal and real value added, total hours worked, and total compensation across provinces and territories. We use a compensation-based measure of wages, defined as total compensation divided by total hours worked. Our sample spans the years 1997 to 2019 and our industry analysis is conducted for 19 industries, corresponding to 2-digit NAICS levels. Our price deflator is an implicit price index, computed as the ratio of

[5] See https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=3610048001.

nominal and real value added. Finally, while the previous section showed that our framework can decompose aggregates across industries and regions, here we focus only on industry disaggregation for brevity.

3.2 Results

Our growth accounting framework from the previous section showed that the contribution of a particular industry to Canada's aggregate real unit labour cost, real wages, and labour productivity depends on two different effects, which we refer to as *pure growth effects* and *reallocation effects*. For each industry the quantitative magnitude of each effect depends on relative levels of wages, labour productivity, and the labour input share adjusted for relative output prices at each time period.

To provide a sense of which industries are quantitatively most important for aggregates, and likely to operate through which effect, Table 1 reports averages for relative wages, labour productivity, and labour input shares adjusted for relative output prices over our sample period. Columns 4 through 6 in the table report within industry averages of real wage growth, labour productivity growth, and real unit labour cost growth.

The first two columns of Table 1 show that across Canadian industries there is a wide range of relative wages and labour productivity. Average relative real wages range from 0.52 (agriculture and accommodation) to 2.24 (mining, oil, and gas). Average relative levels of labour productivity range from 0.41 (education services) to 5.44 (mining, oil, and gas). Industries with higher relative wages also tend to have higher relative levels of labour productivity (correlation close to 0.9). All else equal, industries which have higher relative levels of wages and labour productivity will have larger contributions to aggregate wages, labour productivity, and ULC.

The third column reports the average labour input share adjusted for relative output prices. The distribution of shares is quite skewed, with nearly 50% of the total input share accounted for by the non-business sector, construction, manufacturing, and retail trade. Consequently, within industry growth in real wages and labour productivity are likely to be most apparent in macroeconomic aggregates for these industries.

While Table 1 emphasizes averages over the sample period 1997 to 2019, it is worth mentioning that some industries have exhibited quite significant shifts over this period, which may be obscured by averages. Most notable is manufacturing, which had a labour input share adjusted for relative output prices of nearly 0.18 in 1997, and declined to 0.09 by 2019. The decline in the input share adjusted for output prices reflects both a decline in relative

Table 1: Average relative wages, labour productivity, input shares adjusted for relative output prices, and within industry growth rates

	Weights			Within Industry		
	$\overline{\frac{w_i}{w}}$	$\overline{\frac{LP_i}{LP}}$	$\overline{s_i}$	$\overline{\Delta w_i}$	$\overline{\Delta LP_i}$	$\overline{\Delta ulc_i}$
Non-business sector	1.19	1.21	0.210	0.8	0.89	-0.08
Agriculture [BS11]	0.52	0.7	0.028	2.7	3.99	-0.94
Mining and oil [BS21]	2.24	5.44	0.013	2.74	-0.17	2.49
Utilities [BS22]	1.79	3.33	0.007	1.66	0.79	0.97
Construction [BS23]	1.19	0.92	0.073	-0.15	0.33	-0.47
Manufacturing [BS3A]	1.09	1.05	0.127	1.8	1.64	0.19
Wholesale trade [BS41]	1.03	0.94	0.056	2.39	2.98	-0.55
Retail trade [BS4A]	0.63	0.49	0.103	1.84	2.33	-0.46
Transportation [BS4B]	0.89	0.81	0.053	0.74	0.96	-0.18
Information [BS51]	1.25	1.6	0.019	2.46	2.1	0.38
Finance [BS5B]	1.2	1.13	0.061	2.05	2.3	-0.23
Real estate [BS53]	0.87	2.39	0.019	1.34	1.05	0.35
Professional services [BS54]	1.23	0.92	0.058	0.56	0.94	-0.36
Administrative [BS56]	0.75	0.6	0.044	0.13	0.32	-0.14
Education [BS61]	0.64	0.41	0.004	-0.33	0.67	-0.97
Health care [BS62]	0.96	0.86	0.031	-0.38	-0.29	-0.05
Arts [BS71]	0.68	0.56	0.013	0.34	-0.67	1.09
Accommodation [BS72]	0.52	0.38	0.056	0.68	0.79	-0.1
Other services [BS81]	0.57	0.42	0.036	1.1	1.43	-0.32
All industries	1	1	1	1.09	1.21	-0.11

Notes: Bars indicate sample averages over the period 1997 to 2019. It is not a requirement that the labour input share adjusted for relative output prices sum to one. Unit labour cost averages may differ slightly from average real wage growth minus average labour productivity growth due to rounding.

prices and hours worked shares. Additionally, almost all of this decline occurred from 2000 to 2010, and shares have remained relative constant since.

Columns 4 through 6 in Table 1 report within industry average growth rates of real wages, labour productivity, and unit labour cost. Once again there is very disparate trends in growth across industries. For most industries labour productivity has increased over time, with agriculture exhibiting the largest productivity gains, averaging nearly 4% annually. However, there remain a few industries (mining, oil, & gas, construction, health care services, and arts) with very low or even negative labour productivity growth over this period. There is again a strong correlation (0.7) between average labour productivity growth and real wage growth over this period. As a result, most industries do not exhibit a large change in real unit labour cost from 1997 to 2019. A notable exception is mining, oil, & gas, where real wages averaged nearly 3% growth annually, while labour productivity growth has been negative. Consequently there has been a significant rise in real unit labour cost in the industry.

Table 2: Contributions to aggregate wages, labour productivity and unit labour cost growth by industry

	Real Wages			Labour Productivity			Real Unit Labour Cost		
	Pure	Realloc.	Total	Pure	Realloc.	Total	Pure	Realloc.	Total
Non-business sector	4.25	2.88	7.13	4.8	2.9	7.7	-0.55	-0.02	-0.56
Agriculture [BS11]	0.51	-1.09	-0.58	1.56	-1.66	-0.09	-1.05	0.57	-0.48
Mining and oil [BS21]	-1.18	2.61	1.43	-3.85	7.23	3.38	2.67	-4.62	-1.95
Utilities [BS22]	0.29	-0.08	0.21	0.14	-0.26	-0.12	0.16	0.18	0.34
Construction [BS23]	-0.49	4.46	3.96	0.2	3.48	3.68	-0.69	0.98	0.28
Manufacturing [BS3A]	5.73	-9.19	-3.46	5.3	-8.92	-3.62	0.43	-0.27	0.16
Wholesale trade [BS41]	2.9	-2.21	0.68	3.25	-1.98	1.27	-0.36	-0.24	-0.59
Retail trade [BS4A]	2.54	-1.09	1.45	2.44	-0.85	1.59	0.1	-0.24	-0.14
Transportation [BS4B]	0.67	0.58	1.24	0.74	0.6	1.34	-0.07	-0.02	-0.09
Information [BS51]	1.22	-0.31	0.91	1.4	-0.46	0.94	-0.18	0.15	-0.03
Finance [BS5B]	3.12	-1.36	1.77	3.26	-1.25	2.01	-0.14	-0.11	-0.24
Real estate [BS53]	0.41	0.16	0.57	0.96	0.3	1.26	-0.55	-0.14	-0.69
Professional services [BS54]	0.82	3.17	3.98	1.05	2.36	3.41	-0.23	0.8	0.57
Administrative [BS56]	0.04	1.61	1.65	0.16	1.27	1.43	-0.11	0.34	0.22
Education [BS61]	-0.03	0.19	0.15	0.02	0.12	0.14	-0.05	0.07	0.01
Health care [BS62]	-0.25	1.41	1.16	-0.15	1.24	1.09	-0.1	0.17	0.07
Arts [BS71]	0.06	0.24	0.3	-0.13	0.22	0.09	0.2	0.02	0.21
Accommodation [BS72]	0.41	0.52	0.93	0.34	0.38	0.71	0.07	0.14	0.21
Other services [BS81]	0.44	0.07	0.51	0.43	0.05	0.48	0.01	0.02	0.03
All industries	21.47	2.55	24.02	21.92	4.77	26.69	-0.45	-2.22	-2.67

Notes: Contributions for each industry are computed as the sum of contributions from 1998 to 2019. Columns labelled pure refer to pure growth effects and columns labelled realloc. refer to reallocation effects. The sum of pure effects and reallocation effects equals total effects. Any minor discrepancies are due to rounding.

