April 2016

151 Slater Street, Suite 710
Ottawa, Ontario K1P 5H3
613-233-8891
csls@csls.ca

CENTRE FOR THE STUDY OF LIVING STANDARDS

PRODUCTIVITY TRENDS IN THE CANADIAN TRANSPORT SECTOR: AN OVERVIEW

Fanny McKellips and Matthew Calver

CSLS Research Report 2016-04

April 2016

Prepared for Transport Canada
By the Centre for the Study of Living Standards

Productivity Trends in the Canadian Transport Sector: An Overview

Abstract

In recent decades, the overall growth in productivity of many subsectors of the Canadian transportation and warehousing sector has been above average. In particular, while labour productivity (real GDP per worker) grew an average of 0.64 per cent per year between 2000 and 2014 in the transportation and warehousing sector, labour productivity grew an average of 1.83 per cent per year in the truck transportation subsector, 3.25 per cent per year in the air transportation subsector and 2.09 per cent in the train transportation subsector for the same period. Conversely, in the urban transit subsector, labour productivity decreased an average of 0.76 per cent per year between 2000 and 2014. This report provides a detailed analysis of output, input and productivity trends in four subsectors of the Canadian transportation and warehousing sector. It also examines drivers of the productivity growth for each subsector as well as policies that could enable faster growth. Given the impact that the transportation sector has on many Canadian industries as well as the Canadian economy, maintaining productivity growth is important.

Productivity Trends in the Canadian Transport Sector: An Overview

Contents

Productivity Trends in the Canadian Transport Sector: An Overview

Executive Summary

The performance of the transportation sector is of vital importance for the Canadian economy. According to Statistics Canada, there were 831,645 jobs in the sector in 2014, representing 4.6 per cent of all jobs in Canada. Consumers rely on the sector to commute to work. Firms make use of the transportation sector to receive inputs and ship outputs. Productivity growth is important in order to keep transportation costs low, ensuring competitiveness, and promote the movement of passengers and freight, generating economic activity. For this reason, it is important to periodically evaluate productivity performance in the sector and attempt to identify means to enhance it.

The present study explores productivity trends and their underlying drivers over the 1997-2014 period. Our goals are threefold:

(1) To document the trends of productivity and related variables in the transportation sector and several of its subsectors;
(2) To assess the likely sources of the observed productivity trends; and
(3) To identify policy options to raise productivity performance in the future.

We begin with a brief overview of the aggregate performance of the sector based on data from Statistics Canada. Overall, the transportation sector, which we will define here as the sum of air transportation, rail, trucking, urban transit, water transportation, and pipelines, has had about average performance in terms of GDP growth from 2000 to 2014:

- Real GDP in the sector grew 2.1 per cent annually from 2000 to 2014, which can be broken down into an increase in the number of hours worked by 0.6 per cent annually and growth in labour productivity of about 1.6 per cent.

- This GDP growth was very similar to that of all Canadian industries, where GDP grew 2.0 per cent over the same period. However, hours worked grew faster in the total economy (1.0 per cent) while labour productivity growth was somewhat slower (also 1.0 per cent).

While the transportation sector had above average productivity performance compared to the total economy, there is considerable variation across subsectors. To understand the aggregate performance, it is necessary to examine several of the major subsectors in detail. In particular, we consider air, rail, trucking, and urban transit. Taken together, these four transportation subsectors account for about 80 per cent of nominal GDP in our narrowly defined transportation sector.

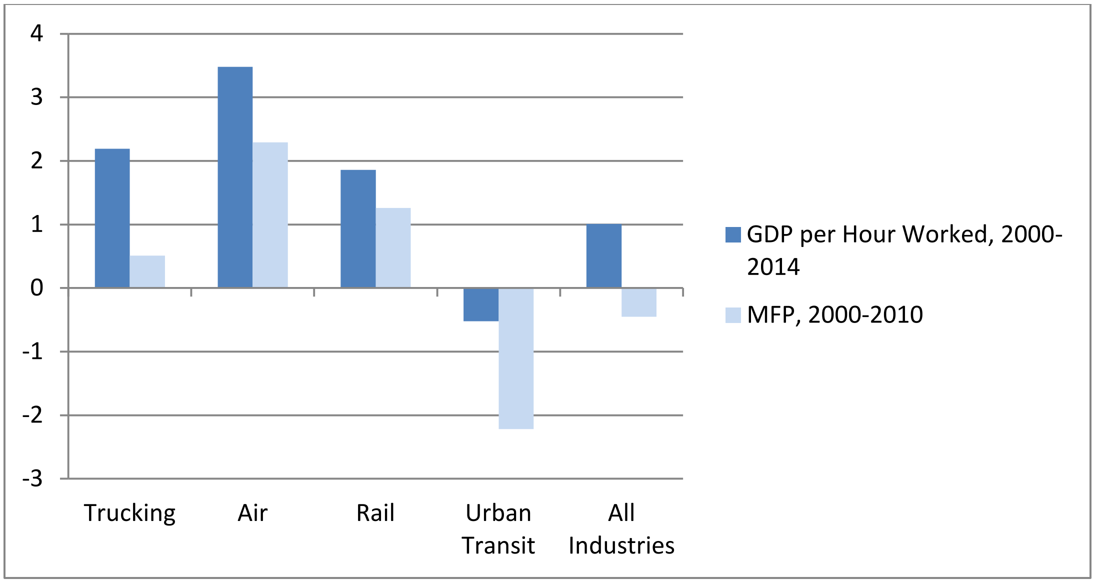
Based on official Statistics Canada data, we find that labour productivity growth was very strong in the trucking, air, and rail subsectors. This reflected above average output growth in air and trucking and below average employment growth in all three subsectors, especially rail. Multifactor productivity (MFP), another measure of productivity which relates output to all inputs used, growth was also stronger than average in all three of these industries. In contrast to the other subsectors which experienced MFP growth from 2000-2014, MFP fell considerably in urban transit. Much of the decline in MFP can be linked to rapidly expanding capital stocks as cities invested in transit infrastructure. Generally, similar trends are observed using data from Transport Canada.

