Research Paper

The Canadian Productivity Review

Canada–United States Labour Productivity Gap Across Firm Size Classes

by John R. Baldwin, Danny Leung, and Luke Rispoli
Economic Analysis Division

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..   not available for a specific reference period
...   not applicable
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0^s value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
^{p} preliminary
^{r} revised
x   suppressed to meet the confidentiality requirements of the *Statistics Act*
^{E} use with caution
F   too unreliable to be published
*   significantly different from reference category ($p < 0.05$)

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The Canadian Productivity Review

The Canadian Productivity Review is a series of applied studies that address issues involving the measurement, explanation, and improvement of productivity. Themes covered in the review include, but are not limited to, economic performance, capital formation, labour, prices, environment, trade, and efficiency at both national and provincial levels. The Canadian Productivity Review publishes empirical research, at different levels of aggregation, based on growth accounting, econometrics, index numbers, and mathematical programming. The empirical research illustrates the application of theory and techniques to relevant public policy issues.

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Abstract

This paper examines and compares labour productivity in Canada and the United States for small and large firms over the period from 2002 to 2008. It quantifies the relative importance of small and large firms in Canada and the United States and measures the relative productivity levels of small versus large firms.

Small firms are relatively more important in the Canadian economy. Small firms are less productive than large firms in both countries. But the productivity disadvantage of small relative to large firms was higher in Canada.

The paper provides an estimate of the impact that these differences have on the gap in productivity levels between Canada and the United States. It first estimates the changes that would occur in Canadian aggregate labour productivity if the share of hours worked of large firms in Canada was increased to the U.S. level. It then quantifies the impact of increasing the relative productivity of small to large firms in Canada up to the relative productivity ratio of small firms to large firms that existed in the United States.

Together, decreasing the relative importance of small firms in the economy and increasing their relative productivity compared to large firms accounts for most of the gap in productivity levels between Canada and the United States in 2002. However, changes in the economy that occurred between 2002 and 2008 reduced the contribution of the small-firm sector to the gap in productivity levels.

Executive summary

This paper examines and compares labour productivity in Canada and the United States for small and large firms over the period from 2002 to 2008. It quantifies the relative importance of small and large firms in Canada and the United States and measures the relative productivity levels of small versus large firms.

Small firms are relatively more important in Canada. In 2008, they accounted for about 70% of hours worked while they only accounted for 56% in the United States. In 2008, the level of Canadian productivity, as measured by nominal gross domestic product per hour worked in small firms was only 47% of that of large firms. The level of small-firm productivity in the United States was also less than that for large firms (about 70%). The gap between the productivity of small and large firms is larger in Canada.

The paper examines the impact of changes in the size distribution on Canadian aggregate labour productivity and on the productivity gap between Canada and the United States. Shifts in the firm size distribution toward larger firms might be expected to have a favorable impact on Canadian overall productivity since larger firms are generally more productive than small firms.

An increase in the employment share of large firms in Canada to U.S. levels would increase Canadian nominal labour productivity by about 6%. The paper also quantifies the impact of bringing the relative productivity of small compared to large firms up to the level that existed in the United States. This increases aggregate Canadian labour productivity by 11% over the period.

Together, decreasing the importance of small firms and increasing the relative productivity of small compared to large firms is found to account for most of the gap in labour productivity levels between Canada and the United States in 2002. However, changes in the productivity of large firms after 2002 meant that the contribution of the small-firm sector fell until it accounted for only about 60% of the gap in 2008.

1   Introduction

Over the 2002-to-2008 period, the importance of small firms, as measured by their share of gross domestic product (GDP) and hours worked, was larger in Canada than in the United States. In this paper, small firms are those with fewer than 500 employees, and large firms are those with 500 or more employees.

In 2008, Canadian small firms generated 53.4% of business-sector GDP, and U.S. small firms produced 46.1%. In that year, small firms generated 70.8% of hours worked in Canada and 55.6% of hours worked in the United States. That Canadian small firms generated relatively more hours worked than they did GDP indicates that they were relatively less productive than their American counterparts.

It has been argued that the disproportionate number of small firms in Canada relative to the United States, may have lowered Canadian aggregate productivity levels and that this, in turn, accounts for part of the gap in productivity levels between Canada and the United States. Generally, larger firms are more productive than small firms, and shifts in the firm size distribution toward larger firms might be expected to have a favorable impact on overall Canadian productivity.

Productivity gaps between small and large firms have been attributed to a number of factors: scale economies related to plant size; shorter production runs; higher prices of capital relative to labour that give rise to differences in capital per worker; the skills possessed by workers and owners; and differences in managerial efficiency.