Based on our growth accounting framework, Table 2 reports the long-run contributions of each industry to aggregate wages, labour productivity, and unit labour cost from 1998 to 2019. The values in the table are computed by summing contributions to aggregates across the sample period. Additionally, the table distinguishes between contributions resulting from within industry growth and contributions from changes in the labour input share adjusted for relative output prices (i.e., reallocation effects).

Given the large fraction of input shares adjusted for relative output prices accounted for by the non-business sector, construction, and manufacturing, it is perhaps unsurprising to see that these industries are quantitatively important for understanding aggregate growth over this period. Through both pure growth effects and reallocation effects, the non-business sector contributed to around 7% of aggregate growth in real wages and labour productivity, while construction contributed to around 4%. However, the reasons for large positive contributions to the aggregate are quite different. The non-business sector contributions result largely from within industry increases in wages and productivity, while construction

contributions are almost entirely from reallocation effects.

In contrast to the non-business sector and construction, manufacturing contributed negatively to both aggregate real wages and labour productivity. This negative contribution to the aggregate occurred in spite of within industry growth in real wages and labour productivity, as reallocation effects dominated pure growth effects.

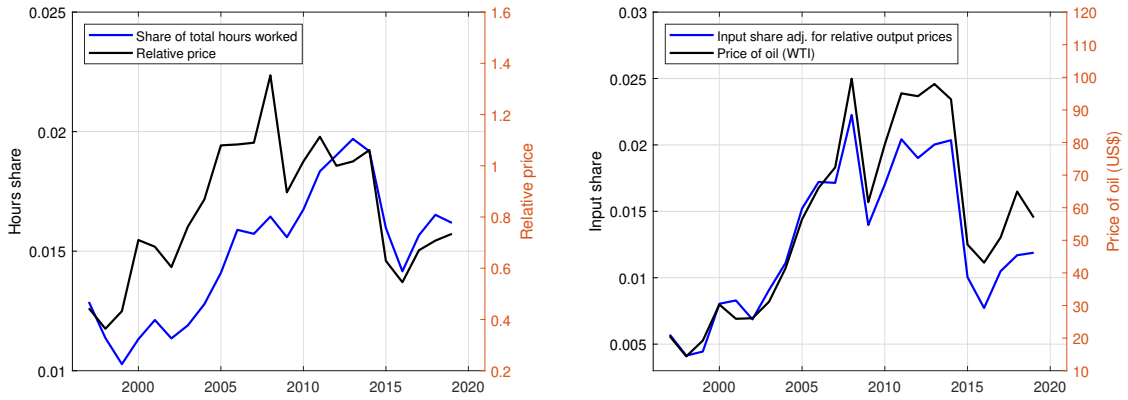
A more surprising contribution (based on input shares adjusted for output prices) to the aggregate comes from mining, oil, & gas. This industry contributed over 3% to aggregate labour productivity and roughly 1.5% to aggregate wages, even though within industry labour productivity growth was on average negative over this period. The explanation for this result resides in the fact that the mining, oil, & gas industry has high relative real wages and levels of labour productivity. As a result, reallocation effects from this industry can be particularly strong. Further, our framework suggests that these reallocation effects reflect movements in both relative prices and shares of hours worked, which coincide with booms in the price of oil.

To illustrate this phenomena, Figure 1 plots the share of total hours worked and relative price of the mining, oil, and gas industry in the left panel, and the labour input share adjusted for relative output prices with the West Texas Intermediate price of oil in the right panel. With rising oil prices beginning in the early 2000s, both the share of hours worked and relative prices begin to rise, with peaks around 2008 and 2015. Together these yield an input share adjusted for relative output prices which is also rising throughout this period. This rise, coupled with the high relative levels of wages and labour productivity, produces a strong reallocation effect, outweighing the negative within industry labour productivity growth in terms of contributions to aggregate labour productivity (see also Sharpe and Bradley (2009)).

For real unit labour cost, industry contributions from pure growth effects and reallocation effects are mostly small in magnitude. This is consistent with the previous facts which documented that industries exhibited strong correlations in both relative levels of real wages and labour productivity, and within industry average wage growth and labour productivity growth.

One exception is the mining, oil, and gas industry, which contributed roughly -2% to aggregate real unit labour cost over this period. Even though real unit labour cost in the mining, oil, and gas industry grew on average by 2.5% per year, illustrated by the pure growth effect contributing 2.67% to aggregate ULC, in total the industry contributed to lower aggregate real unit labour cost due to strong reallocation effects. In part because of the

Figure 1: Mining, oil, and gas: Share of hours worked, relative prices, input shares, and the price of oil



Notes: The share of hours worked corresponds to $\frac{H_{i,t}}{H_t}$, the relative price corresponds to $\frac{P_{i,t}}{P_t}$, and the input share adjusted for relative output prices corresponds to $\frac{H_{i,t}}{H_t}\frac{P_{i,t}}{P_t}$, where i is the mining, oil, and gas industry. The West Texas Intermediate price of oil is the monthly spot price converted to annual by averaging. The data was obtained from the Federal Reserve Bank of St. Louis database, and the series code is WTISPLC.

rise in the input share adjusted for output prices documented above, but also because the level of real unit labour cost in the industry is low. This is easiest to see by comparing the average levels of relative real wages and labour productivity reported in Table 1. Average relative real wages in the industry are high (2.24), however the average relative level of labour productivity is significantly higher (5.44), implying that the level of real unit labour cost in the industry are quite low. Together these produce a strong negative reallocation effect on aggregate real unit labour cost.

Finally, while our previous discussion has centered on long-run industry contributions over the period 1997 to 2019, our framework can also be used to understand short-run changes in aggregate wage, labour productivity, and unit labour cost growth. To facilitate this part of our analysis, we collapse our industry-level data into more coarse definitions, corresponding to goods producing sectors, service producing sectors, and the non-business sector. Industries included in goods production are: (1) Agriculture; (2) Mining, Oil, and Gas; (3) Utilities; (4) Construction; and (5) Manufacturing. Industries in service production are the remaining industries excluding the non-business sector.[6]

Figure 2 depicts the contribution of goods producing industries, service producing industries, and the non-business sector to aggregate real unit labour cost growth, real wage growth, and labour productivity growth from 1998 to 2019. The contribution for each sec-

[6]These definitions follow those used by Statistics Canada in Table 36-10-0480-01.

tor is the total contribution, that is, they combine both pure growth effects and reallocation effects. The length of the bar pertaining to a colour indicates that sectors magnitude of contribution (e.g., a bar mostly in blue indicates that goods producing sectors contributed to the majority of change in that period). Bars extending below 0 on the y-axis indicate a negative contribution. The sum of the bar equals the aggregate variable growth, which is indicated by the solid black line in the figures.

The top panel in Figure 2 shows that the large majority of year-over-year changes in aggregate real unit labour cost growth comes from goods producing industries. Notably in 2009 and 2015 there is large upward contributions to aggregate ULC. An inspection of contributions by goods producing sectors shows that almost all of this is mining, oil, and gas, and 2009 and 2015 are years where oil prices fell dramatically.