Table A: Compound Annual Growth Rates in Major Transportation Subsectors, Output, Labour Input, Labour Productivity, Capital Input, and Multifactor Productivity, Canada, 2000-2014

		Trucking	**Air**	**Rail**	**Urban Transit***	**Transportation****	**All Industries**
Output	Real GDP	2.81	3.42	1.03	2.11	2.14	2.03
Labour Input	Hours Worked	0.61	-0.06	-0.82	2.61	0.58	1.01
	Jobs,	0.95	0.17	-1.04	2.87	0.84	1.32
Labour Productivity	GDP per Hour Worked	2.19	3.48	1.86	-0.52	1.55	1.01
	GDP per Job	1.83	3.25	2.09	-0.76 [B]	1.29 [B]	0.69
Capital	Net Capital Stock	4.86	-0.19	-0.11	5.94 [B]	2.36 [B]	2.41
Capital Intensity***	Capital per Hour Worked	4.42	0.36	1.27	3.18	1.19	1.33
MFP****	MFP	0.51 [B]	2.30 [A]	1.26 [A]	-2.22 [B]	..	-0.45 [C]

Note: Figures represent compound annual growth rates.
[A] MFP data for Air and Rail are based on Transport Canada's Productivity Database, 2000-2013.
[B] From Statistics Canada MFP estimates based on gross output.
[C] This MFP estimate is based on value-added MFP in the business sector.
* The MFP and Capital estimates use data on the broader Transit and Ground Passenger Transportation subsector rather than urban transit, as estimates specific to Urban Transit were not available from Statistics Canada.
** Constructed as the aggregate of rail, trucking, air, urban transit, water transportation, and pipelines. Note that this does not include taxis, scenic and sightseeing transportation, other ground transportation, support services for transportation, postal services and couriers and messengers, and warehousing
*** Estimates are for the 2000-2013 period.
**** Estimates for trucking and urban transit are for the 2000-2010 period. Estimates for air and rail are for 2000-2013. Since time periods and sources differ, most of the MFP estimates are not perfectly comparable to the input and output data nor across sectors.
Source: CSLS Transportation Database using data from Statistics Canada.

Chart A: Compound Annual Growth Rates, Labour Productivity and MFP, Canada



Note: MFP data for Air and Rail are based on Transport Canada's Productivity Database over the 2000-2013 period. Statistics Canada MFP estimates for Trucking and Urban Transit are based on gross output, while All Industries is based on Value Added. The MFP estimate for urban transit uses data on the broader Transit and Ground Passenger Transportation subsector, as estimates specific to Urban Transit were not available from Statistics Canada.
Source: CSLS Transportation Database using data from Statistics Canada.

The Trucking Subsector

Statistics Canada's data reveals the following highlights about the trucking subsector in recent history:

- In 2011, nominal GDP in the trucking subsector was $17.7 billion, representing about 40 per cent of nominal GDP in the transportation sector. Real GDP, which controls for changes in prices through time, is more important for analyzing productivity growth. In the trucking subsector, real GDP grew by 2.8 per cent per year between 2000 and 2014.

- Hours worked grew 0.61 per cent per year over the same period.

- The slow growth of hours worked and the relatively rapid output growth have led to growth in labour productivity of 2.2 per cent per year between 2000 and 2014 when defined as real GDP per hour worked. Labour productivity has grown faster in the truck transportation subsector than in the transportation and warehousing sector of which it is part, and faster than in all industries. However, the productivity level of the sector remains relatively low. Labour productivity was about $33.4 (current dollars) per hour in 2011 which was 60 per cent of the level in all industries.

- Growth accounting reveals that 22 per cent of the growth in (gross output based) labour productivity between 2000 and 2010 was due to rising MFP, 5 per cent was due to capital accumulation, 5 per cent was due to changes in labour composition, and 68 per cent was due to rising intermediate input intensity.

MFP grew significantly from 2000-2010. Economists often like to think of MFP growth as representing technological progress, but it can capture many other factors such as economies of scale, capacity utilization, or changes in the regulatory environment. Federal deregulation of the truck transportation subsector in 1987, along with deregulation in all the provinces by 2001, has led to a degree of competition never before seen in the Canadian trucking industry which has had an undeniable impact on productivity growth. It is likely that some of the increased productivity growth observed since 2000 was related to this more competitive regulatory environment.

Technical progress was also an important driver of productivity growth in the truck transportation subsector. On-board computers introduced during the 1990s have increased the productivity of truck drivers. For example, Hubbard (2001) credits location data available in real-time for improving the ability of dispatchers to more efficiently employ their drivers. Longer trucks and better fuel efficiency have also had a positive impact. In recent years, the use of mobile backhaul applications has facilitated the matching of drivers and backhaul loads which has increased their productivity.

The capital stock in the trucking transportation subsector grew rapidly at a rate of 4.9 per cent per year between 2000 and 2013. The rapid growth of capital stock means that the capital stock per worker nearly doubled between 1997 and 2013. This contributed to the increase in labour productivity. Policymakers should continue further deregulation of the truck transportation subsector to maximize productivity growth, although they will need to be careful not to compromise safety. Increasing the number of long combination vehicles (LCVs), which are currently allowed (with restrictions) in some provinces and banned in others, could increase productivity. There is some trade-off to allowing LCVs because they can be harder on roads, requiring more maintenance. However, LCVs can reduce the total number of trucks on the road and allow for more efficient use of fuel and labour relative to total tonnage of freight shipped.