The factors behind, and the effect of, Canada's greater emphasis on smaller firms has been investigated by a number of researchers (Baldwin and Gorecki 1986; Inwood and Keay 2005; Leung et al. 2008).[1] The issue is usually approached indirectly by developing estimates of improvements in labour productivity that result from existing firms growing larger. These studies have attempted to estimate the impact of scale economies on aggregate productivity, and then to correct for the impact of differences in firm or plant size on estimates of the relative levels of labour productivity between Canada and the United States.

Previous studies have been constrained by a lack of comprehensive data on differences in productivity across firm size classes that allow for direct inter-country comparisons. This paper overcomes that limitation by developing estimates of GDP for Canada and the United States for both small and large firms. These are combined with estimates of employment (hours worked) in order to generate labour productivity estimates in each country for small and large firms for an extensive set of industries. The study covers the period from 2002 to 2008. GDP per hour worked is used as the measure of labour productivity.[2]

Analysis of this issue requires comprehensive and consistent data on firm-size distributions and differences in productivity levels across firm size classes. The study builds on Leung and Rispoli (2014), who estimated the contributions to GDP made by small and large firms in Canada and the United States from 2002 to 2008. A firm, or business, in this study is defined as all units controlled by a parent firm. Firms are classified by the employment of the ultimate parent: small firms are defined as those with 0 to 499 employees; and large firms, 500 or more employees.

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1. Baldwin and Gorecki (1986) and Leung et al. (2008) attributed about half of the difference in manufacturing productivity between Canada and the United States to differences in average firm size. Inwood and Keay (2005) examined a longer period and also find that size contributes about half the difference.
2. Compared with measures of output such as sales, GDP is more complete. It measures value added, the unduplicated value of goods and services generated by labour and capital. Intermediate inputs used by a firm are the key difference between a firm's sales and its GDP. For example, a firm could have high sales but low GDP because it adds little to the value of the intermediate inputs it purchases.

The present study extends the analysis using estimates of output (GDP) and labour input (hours worked) to produce estimates of nominal labour productivity by firm size in Canada and the United States. In both countries, large firms are more capital-intensive than small firms. The paper investigates how labour productivity differs across firm size classes in each country and how it changed between 2002 and 2008. This information is also used to investigate the magnitude of changes in aggregate productivity that would be expected to accompany changes if Canada had the same proportion of large firms by industry as the United States, if Canada had the same industrial structure (e.g., if the share of hours worked by industry were the same), and if the ratio of productivity in small firms relative to large firms were the same in Canada as in the United States.

2 Methodological issues

2.1 Coverage

This analysis focuses on the business sector. In Canada, the business sector is composed of all corporations and unincorporated businesses that are organized for profit and that produce goods and services for sale at a price intended to at least approximate the costs of production. Government business enterprises are included in the business sector. The business sector in Canada accounted for about 78% of total GDP in 2007. In the United States, it accounted for about 80% of total GDP.[3]

2.2 Definition of productivity

The focus of this paper is on labour productivity, an indicator of the efficiency with which the economy uses labour to produce goods and services. Increases in labour productivity closely track changes in real wages (Baldwin and Gu 2009). Labour productivity will be higher in sectors where workers have more capital per worker and where firms exploit economies of scale, employ more skilled workers, use more advanced technologies, or otherwise generate higher levels of innovation, all of which are incorporated into higher levels of multifactor productivity.[4]

Labour productivity is defined here as output per unit of labour input. Output is measured using GDP calculated at basic prices.[5] Labour input is measured using hours worked. The labour productivity of industry i is the weighted average of the labour productivity in small and large firms for industry i, where the weights are the share of hours for each business-size category in industry i.

$$LP_i = \sum_j LP_{ij} \frac{H_{ij}}{H_i}, \tag{1}$$

where LP represents labour productivity, H represents hours worked, and j indexes the business-size categories. Labour productivity for the business-sector as a whole is the

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3. Other sectors of the domestic economy, including government and the non-profit sector (including households and institutions), are part of the non-business sector. In this paper, the non-business sector comprises government administration (federal, provincial, and municipal), defense, hospitals, public education, government residential care facilities, and the rent that is imputed to owner-occupied housing. Non-profit activity is added to the business sector to be consistent with the data totals for the United States that are taken from EU KLEMS.
4. For a discussion of multifactor productivity, see Baldwin and Gu 2007.
5. See Baldwin et al. (2013) for a description of the data sources, methods, and results used to derive the Canadian and U.S. GDPs (at basic prices) and hours worked in this paper. The studies use the same method for each country to derive GDP and hours worked

summation across all industries of the labour productivity of an industry multiplied by its share of business-sector hours worked:

$$LP = \sum_i LP_i \frac{H_i}{H}.$$

(2)

Aggregate labour productivity will be higher if the share of hours worked is higher in those industries with higher labour productivity, if the share of hours worked is higher in those size classes that have higher labour productivity (generally larger firms), or if there is a smaller gap in labour productivity between those that have lower levels of productivity (generally small firms) and those with higher productivity (generally larger firms).