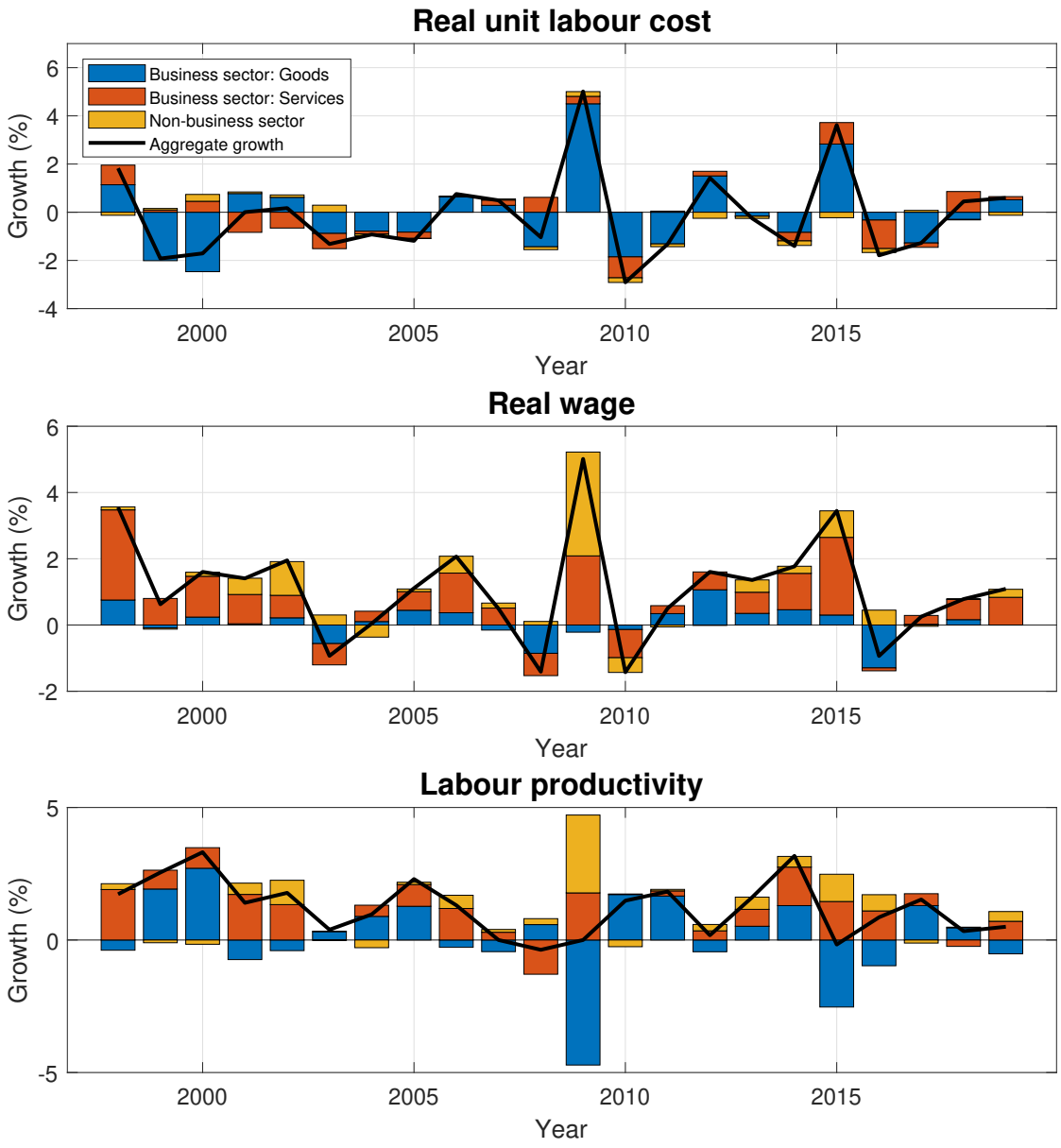
The middle panel in Figure 2 shows that, in contrast to ULC, much of aggregate real wage growth changes comes from the service producing sector and the non-business sector. There is a particularly large contribution from services and the non-business sector in 2009, where the aggregate real wage grew at roughly 5%. Part of this growth can be explained by a fall in the aggregate price level, which declined by 2.35%, and raised real wages. However, aggregate nominal compensation per hour also grew by about 2.5%, increasing from 28.86 per hour in 2008 to 29.59 in 2009.

Finally, turning to contributions to aggregate labour productivity we find that goods producing sectors, service producing sectors, and the non-business sector all contribute to changes in aggregate growth at points throughout the sample period. Goods producing sectors pushed up aggregate labour productivity growth in 1999 and 2000, and this is mostly driven by gains in manufacturing.[7] Notably, in 2009 and 2015 we again see the role played by oil prices as large negative contributions appear for goods producing sectors. However this negative contribution is offset by positive contributions from services and the non-business sector, netting out to yield roughly zero aggregate labour productivity growth.

The plots in Figure 2 can be informative about underlying trends and the future behaviour of macroeconomic aggregates. Using our decomposition it is possible to further examine short-run contributions emanating from pure growth effects and reallocation effects (not shown here). For example, the large increase in real unit labour cost in 2009 and 2015 reflects primarily reallocation from changes in the price of oil. From a policymakers perspective, such an observed change in real unit labour cost from reallocation may call for

[7] Baldwin and Willox (2016) find evidence consistent with this, noting that manufacturing, along with finance, insurance, & real estate and mining, oil, & gas can account for much of the labour productivity growth slowdown in Canada in the 2000s.

Figure 2: Contributions to aggregate unit labour cost, real wages, and labour productivity over time



Notes: Contributions begin in 1998 because our framework uses growth rates and one observation is lost at the beginning of the sample.

different policy prescriptions than if the observed change in real unit labour cost resulted from primarily within industry changes. Our framework offers the possibility to consider such scenarios.

4 Conclusion

In this paper we have decomposed Canadian aggregate real unit labour cost and its two components, real wages and labour productivity, into contributions from 19 industries over the period 1997 to 2019. Importantly, our method disentangles contributions to the aggregate arising from within industry growth and reallocation. We find that goods producing industries play an important role in real unit labour cost short- and long-run growth.

Our paper provides an example of utilizing granular data to understand the behaviour of macroeconomic aggregates. This approach can help policymakers to pinpoint the sources of changes in aggregates of unit labour cost, wages, and labour productivity, while simultaneously observing underlying trends at a disaggregated level.

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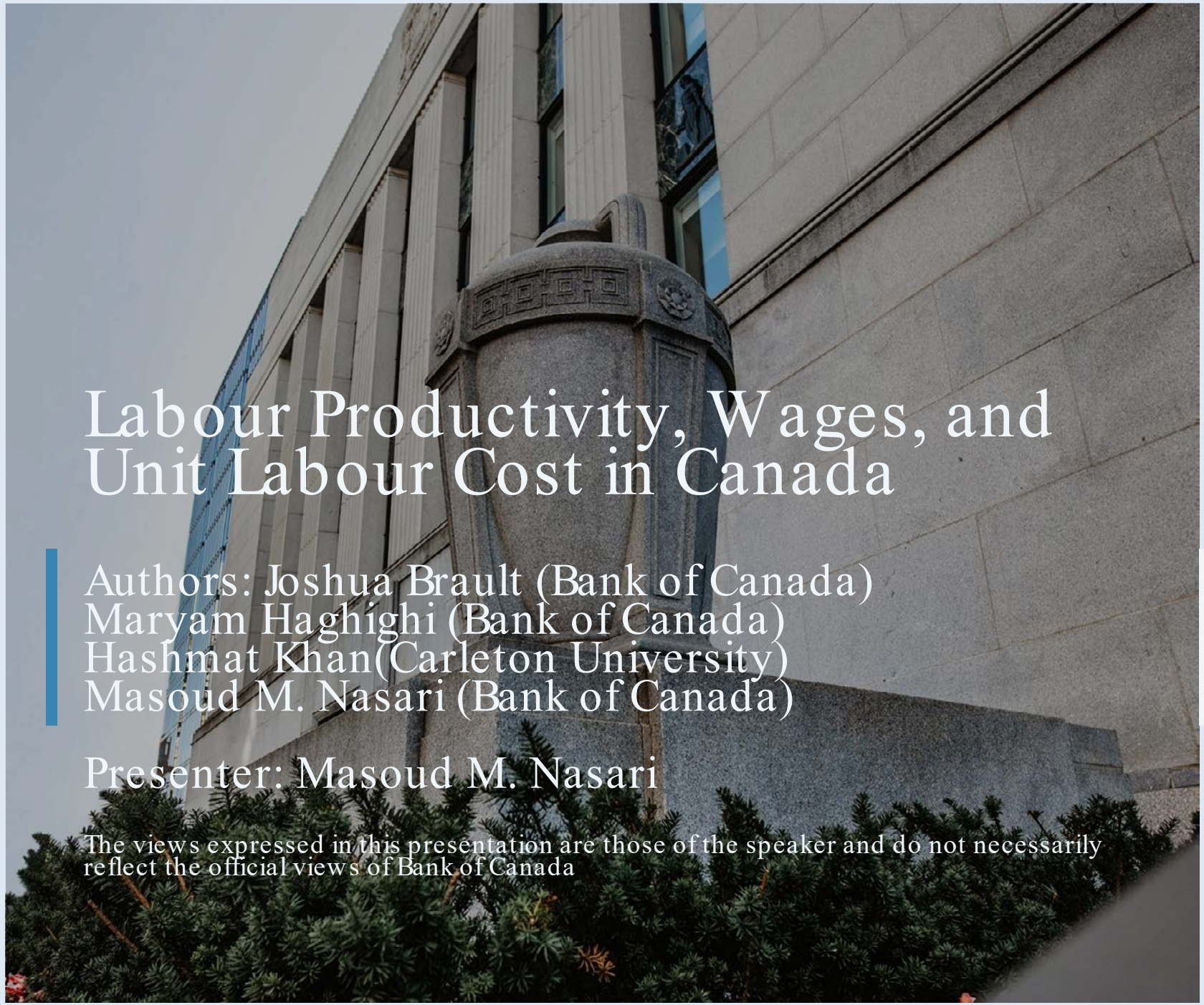