Measures to encourage fuel efficiency, such as encouraging the use of more fuel efficient engines, would generate productivity growth and have positive environmental impacts.

Strategically investing in expanding road networks and double-laning busy highways may also reduce congestion and raise trucking productivity. Similarly, speeding up procedures at Canada-United States borders would reduce delays and costs in the trucking industry. This could be done through creating additional border crossings or enlarging the most problematic crossings such as the Windsor-Detroit crossing.

The Air Transportation Subsector

The following developments occurred in the air transportation subsector:

- Nominal GDP in the air transportation subsector was $5.8 billion in 2011, or about 13 per cent of nominal GDP in transportation. Real GDP growth in this subsector was very strong at an average rate of 3.4 per cent per year over the 2000-2014 period.

- Hours worked decreased slightly, at a rate of 0.1 per cent per year for the same period.

- The relatively stable hours combined with the growth in output have led to a large increase in labour productivity (measured by GDP per hour) of an average of 3.5 per cent per year between 2000 and 2014. The labour productivity level in air transportation is about average at $55.2 per hour in 2011 which is 99 per cent of the labour productivity of the total economy.

Deregulation of the airline industry and privatization of Air Canada in 1988 are understood to have put greater emphasis on the market and increased productivity in the 1990s, although it is difficult to say how these changes continued to impact productivity growth in the 2000s. Changes in the competitive landscape such as the growth of WestJet since it entered the market in 1996 and the recent emergence of Porter Airlines have increased competition in the industry, promoting productivity.

The struggles of the industry in the early 2000s likely generated significant productivity improvements. Air Canada's bankruptcy in 2003 forced it to restructure and cut inefficiencies. This restructuring consisted mainly of wage cuts (which do not directly affect productivity) and layoffs.

Increased load factors have increased revenues and productivity. WestJet's load factor has increased from 70.6 per cent in 1997 to 81.4 per cent in 2014 and Air Canada's load factor has increased from 79.5 per cent in 2005 to 83.2 per cent in 2014. New measures that promote travel using Canadian airlines such as the transit without visa program made Canada more attractive as a transit point to travel through on the way to the final destination and increased the revenue and load factor of airplanes.

Technology has also had a positive impact on productivity in the air transportation subsector. Better fuel efficiency has increased total factor productivity. The internet has revolutionized the airline industry because passengers can purchase tickets directly through airline websites rather than through travel agents. This makes it more likely that customers will take advantage of price incentives to travel on flights with excess capacity, raising average load factors. Better dynamic pricing algorithms and use of big data have lead to more efficient scheduling and allocations of people to seats.

Policies that foster increased demand lead to productivity growth. With a fixed cost per flight, increased demand leads to higher load factors, spreading the fixed cost over a larger number of passengers. Provincial fuel taxes on international flights make Canadian flights uncompetitive at an international level. Reducing or eliminating such taxes would make Canadian flights competitive and increase demand. The liberalization of international transportation links through open skies type agreements can also increase competitiveness of the Canadian air industry.

Further deregulation of the industry would lead to productivity growth. For example, relaxing policies on cabotage (i.e. letting foreign airlines operate domestic routes within Canada) could increase airline competition in Canada. Relaxing night time airport constraints in airports such as Toronto Pearson or allowing the extension of the Toronto Island airport runway to allow jets to land may also increase productivity.

Entry of low cost carriers in Canada would also increase competitiveness within the industry which would lead to more efficiency and productivity growth. Many new carriers have tried to enter but they have tended to fail. Policies which help low cost carriers compete more effectively, including some of those suggested above, may be beneficial.

The Rail Transportation Subsector

Like air and trucking, the rail transportation subsector also exhibited respectable productivity growth:

- In 2011, nominal GDP in the rail subsector was $6.5 billion, or about 15 per cent of GDP in transportation. Over the 2000-2014 period, real GDP grew only 1.0 per cent per year.

- Hours worked has decreased 0.8 per cent per year during the same period.

- The fall in hours worked and increase in output has led to growth in real GDP per hour worked by an average of 1.9 per cent per year between 2000 and 2014. Labour productivity defined as real GDP per worker has grown faster than in the transportation and warehousing sector and also faster than the average for all industries. The labour productivity level in rail transportation was very high in 2011 at $85.4 per hour, 1.53 times that of the total economy.

Deregulation in 1996 with the Canadian Transportation Act has allowed railways to abandon unprofitable lines. Between 1997 and 2013, total track operated decreased an average of 1.5 per cent per year. The abandonment of unprofitable lines has led to increased productivity. The capital stock has slightly decreased over the 2000 to 2013 period, by an average of 0.1 per cent per year.

Privatization of the Canadian National Railway in 1995 has led to changes in management and wide scale layoffs which commentators suggest has increased labour productivity.

Increases in fuel efficiency, the renewal of locomotive fleet and the implementation of dynamic braking and train pacing have increased the productivity of the rail transportation subsector, as have infrastructure improvements such as continuous welded rail. Co-production, the cooperation of railways to share infrastructure, has increased the utilization of railways.

Further deregulation of the rail transportation subsector may lead to further productivity growth. Maximum revenue entitlement for western grain, which effectively regulates grain freight rates below those which would be dictated by the market, should be eliminated and micro-management of grain shipments should be avoided.