Table 1

Share of large-firm business-sector hours worked by industry in Canada and the United States, 2002 and 2008

	Share of large-sized businesses			
	Canada		United States	
	2002	2008	2002	2008
	percent			
Goods producing industries				
Agriculture, hunting, forestry and fishing	1.5	0.9	2.7	2.3
Electricity, gas and water supply	87.4	90.7	83.4	83.6
Construction	8.2	9.8	12.8	13.8
Mines, oil and gas	57.1	59.0	57.3	55.1
Manufacturing	44.1	41.6	57.6	55.5
Total	30.8	28.7	38.8	36.8
Service producing industries				
Wholesale and retail trade	28.4	35.5	46.2	50.1
Transport and storage and communications	38.0	45.4	59.6	62.8
Financial intermediation	63.5	62.3	69.4	67.8
Real estate, renting and business activities	24.1	27.7	43.2	45.9
Education	33.6	25.0	51.1	54.4
Health and social work	5.2	7.6	49.3	49.4
Hotels and restaurants	11.8	14.7	36.3	36.2
Other community, social and personal services	10.1	10.0	16.4	18.7
Total	25.3	29.4	44.8	46.8
Business sector	27.0	29.2	43.2	44.4

Notes: Industries are at the *S*-level aggregation based on the North American Industry Classification System. Authors' own calculations using the sources below.
Sources: Statistics Canada; Bureau of Economic Analysis; and Census of U.S. Business Statistics.

3 The relative importance of large firms in Canada and the United States

Canadian large firms accounted for 29.2% of hours worked in the business-sector in 2008. This was substantially below that in the United States (44.4% in 2008) (Table 1).

Across goods-producing industries and services, there are considerable differences between the two countries in the share of hours worked in large firms. Shares in the United States are generally higher. The United States had more industries (seven industries) whose large-firm share was more than 50% in 2008 compared to Canada (three industries). The tendency to employ proportionally more workers in large firms extends across much of the industrial spectrum—but is higher on average in the service sector (some 17 percentage points in 2008) than in the goods-producing sector (some 8 percentage points in 2008).

4 Nominal gross domestic product per hour worked by firm size

Large firms differ from small firms in terms of their production process. The growth that transforms small firms into large firms often involves the application of more capital per worker to mechanize processes or to develop intellectual capital (Caves and Pugel 1980). Larger firms are also more likely to make intangible investments, such as in advertising, skill enhancement, and research and development.[6] As well, larger firms tend to hire workers with more education and skills and to pay higher wages (Brown and Medoff 1989; Morissette 1993). These practices lead, on average, to differences in labour productivity between large and small firms.

In 2008, as measured by nominal GDP per hour worked, Canadian labour productivity in large firms ($75.6/hour) exceeded that in small firms ($35.7/hour) (Table 2). In Canada, labour productivity of small firms was about half that of large firms. The level of labour productivity in the United States was also larger for large firms ($59.9/hour in 2008) than for small firms ($40.8/hour in 2008) (Table 3). However, in the United States, small firms were about 70% as productive as large firms in 2008. This is considerably higher than in Canada.

In Canada and the United States, large firms have a greater presence in industries that require substantial capital than do small firms. The industries that are more capital-intensive are the infrastructure industries (utilities, communications, and transportation), resource-based industries (mining and oil and gas), and finance and manufacturing. These capital-intensive industries are more common in the goods-producing industries, where there is also a higher concentration of large firms.

The scale effects present in the capital-intensive industries are sufficiently important that small firms experience larger productivity disadvantages in these industries. In the goods-producing industries in 2008, nominal GDP per hour worked in Canada for small firms was just 33% of large firms while it was 62% for services industries. In the United States, the same relative differences can also be found. The labour productivity of small firms was 44% and 79% of large firms in the goods and services sectors, respectively.

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6. See Baldwin and Hanel (2003, chapter 7) and Baldwin and Gellatly (2003, chapter 11) for a comparison of the innovation profiles of large and small firms.

The differences in the importance of smaller firms and in the relative productivity of small to large firms reinforce each other so as to depress Canadian productivity relative to U.S. productivity. For the business sector as a whole, Canadian small firms incurred a relatively larger productivity disadvantage than did their U.S. counterparts. The ratio of small-firm to large-firm productivity in Canada was 69% of the same ratio in the United States (Table 4). At the same time, small firms accounted for a relatively larger share of hours worked in Canada.