Labour Productivity, Wages, and Unit Labour Cost in Canada

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Maryam Haghighi (Bank of Canada)
Hashmat Khan(Carleton University)
Masoud M. Nasari (Bank of Canada)

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The views expressed in this presentation are those of the speaker and do not necessarily reflect the official views of Bank of Canada

BANK OF CANADA
BANQUE DU CANADA

July 15, 2023

Background

- Aggregate labour productivity developments are an important consideration for central banks and policy makers
- In relation to wage developments, they can provide useful information on the inflation outlook
- For example, in April 2023, the Governor of Bank of Canada Tiff Macklem said ,“Wage growth has been running at four to five per cent and unless there’s a surprising acceleration in productivity, that’s not consistent with two per cent inflation.”

Motivations for creating a platform for labour productivity data

- Motivated by the importance of timely and dynamic labour productivity data for researchers, academics, executives and curious minds to conduct analysis and draw educated conclusions, we created the Canadian Labour Productivity Platform (CLaPP)
- CLaPP is a publicly available platform that hosts and visualizes aggregate and disaggregate labour productivity data
- Aggregate data are also available from Canadian Statistical Agencies and some international institutions such as OECD
- What distinguishes CLaPP is that it provides aggregate and disaggregate data alongside with interactive visualizations at sectoral and regional levels on the same platform

CLaPP

Canadian Labour Productivity Platform

CLaPP

- is a joint project with Carleton University
- has its dedicated domain, server and website hosted by Carleton University
  - www.carleton.ca/clapp
- uses the latest publicly available data from Statistics Canada
- provides easy to understand and interactive story telling visualizations along sectoral and regional dimensions
- has the flexibility and capacity of expanding to include more economic measures and to host deep diving results, insights, research and analysis

carleton.ca/clapp/

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Canadian Labour Productivity Platform

Canadian Labour Productivity Platform (CLaPP)

LABOUR PRODUCTIVITY TRENDS

CURRENT SNAPSHOT

RESEARCH AND ANALYSIS

HOW TO CITE CLAPP DATA

CONTACT US

DEPARTMENT OF ECONOMICS

Labour productivity measures the efficiency of workers in producing goods and services. It is an important indicator of economic performance for a variety of reasons. Labour productivity is closely linked to businesses' costs of production (unit labour cost), international competitiveness, the output gap, and inflationary pressures in the economy. Over longer time horizons labour productivity is also tied to wages and the average standard of living.

About the Project

CLaPP is a Carleton University project led by the Department of Economics with collaborative support from the Bank of Canada. The platform provides data on Canadian labour productivity which is updated monthly. A distinguishing feature of CLaPP is that it provides both aggregate and disaggregated (sectoral/regional) labour productivity data alongside with rich visualizations.

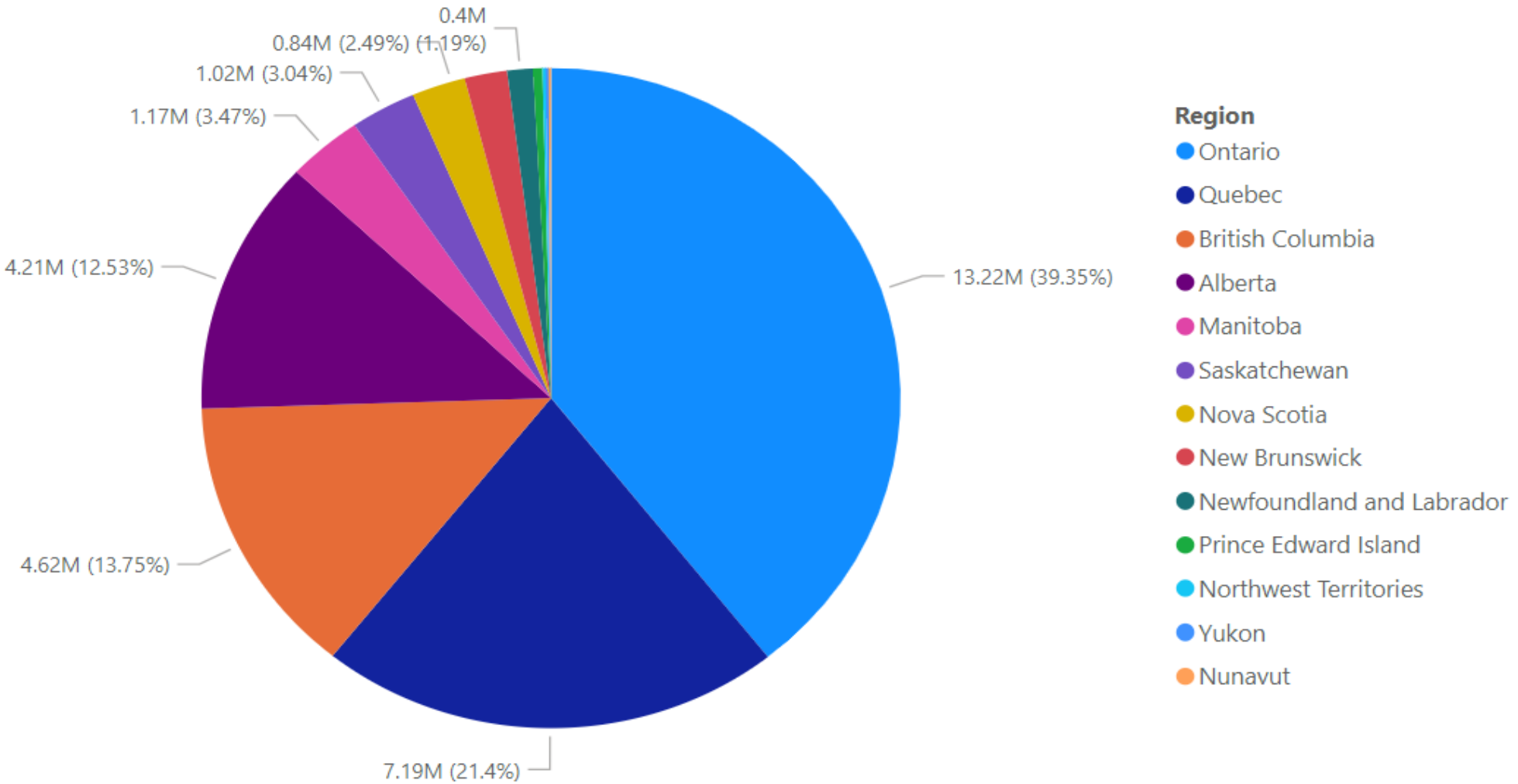
IDAS INFORMATION, DATA AND ANALYTICS SERVICES | LA SECTION DES DONNÉES, DE L'INFORMATION ET DE L'ANALYTIQUE

Current Snapshot - Canadian La

Microsoft Power BI

app.powerbi.com/view?r=eyJrIjoiYTU2ZTBkZjgtZDZmZS00YjliLWIwMzktN2RjMTY3YjEzM2FkIiwidCI6IjZhZDkxODk1LWRlMDYtNDg1ZS1iYzUxLWZjZTEyNmNjODUzMCIsImMiOjN9&pageNa