As productivity is increased, safety must remain a concern. Accidents have a cost for railways and this can lower productivity. The externalities for society in terms of safety also need to be accounted for in any comprehensive evaluation of the output of the rail sector. Policy should encourage factors that increase safety, such as overpasses that lower the risk at public crossings. These also have the added benefit of facilitating the flow of railway traffic, as opposed to level crossings, and this increases productivity not only for rail but for road traffic as well. Level crossings can potentially reduce rail productivity because of regulations regarding blocked crossings.

Urban Transit Systems

Data specifically on urban transit systems (NAICS code 4851) are not always available from Statistics Canada because the data is sometimes only available at the three-digit NAICS level (for the capital stock, for example). When these are unavailable, this report provides data for the transit and ground passenger subsector of which the urban transit systems subsector is a major part along with other modes of ground transit such as taxis and chartered buses.

The economic performance of urban transit subsector can be summarized as follows:

- The nominal GDP of urban transit systems was $5.3 billion in 2011, or about 12 per cent of transportation. Real GDP in the sector has increased an average of 2.1 per cent per year between 2000 and 2014.

- Hours worked grew at a rate of 2.6 per cent per year over the same period.

- Labour productivity has been declining in urban transit systems. When defined as real GDP per hour worked, it declined at an average rate of 0.5 per cent per year between 2000 and 2014. This is due to the greater growth of hours worked than real GDP. Labour productivity in the sector was $44.0 per hour in 2011, or about 78.9 per cent of the level in the total economy.

- Growth accounting reveals that -2.22 percentage points of the growth in (gross output based) labour productivity in urban transit and ground passenger transportation between 2000 and 2010 were due to falling MFP, 1.41 percentage points were due to capital accumulation, 0.41 percentage points were due to changes in labour composition, and 0.74 percentage points were due to rising intermediate input intensity.

Capital productivity has fallen very quickly in transit and ground passenger transportation, by an average of 4.8 per cent per year between 2002 and 2013. This is due to the fast increase in capital stock which grew faster than the real GDP. The net capital stock grew at an average rate of 5.9 per cent per year between 2000 and 2013 in transit and ground passenger transportation. Although the increase in capital stock has caused a fall in capital productivity, it represents costly investments in the transit systems of Canadian cities which should lead to productivity growth in the future, as well as fulfilling societal goals.

Urban rail transit in major cities, such as subways, commuter rails, and light rails, have been beneficial because they increase speed and reliability compared to buses, have a positive environmental impact, increase passenger comfort and have low operating costs. Such systems are capital intensive. The large capital investments lower capital productivity in the short run, but will increase labour productivity and have positive social impacts in the long run.

Urban transit has important social impacts which are not captured in the output but are important from a societal perspective. The most important example is the impact of greenhouse gas emissions on the economy. The growing recognition of these impacts has lead to policy decisions which lower productivity as traditionally measured but are important for society. For example, serving areas with low density is important for cities but is unproductive from a strict output perspective. Policymakers need to strike a balance between maximizing productivity growth in this sector and pursuing other objectives.

Although productivity has fallen in this subsector, technical progress has still had some positive impact on productivity in urban transit systems. Bus dwell times have decreased due to electronic fare collection systems and better scheduling, and articulated and double-decker buses have increased capacity for a fixed amount of labour.

Going forward, increasing ridership outside of rush hour would increase capacity utilization on urban transit systems which would increase productivity. This could be done through a variety as policies, such as: decreasing the cost of fares during off-peak hours, increasing taxes on gas and parking, charging congestion charges and tolls, promoting an environment that supports urban transit, and offering Wi-Fi on urban transit.

Conclusion

Productivity in the transportation sector has generally been a success story. Three of the four subsectors which we have considered experienced strong labour productivity growth between 2000 and 2013. The primary sources of the significant productivity growth in air, rail, and trucking transportation seem to have been technological improvements, competitive pressures, deregulation, incentives to increase fuel efficiency in response to rising fuel prices, organizational factors, and investments in capital. Productivity in urban transit has fallen considerably which seems to be the result of transit authorities investing in expanding their services. These expansions may serve other social goals and may lead to productivity improvements in the future, so the associated decline observed in productivity should not necessarily be viewed as a cause for great concern.

We have offered several suggestions to enhance productivity in the future: minimize unnecessary regulation, promote competition, incentivize firms to adopt and develop new technologies and train their staff to use them effectively, create environments in which capacity can be utilized fully, and invest in infrastructure. Of course, policymakers must take into consideration more factors than just productivity. Other objectives such as environmental sustainability and safety are also important and should be considered jointly with productivity and output when developing policies.