Table 2

Nominal business-sector gross domestic product per hour worked, by industry and firm size, Canada, 2002 and 2008

	Small firms			Large firms			Relative		
	Level		Average annual growth	Level		Average annual growth	Small to large firms		Average annual growth
	2002	2008	2002 to 2008	2002	2008	2002 to 2008	2002	2008	2002 to 2008
	Canadian dollars		percent	Canadian dollars		percent	percent		
Goods producing industries									
Agriculture, hunting, forestry and fishing	24.7	35.9	6.4	36.1	37.5	0.7	68.5	95.6	5.7
Electricity, gas and water supply	226.5	234.6	0.6	156.1	178.4	2.3	145.1	131.5	-1.6
Construction	28.7	38.4	5.0	46.3	63.8	5.5	62.0	60.2	-0.5
Mines, oil and gas	105.4	116.5	1.7	204.4	435.8	13.4	51.6	26.7	-10.4
Manufacturing	31.5	37.3	2.9	66.1	68.4	0.6	47.6	54.6	2.3
Total	32.2	41.3	4.2	82.0	127.0	7.6	39.2	32.5	-3.1
Service producing industries									
Wholesale and retail trade	23.2	31.1	5.0	29.3	37.5	4.2	79.2	82.8	0.7
Transport, storage and communications	24.3	28.0	2.4	68.2	76.2	1.9	35.6	36.8	0.5
Financial intermediation	42.0	51.9	3.6	61.1	81.4	4.9	68.7	63.7	-1.3
Real estate, renting and business activities	42.4	47.1	1.8	40.6	51.8	4.1	104.4	90.9	-2.3
Education	24.3	28.3	2.6	35.0	45.9	4.7	69.4	61.6	-2.0
Health and social work	30.5	39.3	4.3	47.9	53.0	1.7	63.8	74.1	2.5
Hotels and restaurants	13.2	16.2	3.4	27.0	29.7	1.6	49.0	54.6	1.8
Other community, social and personal services	18.6	23.6	4.0	32.8	43.5	4.8	56.6	54.1	-0.7
Total	26.9	33.2	3.6	44.1	53.7	3.3	60.9	61.8	0.2
Business sector	28.5	35.7	3.8	57.8	75.6	4.6	49.2	47.2	-0.7

Note: Industries are at the *S*-level aggregation based on the North American Industry Classification System.
Source: Statistics Canada, authors' calculations.

Table 3

Nominal business-sector gross domestic product per hour worked, by industry and firm size, United States, 2002 and 2008

	Small firms			Large firms			Relative		
	Level		Average annual growth	Level		Average annual growth	Small to large firms		Average annual growth
	2002	2008	2002 to 2008	2002	2008	2002 to 2008	2002	2008	2002 to 2008
	U.S. dollars		percent	U.S. dollars		percent		percent	
Goods producing industries									
Agriculture, hunting, forestry and fishing	15.0	28.3	11.2	31.6	37.7	3.0	47.5	75.2	8.0
Electricity, gas and water supply	138.5	258.7	11.0	158.7	216.7	5.3	87.2	119.4	5.4
Construction	27.2	31.3	2.4	36.7	46.1	3.9	74.1	67.9	-1.5
Mines, oil and gas	75.4	152.8	12.5	123.1	233.1	11.2	61.3	65.6	1.1
Manufacturing	29.5	39.0	4.8	53.0	73.3	5.5	55.6	53.1	-0.8
Total	27.3	37.6	5.4	58.6	84.6	6.3	46.7	44.4	-0.8
Service producing industries									
Wholesale and retail trade	35.8	43.4	3.2	41.1	50.4	3.4	87.0	86.0	-0.2
Transport, storage and communications	26.8	38.6	6.3	57.3	72.3	3.9	46.7	53.4	2.2
Financial intermediation	74.4	80.5	1.3	79.2	96.4	3.3	93.9	83.5	-1.9
Real estate, renting and business activities	51.0	64.5	4.0	42.5	56.9	5.0	120.1	113.4	-1.0
Education	18.9	24.0	4.0	24.2	30.4	3.8	78.1	79.0	0.2
Health and social work	27.8	32.1	2.4	28.3	37.4	4.8	98.3	85.8	-2.2
Hotels and restaurants	17.0	19.1	1.9	24.3	32.1	4.7	69.9	59.5	-2.7
Other community, social and personal services	23.2	27.8	3.1	26.9	32.1	3.0	86.3	86.5	0.0
Total	34.6	42.0	3.3	42.7	53.5	3.8	80.9	78.6	-0.5
Business sector	32.5	40.8	3.9	46.6	59.9	4.3	69.7	68.1	-0.4

Note: Industries are at the *S*-level aggregation based on the North American Industry Classification System.
Source: Statistics Canada, authors' calculations.