Hours by Region



TRENDS
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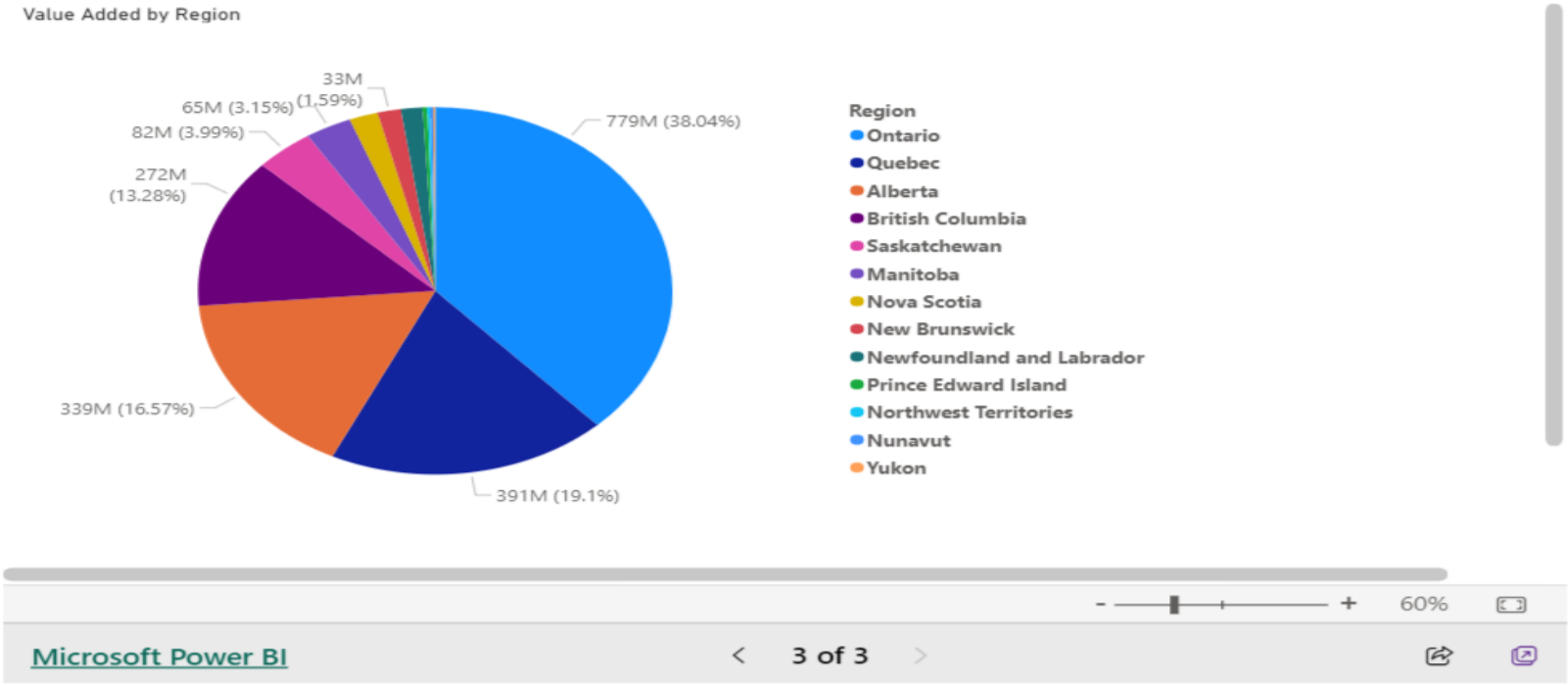
The four most populated provinces, Alberta, British Columbia, Ontario, and Quebec, represent a substantial share of Canada's hours worked, roughly equal to 86%. The data is obtained from Statistics Canada Table 36-10-0480-01 (https://doi.org/10.25318/3610048001-eng) and the industry disaggregation is at level 5.

Value Added by Region



The above figure reports nominal value added across provinces and territories for 2022 in a pie chart.

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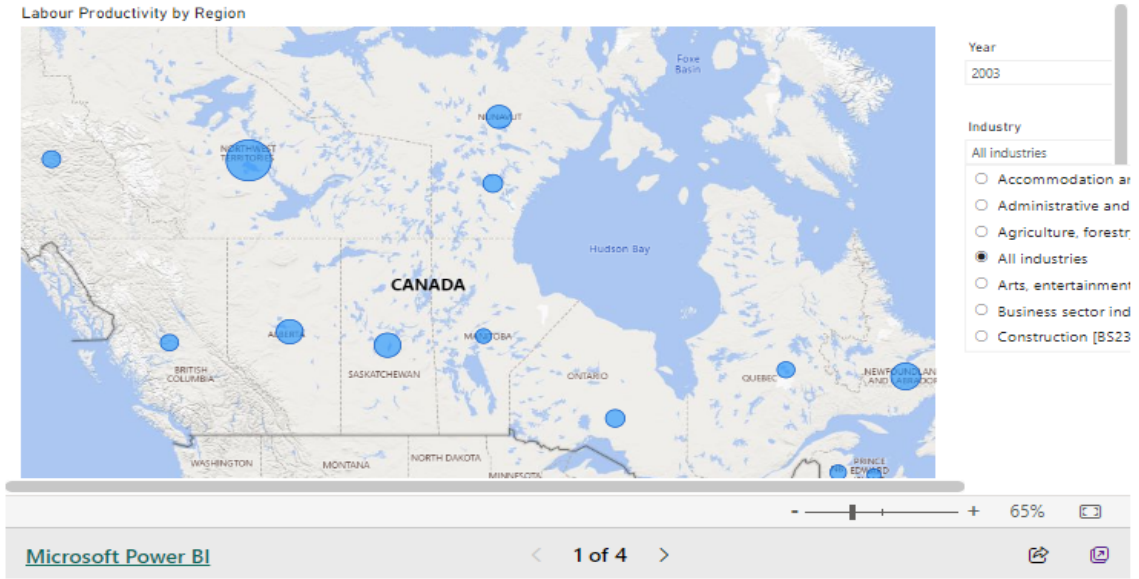
and the average standard of living.

For most industries and the aggregate, the level of labour productivity tends to grow positively over time. However, it can also fluctuate over shorter horizons for a variety of reasons. These reasons include changes in total/multi- factor productivity, capital utilization rates, and the capital-labour ratio. Canada's aggregate measure of labour productivity is also influenced by the allocation of economic activity across regions and industries.

Bubble Map



Labour productivity is defined as real output per hour worked. Real output is a value added measure and at the disaggregated level is constructed from a Fisher chain index evaluated in 2012 chained dollars. Hours worked is the total number of hours worked in all jobs, including overtime. The data is obtained from Statistics Canada Table 36-10-0480-01 (https://doi.org/10.25318/3610048001-eng) and the industry disaggregation is at level 5.

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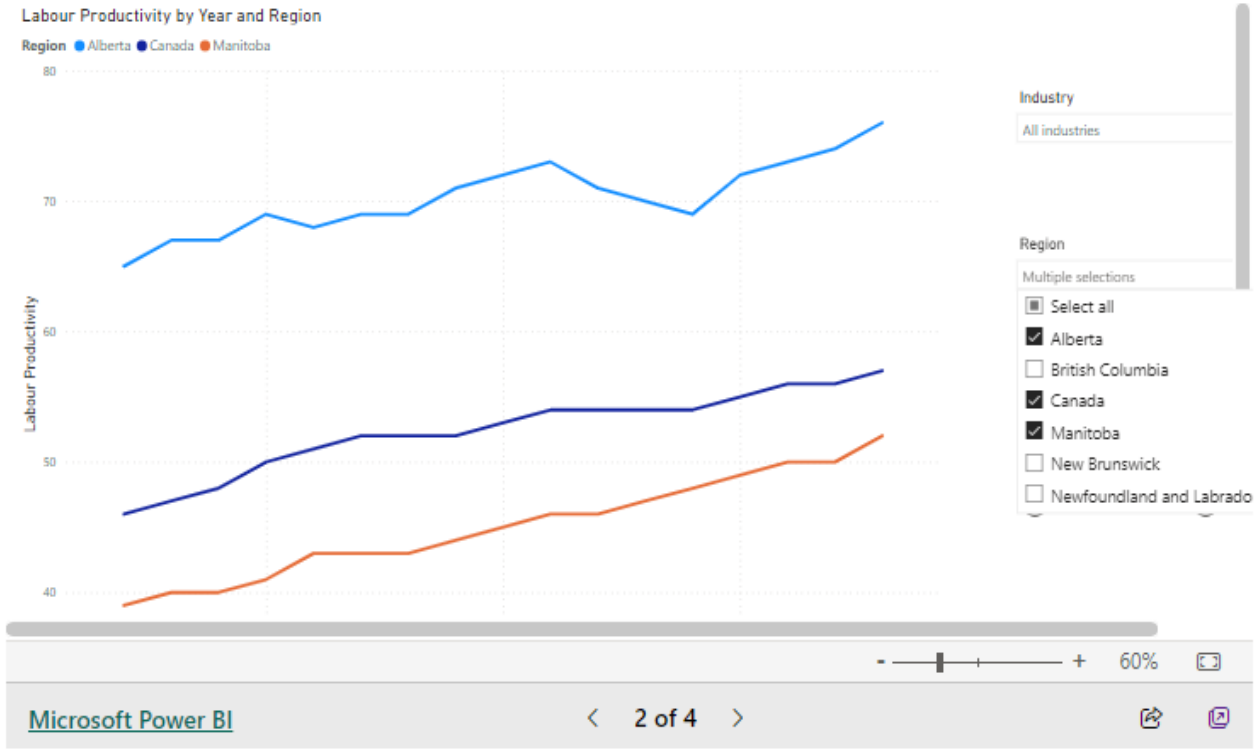
Productivity Over Time