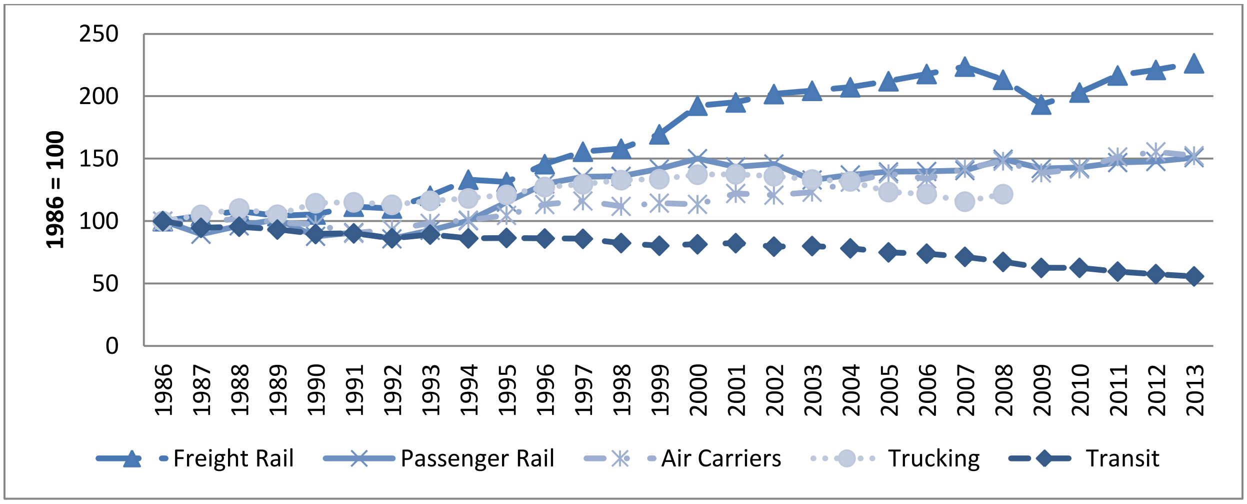
Productivity Trends in the Canadian Transport Sector: An Overview[1]

Section 1: Introduction

Canada's transportation sector facilitates the movement of people, goods, and services throughout the country and internationally. In order to keep costs low for consumers and maintain the competitiveness of the domestic industry, it is important that the transportation sector is highly efficient.

In recent years, Canada's productivity performance has generally been quite poor, and the transportation and warehousing sector is generally no exception. Between 2000 and 2014, output, hours worked, and labour productivity (output per hour worked or output per worker) in transportation and warehousing have all grown slightly slower than the average of all Canadian industries. Between 2000 and 2010, multifactor productivity (MFP) growth in transportation and warehousing has been slightly above the average in all industries, but it was still negative. This mediocre performance seems to have occurred despite deregulation in the last few decades and recent infrastructure investments. However, the aggregate productivity performance glosses over considerable variation among transportation industries.

Chart 1: Total Factor Productivity in Selected Transport Sectors, Canada, 1986-2013



Source: Transportation Canada's Productivity Database

[1] This report was written by Fanny McKellips and Matthew Calver under the supervision of CSLS Executive Director Andrew Sharpe. Funding for this project was provided by Transport Canada. The authors thank officials from Transport Canada and Bert Waslander for providing comments on an earlier draft of the report. We are also grateful to James Uguccioni for assistance in editing the report. Please direct any questions to andrew.sharpe@csls.ca or matthew.calver@csls.ca

This project is motivated by Chart 1, which shows Transport Canada's estimates of MFP in several transportation subsectors between 1986 and 2013. One sees that productivity growth was actually fairly strong in air and rail, but productivity in urban transit has fallen significantly. Each of these sectors is quite distinct and there are likely different stories underlying their diverging performance. In order to understand the aggregate performance of the transportation sector, it is necessary to carefully examine what has happened within these subsectors.

The objectives of this report are to document recent trends in productivity and related variables in the truck, air, rail, and urban transit systems subsectors,[2] understand the drivers of productivity growth (or lack thereof) in these sectors, and make policy recommendations to support future productivity growth in these subsectors. To meet these objectives, this report uses data from Statistics Canada to understand productivity in the four subsectors, and compares these results to those available from Transport Canada when possible. The assessment of the sources of the productivity trends and the policy recommendations are formed based on an analysis of the data and literature on productivity and transportation

This report builds on an overview conducted by the Conference Board of Canada in 2009 using Transport Canada data up to 2006 and previous research by the Centre for the Study of Living Standards (CSLS) on productivity in the transportation sector (Sharpe and Johnson, 2011; CSLS, 2012). This study extends that of the Conference Board by using data up to the 2013-2015 period depending on data availability.

The report is organized as follows. Section two discusses definitions and data sources used in this report and provides an overview of the transportation and warehousing sector. Sections three, four, five, and six are devoted to the trucking, air, rail and urban transit subsectors respectively. Each of these four sections is organized into three parts: a detailed analysis of productivity data and related economic variables; a discussion of the factors that drove productivity trends in the sector; and policy recommendations. Finally, section 7 concludes.

[2] These subsectors account for about half of total output in transportation and warehousing and about 80 per cent of total output in "transportation" which we define here as the aggregate of water transportation, air, rail, urban transit, pipelines, and trucking. We briefly present data on several other transportation subsectors but do not evaluate them in depth. This report does not provide an in-depth analysis of productivity trends in the water transportation subsector as this subsector is of minimal importance in the transportation and warehousing sector (only 2.6 per cent of the transportation and warehousing sector GDP is attributable to water transportation). However, data on this subsector are provided in the CSLS transportation database accompanying this report.

Section 2: Productivity Measurement in the Transportation Sector: Definitions and Methodologies

Before exploring productivity trends within specific transportation subsectors, it is important to have some background information on the transportation sector and what productivity statistics measure in the context of this sector. This section is split into four parts. The first part provides a short overview of productivity. The second describes distinctive features of the transportation and warehousing sector, defines the four subsectors this report focuses on, and provides a brief discussion of the economic performance of the sector as well as an international comparison. The third part describes several challenges to productivity measurement specific to the transportation sector. The fourth part summarizes the major variables considered in this report and their sources.