Table 4

Canada–United States relative productivity small-firm disadvantage by industry, 2008

	Canadian relative productivity	Small firm share	United States relative productivity	Small firm share	Canada–United States relative Productivity small firm disadvantage	Canada–United States relative small firm share
			percent			
Goods producing industries						
Agriculture, hunting, forestry and fishing	95.6	99.1	75.2	97.7	1.27	1.01
Electricity, gas and water supply	131.5	9.3	119.4	16.4	1.10	0.57
Construction	60.2	90.2	67.9	86.2	0.89	1.05
Mines, oil and gas	26.7	41.0	65.6	44.9	0.41	0.91
Manufacturing	54.6	58.4	53.1	44.5	1.03	1.31
Total	32.5	71.3	44.4	63.2	0.73	1.13
Service producing industries						
Wholesale and retail trade	82.8	64.5	86.0	49.9	0.96	1.29
Transport, storage and communications	36.8	54.6	53.4	37.2	0.69	1.47
Financial intermediation	63.7	37.7	83.5	32.2	0.76	1.17
Real estate, renting and business activities	90.9	72.3	113.4	54.1	0.80	1.34
Education	61.6	75.0	79.0	45.6	0.78	1.64
Health and social work	74.1	92.4	85.8	50.6	0.86	1.83
Hotels and restaurants	54.6	85.3	59.5	63.8	0.92	1.34
Other community, social and personal services	54.1	90.0	86.5	81.3	0.63	1.11
Total	61.8	70.6	78.6	53.2	0.79	1.33
Business sector	47.2	70.8	68.1	55.6	0.69	1.27

Note: Industries are at the *S*-level aggregation based on the North American Industry Classification System.
Source: Statistics Canada, authors' calculations.

In the goods sector, much of the relative productivity disadvantage occurs in the mining and oil and gas sector. In the services sector, the relative productivity disadvantage exists across most sectors—as does the relatively larger importance of small firms in Canada than in the United States.

Aggregate productivity levels of a country depend ultimately on the nature of the composition of its business sector and the productivity of each underlying component. A country that produces more from business units that are more productive will have a higher level of aggregate productivity. It is apparent that Canadian productivity performance relative to the United States has been affected by the structural traits presented here. A larger percentage of Canada's workforce is employed in small firms. Furthermore, these firms not only had lower productivity than large firms, but their disadvantage was greater than that of U.S. small firms. The following sections explore the magnitude of the impact of these structural and performance differences on the gap in Canada–United States labour productivity levels.

5   Price index for comparing Canada and United States output

Relative labour productivity between Canada and the United States is derived by comparing the volume of output per hour worked in Canada to the volume of output per hour worked in the United States. The estimates of labour productivity for each country are generated as nominal GDP per hour worked and are calculated in the national currency of each country. In order to be transformed from a relative dollar estimate into a relative volume estimate, a relative price index is required.

The relative price index needed for this purpose is a measure of producing power parity (PPP) that captures the relative prices of both inputs and outputs for each industry.[7] The usual expenditure-based purchasing power parity measure that Statistics Canada produces is derived from price data on final expenditure categories and therefore, by itself, will not suffice for this purpose.

Producing power parity indices are particular difficult to produce at the industry level—because the programs used by statistical agencies are aimed at final demand for the entire business sector and do not capture final product prices in industries that produce mainly intermediate products and do not capture intermediate products in general.

Estimates of producing power parities have been generated that use imputed prices for those areas where they are missing from direct sources. Producing power parities (PPPs) are obtained for 1999 from Baldwin, Gu and Yan (2008). These are consistent with the basic-price concept of output and for the benchmark year 1999. These PPPs between Canada and the United States are expressed as the price of one Canadian dollar's worth of a product in terms of U.S. dollars. The 1999 estimates were projected forward using the relative movements of the business-sector GDP deflators for Canada and the United States (see Table 5). The Canadian prices are taken from the National Accounts while the U.S. prices are taken from the Bureau of Labor Statistics (BLS) for the business sector.[8]

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7. Exchange rates are not suitable since they do not necessarily capture relative prices (see Baldwin and Macdonald 2009).
8. The Canadian prices series is derived from basic prices while the BLS business sector series uses market prices.

These average price relatives pertain to the population as a whole. They do not exist for different size classes.[9]

Table 5

Value added producer price parities (PPPs) at basic prices, 1999 to 2008

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
	percent									
Business sector	0.83	0.81	0.81	0.82	0.79	0.78	0.78	0.78	0.77	0.74
	index									
Price deflators										
United States	95.8	97.6	99.3	100.0	100.5	102.8	106.0	109.1	111.9	113.3
Canada	94.2	98.6	99.9	100.0	103.7	107.5	111.4	114.5	118.4	124.4
Relative	1.02	0.99	0.99	1.00	0.97	0.96	0.95	0.95	0.94	0.91

Note: PPPs for the benchmark year 1999 are from the source indicated below. They are projected forward using the growth in the relative U.S. to Canada business-sector price deflators.
Source: J.R. Baldwin, W. Gu and B. Yan. 2008. *Relative Multifactor Productivity Levels in Canada and the United States: A Sectoral Analysis*. Ottawa: Statistics Canada.