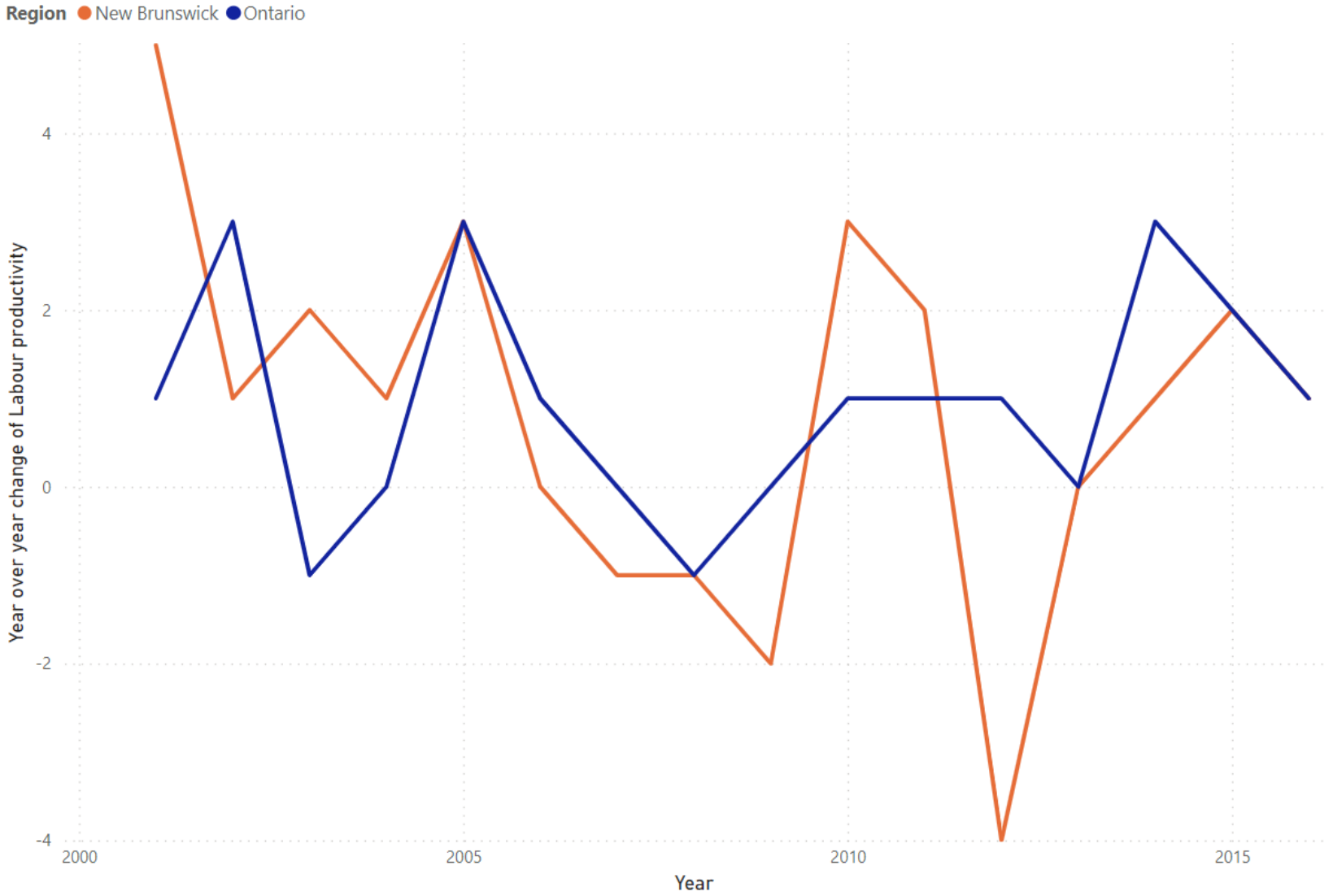


Since measures of real value added are constructed from Fisher chain indexes they are not additive, implying that summing real value added across industries does not yield Canada's real value added. Subsequently, it is often more informative to compare the growth rate of labour productivity across industries over time. The growth rate is computed as the log difference of the level of labour productivity multiplied by 100.

Labour Productivity Trends - Ca | Microsoft Power BI

app.powerbi.com/view?r=eyJrIjoiNmE1MjBiZmEtMDZlOC00MDBiLWIxMzAtZWFmZmExZjkxMGVjIiwidCI6IjZhZDkxODk1LWRlMDYtNDg1ZS1iYzUxLWZjZTEyNmNjODUzMCIsImMiOjN9&pageName=ReportSection7d72b1db6194f5474483

Year over year change of Labour productivity by Year and Region



Industry

Business sector industries

Region

Multiple selections

- [ ] Newfoundland and Labrador
- [ ] Northwest Territories
- [ ] Northwest Territories including ...
- [ ] Nova Scotia
- [ ] Nunavut
- [x] Ontario
- [ ] Prince Edward Island

A growth accounting analysis of unit labour cost in Canada

- Unit labour cost (ULC) is a common metric central banks use to gauge inflationary pressures in the economy and directly related to data in CLaPP
- ULC also features prominently in determining inflation dynamics of modern structural macroeconomic models used at central banks for policy analysis and forecasts

Definition of ULC

$$ULC_t = \frac{w_t}{lp_t} = \frac{Real\ wage}{labour\ productivity}$$

$w_t = \frac{W_t}{P_t}$: Real wage at time t

$lp_t = \frac{y_t}{H_t}$: Labour productivity at time t

P_t: Price level at time t

W_t: Nominal wage at time t

H_t: Number of hours worked at time t

y_t: Output at time t

A Growth accounting analysis of unit labour cost in Canada--Continued

- Aggregate values of ULC at the National level conceal
  - (i) the contributions of the sub-National components
  - (ii) the allocation of economic activities
- We present a decomposition of the growth rate of ULC by decomposing its two components, i.e., wages and labour productivity, across geographical regions and industry sectors
- The decomposition assesses the contributions of
  - (i) the pure growth
  - (ii) the reallocations