A. What is Productivity[3]

Productivity can be defined as the ratio of output to input. While this is a very simple definition, there are many different productivity measures because there are many ways to quantify output and input. The appropriate measure depends upon the specific purpose which it is being used for. The remainder of this subsection will discuss several topics relevant for productivity analysis including the types of productivity measures which will be considered in this report and the major motivations for measuring productivity.

i. Partial vs Total Measures of Productivity

This report will consider both partial and total measures of productivity. The distinction lies in which inputs are considered. Partial productivity measures are a ratio of output to a single input. The input can be labour, capital, fuel, etc. For example, labour productivity in an industry is often defined as output in that industry divided by the number of hours worked in the industry. It is also common to use employees or jobs as the measure of labour input. Using hours has the advantage of controlling for the share of jobs which are full-time or the amount of overtime being worked. Similarly, capital productivity is defined as output divided by the capital stock (or capital services).

Partial productivity measures have the advantage that they are simple to calculate and easy to understand. However, partial productivity measures do not control for changes in other inputs so that changes in partial productivity reflect the influences of changes in the use of other inputs in addition to other factors of interest which impact productivity. If labour productivity rises, it could be the result of increased use of capital, intermediate inputs, or fuel. Consequently, labour productivity is not a great measure of technical change.

Multifactor productivity (MFP, also referred to as total factor productivity or TFP) is an alternative productivity measure. MFP is the ratio of output to a combined measure of all inputs in production. Thus MFP growth represents a residual, the growth in outputs beyond what can be

---

[3] This section draws upon an overview of productivity presented in Sharpe and de Avillez (2012)

explained by growth in inputs assuming constant returns to scale. Although economists like to interpret MFP growth as technical change, MFP growth may be due to capacity utilization, increasing returns to scale, and measurement error, among other factors.

Multifactor productivity has the advantage of being a more comprehensive measure of productivity than partial productivity measures. However, MFP growth is still an imperfect measure of technical change and MFP is considerably more complicated, requiring assumptions as to how inputs should be aggregated. This is typically done using factor costs as weights.

ii. Physical vs Revenue Based Measures

A measure of output is also needed to calculate productivity. In all but the simplest cases, economists are concerned with multiple types of output which need to be aggregated. The standard approach is to add the dollar values of outputs. Theoretically, prices should indicate the relative importance of different types of output, so this is generally considered a reasonable approach. However, it is complicated by the fact that relative prices of outputs change through time. Economists interested in technical change usually do not want their productivity measure to include price changes, so index number techniques are used in order to construct measures of "real" output.

The transportation sector is somewhat unusual in that the major outputs can all be measured in common physical units rather than dollars. For example, freight can be measured in tonne-miles regardless of the type of freight. It is not uncommon for productivity to be quantified in terms of units of physical output in this industry. This makes a lot of sense if researchers are interested in trying to measure technical change in the industry. On the other hand, it may be more sensible to use revenue (dollar) based measures if one is interested in weighting types of cargo by their relative values or comparing transportation to other sectors of the economy.

Statistical analysis in this report focuses on revenue-based output measures, although physical output measures are mentioned from time to time in reference to the literature.

iii. Gross Output Productivity vs Value Added Productivity

Two major types of revenue-based output measures are discussed in this report: gross output and value added.

Gross output consists of all goods and services produced by an economy, sector, industry or establishment during a certain period of time. Value added (or GDP at basic prices), on the other hand, measures the contribution of primary inputs (labour and capital) to the production process. While gross output refers to the value of an actual physical quantity, there is no physical representation of value added. The key difference between value added and gross output is that gross output includes the contribution of intermediate inputs while value added does not.[4]

When dealing with the economy as a whole, the value added approach is the natural choice, because it avoids double counting of intermediate inputs in the aggregate output. In practice, the value added approach is also the standard choice of most sectoral productivity analysis. Trueblood and Ruttan (1992) argue, however, that when investigating the productivity performance of a particular sector, the focus should be on the total input-output relationship in order to evaluate the overall gains in both primary and intermediate input use. This is particularly true in the case of sectors that experienced significant shifts in the use of inputs through time, such as the primary agriculture sector, where intermediate inputs (feed, fertilizers, pesticides, etc.) play a much more prominent role nowadays than they did in the past. While we discuss both gross output and value added in each subsector, we focus our attention on value-added productivity measures.

iv. Growth vs Levels

Productivity can be expressed either in growth rates or in levels. The economics literature largely focuses on productivity *growth rates*, which typically refer to changes in *real* variables (as opposed to *nominal* variables), e.g. value added labour productivity growth represents the increase of real GDP per hour worked over time; gross output MFP growth measures the increase of real gross output per unit of aggregate labour, capital, and intermediate inputs.

In this report, however, we are also interested in making *level* comparisons. Productivity level comparisons are often done in current dollars (i.e., using nominal output), as these estimates capture relative prices at the time of comparison, whereas estimates in *constant dollars* may not. However, when real output is calculated using *chained dollars*,[5] changes in relative prices are also incorporated in the estimate, and goods and services which experienced relative price increases receive higher weights than goods and services that experienced price decreases.

Productivity level discussions in this report focus on real levels instead of nominal levels for consistency, i.e. since growth rates are calculated based on real output, having real productivity levels produces a consistent set of estimates. The real output measures used in the report are based on chained dollars, thus the impact of shifts in relative prices is considered. Nominal productivity levels are also discussed whenever they might provide additional insights. Regardless of whether nominal or real GDP figures are used for interprovincial productivity

[4] Diewert (2015) derives a simple formula showing how value added and gross output measures of TFP growth are related. Generally, gross output TFP growth is magnified in a value added framework. The magnification factor is approximately equal to the reciprocal of the share of primary inputs in total input use. See Calver (2015) for an empirical illustration of this relationship.