6 Effect of changes in size distribution on labour productivity

The tendency for Canada to have a disproportionate share of economic activity in small firms compared to the United States and to have small firms that are relatively less productive than large firms has led analysts to ask whether industrial structure and firm size might provide an explanation for the gap in productivity levels between the two countries.

The discussion of the impact of small firms on the size of the productivity gap revolves here around three questions. How much of the gap occurs because Canada has more small firms? How much of the gap occurs because it focuses more on industries where small firms are important? How much of the gap occurs because Canadian small firms have a relatively higher productivity disadvantage compared to large firms? These questions are answered here sequentially.

First, estimates are derived of the changes that would occur in Canadian aggregate labour productivity if Canada increased its relative share of hours worked of large-firms in each industry to the U.S. level. If there are particular barriers to growth of smaller firms in Canada, then the impact of increasing the share of larger firms provides an estimate of the increase that might be expected to follow from reducing these barriers.

Second, estimates are derived for the impact of bringing the relative productivity of small to large firms in Canada up the level that existed in the United States. This analysis seeks to measure the impact of reducing productivity disadvantages experienced by small firms in Canada to those experienced by U.S. small firms.

Third, estimates are generated of the impact on aggregate labour productivity of changing the relative importance of hours worked in each industry to reflect that of the United States. This last question examines the potential size of the gap that is owed to differences in the industry structure of the two countries.

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9. The lack of a firm-size specific PPP means that differences in nominal productivity between small and large firms in Canada and the United States may arise from differences in real productivity or from differences in relative prices—that is the relative prices of large firms may differ from that of small firms.

Nothing in this analysis presumes that any of these changes could readily occur. Increasing the relative importance of large firms would have to overcome barriers to growth or natural factors that facilitate the presence of small firms. Changing the relative labour productivity of small firms might require changes in the ability of small firms to access or to apply capital to the production process. Changing the industrial structure to favour industries that possess a larger proportion of larger firms might require policies that counteract the comparative advantages that Canada possesses that affect industry structure, or may lead to other economic and social impacts beyond the scope of this study.

Answers to all three questions require counterfactuals that ask what productivity levels would exist if something were changed. They are addressed here sequentially. That is, changes in firm shares, or relative productivity, or industry structure are explored independently of one another. New estimates of aggregate productivity are calculated making changes in individual assumptions—holding other characteristics constant. These changes, if they actually occurred, may reinforce or counteract one another. That is, a change in relative importance of small firms may occur simultaneously with a change in relative productivity—for example, if the removal of small firms occurs primarily through the exit of the least productive, the relative productivity of small to large firms may increase as the share of small firms is decreased. In the analysis presented here, account is not given to how the changes that are considered might work interactively.

The counterfactuals require a detailed comparison of Canada–United States firm-size differences by industry and a calculation of the proportion of the productivity difference that come from differences in firm-size distributions. These differences in the relative importance of different industries from 2002 to 2008 were summarized in Section 3, which were based on estimates from Leung and Rispoli (2014).

To help answer these questions, estimates are generated of the increase in the aggregate Canadian nominal productivity for each of the counterfactuals and then the change in the relative productivity between Canada and the United States is corrected by the PPP price relative (Table 6) for each of the years 2002 to 2008.

Estimates are first presented of the amount by which an arbitrary shift of total hours worked from small firms to large firms would increase aggregate labour productivity in Canada, while holding constant the labour productivity of each size class and the overall importance of different industries (Counterfactual One).[10] This is done by calculating aggregate productivity for large firms and for small, and then, by reweighting the two using the U.S. share of hours worked for small and large firms. To put this in context, over the 2002-to-2008 period, the hours worked share of large business in the U.S. business-sector was about 15 percentage points higher than in Canada.

Canadian labour productivity by industry *i* is estimated here as the weighted average of the labour productivity in the small and large business categories for industry *i*, where the weights are the share of U.S. hours for each business-size category in industry *i*.[11]

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10. No assumptions are made as to how this might happen. It could occur from shifting industry composition within the industry classifications in this study or from a shift in the underlying firm-size structure. A more detailed study of actual changes would have to examine each of these factors in order to gauge whether industry structure or actual firm size is the cause of productivity differences between Canada and the United States.

11. As the hours share for large firms is increased, we assume that the labour productivity in each business-size category is held constant. Equation (3) is used to calculate each industry's labour productivity under the different counterfactual scenarios. Equation (4) is then used to estimate the counterfactual business sector labour productivity. Conducting the analysis directly at the business sector level would mix two effects—changing industry composition across the industries and changing firm-size distributions. It should be recognized that this method still leaves a degree of industry compositional effects below the two-digit industries used herein.

$$LP_i = \sum_j LP_{ij} \frac{H_{ij}}{H_i}, \tag{3}$$

$$LP_{BS} = \sum \frac{H}{H} LP, \tag{4}$$

where *LP* represents labour productivity, *H* represents hours worked, and *j* indexes the business-size categories. Labour productivity for the business-sector as a whole is the summation across all industries of the labour productivity of an industry multiplied by its share of Canadian business-sector hours worked.