Decomposition of ULC's growth

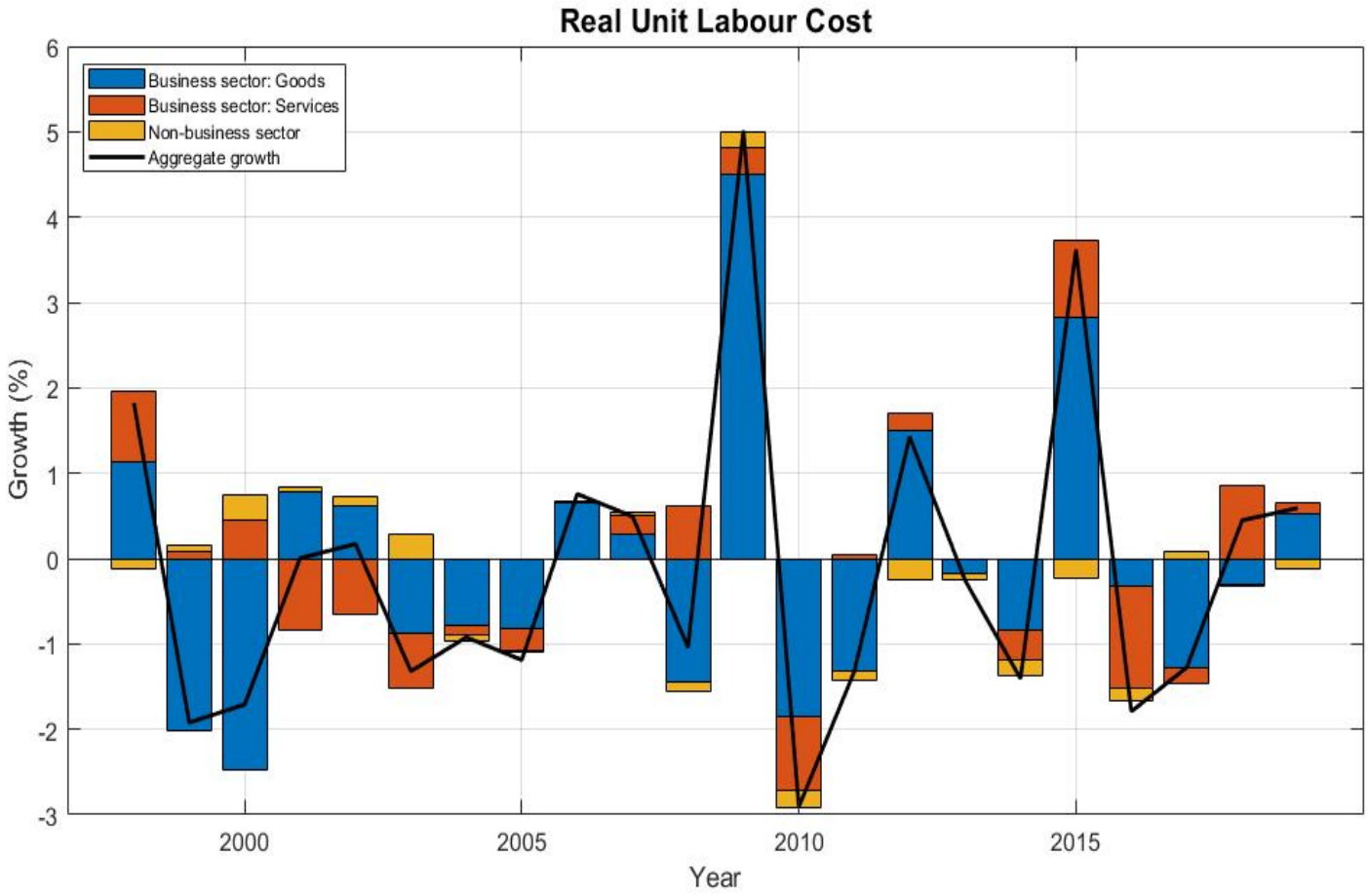
$$\frac{\Delta w_t}{w_{t-1}} = \sum_{j \in J} \sum_{i \in I} \left(\overbrace{\frac{w_{i,j,t-1}}{w_{t-1}} s_{i,j,t} \, \Delta w_{i,j,t}}^{Pure\ growth} + \overbrace{\frac{w_{i,j,t-1}}{w_{t-1}} \Delta s_{i,j,t}}^{Re-allocation} \right)$$

$$\frac{\Delta lp_t}{lp_{t-1}} = \sum_{j \in J} \sum_{i \in I} \left(\underbrace{\frac{lp_{i,j,t-1}}{lp_{t-1}} s_{i,j,t} \, \Delta lp_{i,j,t}}_{Pure\ growth} + \underbrace{\frac{lp_{i,j,t-1}}{lp_{t-1}} \Delta s_{i,j,t}}_{Re-allocation} \right)$$

- $s_{ijt} = \frac{H_{ijt} P_{ijt}}{P_t H_t}$: Labour input share adjusted for relative output prices in region j and industry i at time t
- Even in the absence of wage/productivity growth, the aggregate can increase if labour input share adjusted for relative output prices increases in areas/industries with higher relative wages/productivity

Some findings and results

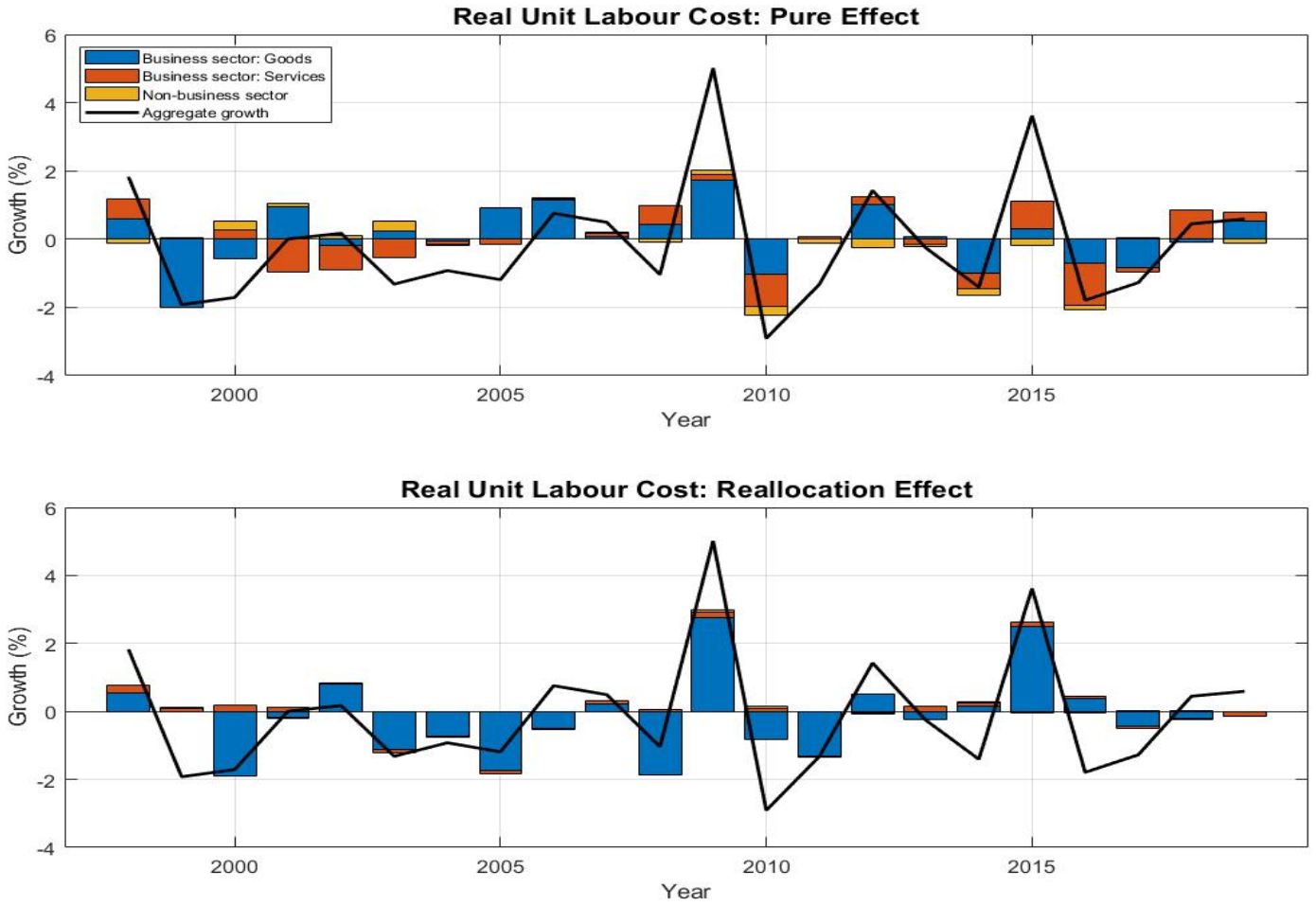
Data: Annual values from 1997 to 2019



The goods sectors account for a large proportion of ULC variation, even though it only accounts for roughly one quarter of the labour input share adjusted for output prices

Some findings and results (continued)