[5] Constant dollar and chained dollar measures are calculated using fixed-base quantity indexes and chained quantity indexes, respectively. As the name implies, a fixed-base index has a fixed base period, which is used as a basis of comparison with all the other periods. A chained index, on the other hand, has no fixed base period, but rather takes into account data from two successive periods. For a detailed discussion on this issue, see Appendix A in Sharpe and de Avillez (2010).

level comparisons, it is important to note that these comparisons should be used with caution, due not only to differences in industry composition between provinces, but also due to the lack of industry purchasing power parity (PPP) estimates at the provincial level.

v. Transport Canada's TFP Measures

In addition to official data publicly available from Statistics Canada on the transportation sector, this report uses Transport Canada's internally produced estimates of TFP. This subsection provides a general overview of the methodology employed by Transport Canada in constructing these estimates. Additional industry-specific details are presented in the appendix. The discussion is based primarily upon the description provided in Gregory (2012), which specifically focused on the air transportation sector.

We also draw upon information from the appendix of Iacobacci and Schulman (2009) and communications with Transport Canada officials.

Transport Canada has provided TFP estimates for four transportation subsectors: trucking, air, rail (split into passenger rail and freight rail), and public transit. In most cases, annual data are available from 1981 to 2013, although the series for passenger rail and public transit only begin in 1986 and the trucking series ends in 2008 (see Table 1).

Table 1: Availability of Transport Canada TFP Estimates

Subsector	Time Period
Trucking	1981-2008
Air	1981-2013
Rail (Passenger)	1986-2013
Rail (Freight)	1981-2013
Public Transit	1986-2013

The TFP indices are constructed by comparing growth in output to growth in inputs in each transportation sector. This requires both an index of output and an index of inputs for each sector.

Aggregate Output

Transport Canada constructs indirect volume indices of output for each transportation subsector. These indirect indices of aggregate output are generated by constructing corresponding aggregate price indices and then using these to deflate the nominal values of total revenues in each transportation subsector.

An aggregate price index is constructed in a few simple steps. First, prices are calculated for each category of output. The categories considered vary from sector to sector (see appendix). In some cases (such as air transportation) this involves standardizing prices to reflect stage lengths. This standardization is necessary due to high fixed costs regardless of the length of the trip.[6]

Once the set of prices in the industry is established, the prices are aggregated into an index using a standard Tornqvist aggregation method along the lines of that proposed by Caves, Christensen, and Diewert (1982). Essentially, an average price increase in the industry from one year to the next is calculated where price growth in each category is weighted by that category's share in total revenues. The share of total revenues is calculated simply as the average of revenue shares at the beginning and the end of the time period under consideration.

More formally, the aggregate price change for the industry between time t-1 and t, P_t^i, is calculated as

$$P_t^i = \sum_c r_t^{ic} * \left(lnP_t^{ic} - lnP_{t-1}^{ic}\right),$$

where P_t^{ic} is the (standardized) price for output category c of industry i at time t and r_t^{ic} is the average share of category c in total industry revenues between periods t-1 and t,

$$r_t^{ic} = \frac{1}{2} * \left[\frac{R_{t-1}^{ic}}{\sum_d R_{t-1}^{id}} + \frac{R_t^{ic}}{\sum_d R_t^{id}}\right],$$

where R_t^{id} denotes revenues for category d of industry i at time t.

This aggregation is performed for each pair of consecutive years over the period for which the time series is being constructed. The output price index for the industry over the entire period, I_t^{pi}, is created by choosing a price level in some base year (the first year) and subsequently applying the annual growth rates from the aggregation.[7]

$$I_t^{pi} = e^{P_t^i} * I_{t-1}^{pi}$$

Finally, nominal revenues are deflated by this price index to obtain a measure of output.

Inputs

Several types of inputs are considered. These generally include labour, capital, fuel / energy, and other intermediates. We briefly discuss the procedure for obtaining volume indices for each input. Generally, the input quantity indices are constructed using a Tornqvist index similar to that described for output prices. However, the input quantity indices are constructed directly instead of calculating a price index and using it to deflate nominal revenues.

[6] In air transport, for example, the standardization entails multiplying the raw price by the square root of the ratio of the observed stage length within the category to the average stage length for that category.

[7] This is referred to as "chaining"

Labour

Labour input is measured by the number of employees. Growth rates of several different types of employment are weighted by their corresponding shares in total wages to construct a labour quantity index using a Tornqvist style approach. The procedure looks very similar to that used to construct the output price index.

First, L_t^i, the aggregate employment change for the industry between time t-1 and t, is calculated as:

$$L_t^i = \sum_c lc_t^{ic} * \left(lnL_t^{ic} - lnL_{t-1}^{ic} \right),$$

L_t^{ic} is the employment in labour category c of industry i at time t and lc_t^{ic} is the average share of category c in total industry revenues between periods t-1 and t:

$$lc_t^{ic} = \frac{1}{2} * \left[\frac{LC_{t-1}^{ic}}{\sum_d LC_{t-1}^{id}} + \frac{LC_t^{ic}}{\sum_d LC_t^{id}} \right],$$

where C_t^{id} denotes revenues for category d of industry i at time t.

Then these year-over-year employment changes are chained to employment in a base year to obtain an employment index, I_t^{Li}, over the entire period:

$$I_t^{Li} = e^{L_t^i} * I_{t-1}^{Li}$$

Energy

Sometimes several different types of fuel are used. Rather than performing a Tornqvist aggregation, the quantities of fuel are simply converted into equivalent energy measured in (tera- or peta-) joules. Since these are readily comparable, an index is created by normalizing the energy requirements through time relative to a base year which is set equal to 100.

Capital

In all transportation subsectors, the capital stock owned by the subsector is calculated using a perpetual inventory approach. Land assets are separated from total capital assets by applying the average ratio of land to total assets to the gross value of total assets. The difference between the land value estimated in one year and the land value estimated in the next is assumed to be equal to the amount of expenditure on land in the year. This amount is deflated by a land price index.