For the entire business-sector, Canadian labour productivity would increase an average of 6% over the period from 2002 to 2008 (column 3, Table 6). The percentage increase is similar across all years in the period.

The changes derived from the first counterfactual experiment would not eliminate the gap in real productivity. In 2002, this gap is 23 percentage points (column 10, Table 6). The changes embedded in the counterfactual would eliminate some 6 percentage points of the gap (column 11, Table 6) or about 26% of the total.

A second counterfactual (Counterfactual Two) is calculated by using the relative U.S. small/large firm ratio of labour productivity to reestimate the total labour productivity of Canadian small firms.

Canadian labour productivity by industry *i* is estimated here as the weighted average of the labour productivity in the small and large business categories for industry *i*, where the weights are a share of Canadian hours for each business-size category in industry *i*.

In this counterfactual, the Canadian labour productivity of small firms (LP_s) is estimated as a percentage of U.S. labour productivity of small relative to large firms while the Canadian large-firm productivity levels do not change from the original ones as derived in this study. Again, the results are summed (using the share of Canadian hours worked by industry) to estimate the impact for the business-sector overall

$$LP_i = \sum_j LP_{ij} \frac{H_{ij}}{H_i}, \tag{5}$$

Labour productivity for Canadian small firms is recalculated using:

$$^{Can}LP_{is} = {}^{U.S.}LP_{is} / {}^{U.S.}LP_{iL} * {}^{Can}LP_{iL} , \tag{6}$$

$$LP_{BS} = \sum \frac{H}{H} LP, \tag{7}$$

where *LP* represents labour productivity, *H* represents hours worked, and *j* indexes the business-size categories. Labour productivity for the business-sector as whole is the summation across all industries of the labour productivity of an industry multiplied by its share of Canadian business-sector hours worked.

Table 6

Effect on labour productivity of counterfactual changes in firm size distribution, by industry, Canada, 2002 to 2008

	Canadian labour productivity estimates							United States labour productivity	Producer power parities	Canada–United States relative productivity			
	Original	Counterfactual								Original	Counterfactual		
		One	Relative to original	Two	Relative to original	Three	Relative to original				One	Two	Three
	canadian dollars	canadian dollars	ratio	canadian dollars	ratio	canadian dollars	ratio	U.S. dollars	ratio		ratio		
2002	36.4	39.0	1.07	40.9	1.12	35.2	0.97	38.6	0.82	0.77	0.83	0.87	0.75
2003	38.0	40.6	1.07	42.4	1.12	36.0	0.95	40.8	0.79	0.74	0.79	0.82	0.70
2004	39.5	42.1	1.06	44.4	1.12	37.4	0.94	42.9	0.78	0.72	0.76	0.81	0.68
2005	42.1	44.9	1.07	46.3	1.10	39.2	0.93	45.1	0.78	0.72	0.77	0.80	0.67
2006	43.8	46.3	1.06	48.2	1.10	40.8	0.93	46.7	0.78	0.73	0.77	0.80	0.68
2007	45.3	48.0	1.06	50.5	1.11	42.4	0.94	48.2	0.77	0.72	0.77	0.81	0.68
2008	47.3	49.6	1.05	53.0	1.12	43.7	0.92	49.2	0.74	0.71	0.75	0.80	0.66
Average	...	...	1.06	...	1.11	...	0.94	...	...	0.73	0.78	0.81	0.69

... not applicable
Source: Statistics Canada, authors' calculations.

Doing this increases aggregate Canadian labour productivity by 11% over the period (column 5, Table 6). Once again, the percentage increase in Canadian productivity derived from a reduction in the productivity gap between small and large firms is relatively constant over time.

It would account for about another 10 percentage points (column 12) of the 23 percentage point gap in 2002 or about 43% of the gap in that year.

The third counterfactual (Counterfactual Three) is calculated for each industry by summing the original labour productivity of small and large firms using the share of U.S. hours worked by industry to estimate the impact for the business-sector overall. The changes deriving from this counterfactual experiment decreased the level of nominal Canadian labour productivity by 6% on average over the period (column 7, Table 6). Canada is concentrated in industries where it has a relative productivity advantage.

Finally, it should be noted that part of the gap of 23 percentage points occurs because a different methodology is used in the two countries to measure labour inputs. Baldwin et al. (2005) demonstrate that a correction for differences in methodology decreases the relative size of Canada–United States relative labour inputs and increases estimates of Canada–United States relative labour productivity by 10%.[12] In this case, it would account for about 7 to 8 percentage points of the productivity gap.