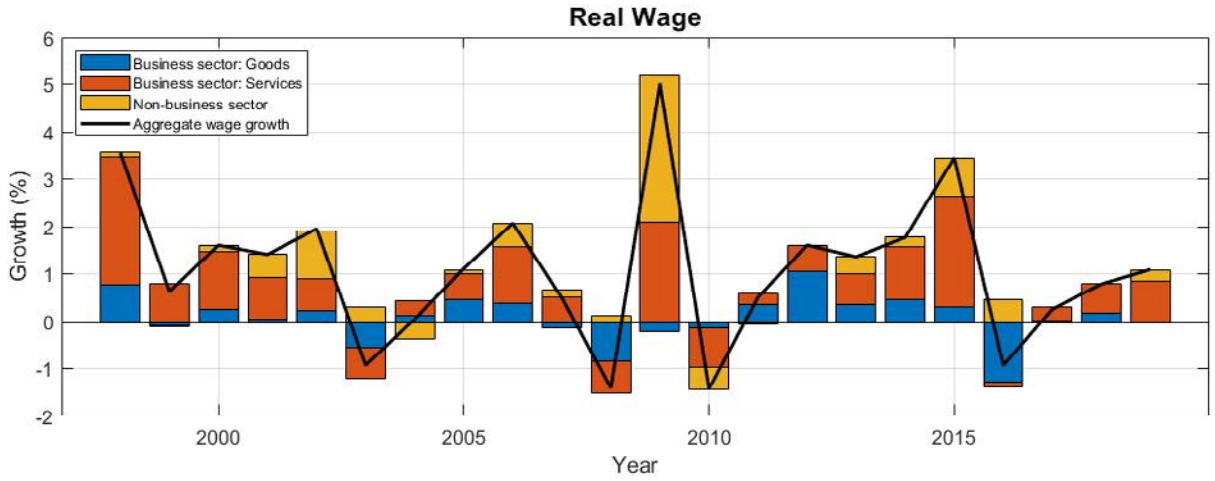
Data: Annual values from 1997 to 2019

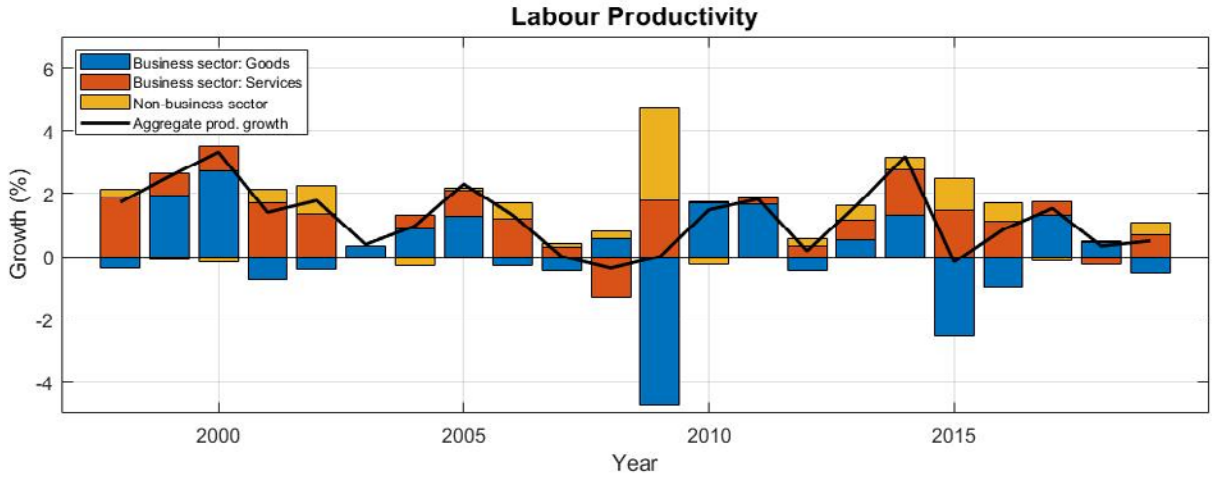


Reallocation effects are playing a large role

Decompositions of wages and labour productivity

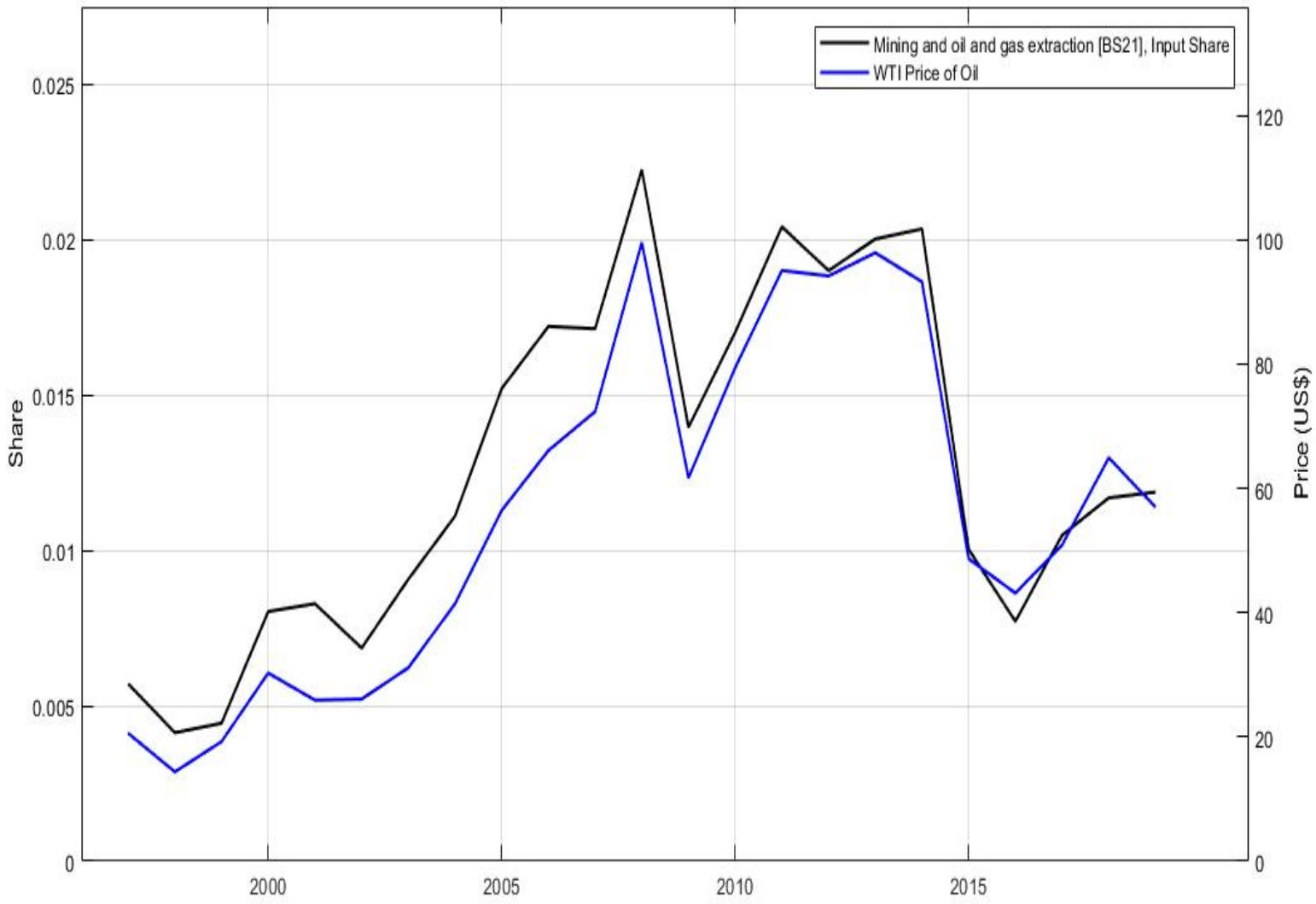
Data: Annual values from 1997 to 2019





The input share of Mining, Oil and Gas

Data: Annual values from 1997 to 2019



Future plans

- Identifying common trend(s) and cyclic co-movement of labour productivity data across geographical regions and sectors
- Determining convergence or divergence of labour productivity across regions/sectors relative to the aggregate values
- Producing decompositions of wages, labour productivity and ULC at a higher frequency than annual
- Studying the effect of AI on labour productivity, wage dispersion and, income distribution
- Improving data visualization and analysis on CLaPP