When the impact of differences in methodology is accounted for, most of the productivity gap between Canada and the United States was the result of the relatively larger proportion of small firms in Canada and the relatively large productivity disadvantage of this group compared to large firms at the beginning of the post 2000 period.

Changes however in the industrial climate over the post 2000 period reduced the contribution that small firms made to the size of the overall gap. Over this period, Canadian labour productivity in the business sector slowed over this period relative to the United States (Baldwin and Gu 2009). And this slowdown came primarily from two sectors—manufacturing and information and culture (telecommunications). Manufacturing felt the impact of increases in the U.S./Canada exchange rate as export intensity fell and plants moved back up their cost curve (Baldwin et al. 2011a). Leung and Rispoli (2013) describe how large firms declined in importance over this period.

Not surprisingly, then, the impact of small firms on the productivity gap declined over time as other forces affecting the performance of large firms were the primary driver of the ever widening gap in Canada/U.S. productivity levels post 2000. Between 2002 and 2008, the impact on the total gap of the 'small-firm disadvantage' fell dramatically—from accounting for almost all of the productivity gap not accounted for methodological differences to only accounting for about 60% of it.

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12. See also Maynard 2007.

7 Conclusion

Canada has sometimes been described as having a dearth of large firms or a surfeit of small firms compared to the United States. While small firms are often regarded as a dynamic and innovative segment of the population, in many cases, they are not able to exploit the scale economies associated with size and therefore possess a productivity disadvantage. The consequence, it has been argued, is relatively lower aggregate business-sector productivity in Canada.

Analysis of the importance of this issue requires comprehensive and comparable data on firm-size distributions in Canada and the United States and on differences in productivity levels across firm size classes. Until now, these data have not been available.

This study and related papers in this series (Rispoli 2009; Leung and Rispoli 2011; Baldwin et al. 2013; Leung and Rispoli 2014) examine the importance of firm size by measuring the GDP generated, the employment provided, and, consequently, the labour productivity of different size classes. Leung and Rispoli (2014) estimated both GDP and the labour input (hours worked) for Canada and the United States using similar methods.

These estimates reveal that small firms are relatively more important in the Canadian economy. In 2008, they accounted for about 70% of hours worked in Canada while they accounted for about 56% of hours worked in the United States. In 2008, the level of Canadian productivity, as measured by nominal GDP per hour worked in small firms, was only 47% of the productivity of large firms. The level of productivity for small U.S, firms was only 70% of the productivity of large firms. Therefore the gap between the productivity of small firms and that of large firms was larger in Canada.

Since aggregate productivity is just the weighted sum of the productivity of the underlying enterprises that make up the economy, changes in size distributions or relative productivity (*ceteris paribus*) will result in changes in aggregate productivity. Increasing the proportion of the more productive firms while holding constant their relative productivity will increase aggregate productivity. Increasing the relative productivity of small firms while holding constant their relative importance as measured by the share of hours worked will also increase aggregate productivity.

When set against the gap in labour productivity between Canada and the United States, the joint effect of making both of these changes is substantial. In the early 2000s, decreasing the share of small firms in Canada to levels in the United States and reducing the relative productivity gap between small and large firms to U.S. levels would have eliminated almost all of the productivity gap.

In that limited sense, the productivity gap between Canada and the United States owed much to the concentration of small firms in Canada. However, this conclusion needs to be accompanied by several caveats.

Nothing here explains the root cause of the small-firm disadvantage. It could be that the productivity disadvantage and the differences in the size distribution are related. This could occur when growth prospects are inversely related to the size of the productivity gap—if small firms with productivity disadvantages are less likely to grow to become large firms. Or these characteristics may be unrelated. There may be unrelated issues that prevent small firms from growing to become larger ones and that at the same time lead to large productivity disadvantages. It may be that the size of the Canadian market affects the size distribution and at the same time affects relative productivity.

It is also worth noting that these results should not be interpreted emotively as showing that small firms are in some sense responsible for their condition or are "the problem." It may be that regulation, or trade barriers, or financing, or other institutional constraints are behind the Canadian small-firm disadvantage. But the results of this paper indicate that questions about the relationship between the size of the productivity gap between Canada and the United States might usefully begin by asking what it is that affects the relatively large size of the small-firm sector in Canada and its relatively lower levels of productivity.[13] The latter question should include the possibility that the differences in relative productivity between small firms and large firms depend partially on differences in price relatives across sized classes that are not taken into account in this analysis—because the PPPs used herein presume differences in prices across countries that are constant across size classes.

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13. See Baldwin et al. (2011*b*) for a discussion of how much of the productivity gap between Canada and the United States comes from the unincorporated sector in Canada.

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