The value of land is subtracted from net operating assets in order to obtain a value for the remainder of the capital stock. Capital price indices are derived by taking the ratio between current and constant dollar estimates for capital in the industry. Real investment (net of depreciation) is estimated by taking the difference between assets in the current and previous years and deflating by the capital price index.

The stock of assets in a base year is estimated by applying the capital price deflator in the base year to the book value of assets in that year.[8] Net investment rates are then applied to the base year capital stock to obtain a time series.

In several sectors, leased capital which is not owned by the industry also needs to be calculated. This is done by applying a rental price index to rental expenditures. The rental price index is constructed from two price indices, one for the type of capital being rented and another for the price of the funds used for the leasing.

The owned and leased capital indices are aggregated using a Tornqvist index in the same manner as for labour.

Intermediates

This category includes all inputs which are used besides capital, labour, and fuel. The nominal values of the various classes of intermediate inputs have been deflated using corresponding price indices.

Aggregate Inputs

The indexes for each input described above are aggregated using a Tornqvist quantity index approach. In particular,X_t^i, the aggregate price change for the industry between time t-1 and t, is calculated as:

$$X_t^i = \sum_c c_t^{ic} * (lnX_t^{ic} - lnX_{t-1}^{ic})$$

where X_t^{ic} is the quantity for input c of industry i at time t and s_t^{ic} is the average share of category c in total industry costs between periods t-1 and t:

[8] This may strike the reader as circular – constant dollar stocks were used to construct the price index which is now be applied to the book value of assets in order to obtain an estimate of the capital stock. The key is that the original capital stock estimate was from Statistics Canada while the price index and investment rates are being applied to the observed book value in the base year. Officials from Transport Canada have informed us that this is done because the book value in a given year is viewed as a more reliable anchor for the level than the Statistics Canada capital stock which has been derived over time.

$$c_t^{ic} = \frac{1}{2} * \left[\frac{C_{t-1}^{ic}}{\sum_d C_{t-1}^{id}} + \frac{C_t^{ic}}{\sum_d C_t^{id}} \right]$$

where C_t^{id} denotes costs for category d of industry i at time t.

$$I_t^{xi} = e^{X_t^i} * I_{t-1}^{xi}$$

Total Factor Productivity

The TFP index is calculated by dividing the aggregate output quantity index by the aggregate input index. Note that this is a gross-output based TFP measure, as it considers all output produced by the sector (not just value added) and includes intermediate inputs.

vi. Growth Accounting

There are many factors which impact labour productivity. Growth accounting is a standard approach in the economic literature to estimating the contributions of input growth and MFP growth to labour productivity growth. This approach is used to evaluate the sources of labour productivity trends observed in this report.

The standard neo-classical framework assumes a production function F(.) that combines inputs and transforms them into output (Y). In a value-added framework, inputs include labour (L) and capital (K), such that:

$$Y_t = A_t F(L_t, K_t) \qquad (1)$$

where *A* represents multifactor productivity and *t* is a time subscript. Labour input *L* can be decomposed into hours worked (*H*) and labour quality (*QL*):

$$L_t = H_t * QL_t; \qquad (2)$$

and capital intensity (*KI*) can be defined as:

$$KI_t = \frac{K_t}{H_t} \qquad (3)$$

A common functional form for F(.) used in growth accounting exercises[9] is the Cobb-Douglas form, such that equation (1) becomes:

$$Y_t = A_t L_t^{\alpha} K_t^{\beta} \quad (4)$$

where the coefficients α and β indicate the output elasticity with respect to labour and capital, respectively.[10]

Since labour productivity is output per hour worked, we divide both sides of (4) by *H*:

$$\frac{Y_t}{H_t} = \frac{A_t L_t^{\alpha} K_t^{\beta} C_t^{\gamma}}{H_t} = \frac{A_t (H_t * QL_t)_t^{\alpha} K_t^{\beta}}{H_t} = A_t QL_t^{\alpha} * \left(\frac{K_t}{H_t}\right)^{\beta} = A_t QL_t^{\alpha} KI_t^{\beta} \quad (5)$$

Assuming constant returns to scale (such that $\alpha + \beta = 1$) and taking the natural logarithms of both sides of equation (5), we have that:

$$lp_t = (y_t - h_t) = a_t + \alpha\, ql_t + \beta(k_t - h_t) \quad (6)$$

where lower case letters denote the natural logarithm of the original variable (e.g. *y=lnY*) and lp_t denotes the natural logarithm of labour productivity. Thus, labour productivity growth from period *t-1* to period *t* can be approximated as:

$$\Delta lp = \Delta(y - h) = \Delta a + \alpha\, \Delta ql + \beta \Delta(k - h) \quad (7)$$

where Δ indicates the change in the variables between periods *t* and *t-1*.

Equation (7) decomposes labour productivity growth into three components: 1) multifactor productivity growth; 2) labour composition growth (weighted by the coefficient α and 3) capital input growth that exceeds hours worked growth (weighted by the coefficient β). It is clear, therefore, that what matters for productivity growth is not capital input growth *per se*, but capital input growth in excess of hours worked growth. In other words, what matters for labour productivity growth is *capital intensity* growth. Increased capital intensity indicates *capital deepening*, i.e. workers have more capital to work with.

[9] The standard growth accounting framework applies more generally to any production function exhibiting constant returns to scale under the assumption of perfect competition, but is often illustrated using the Cobb-Douglas functional form for mathematical simplicity.

[10] The output elasticity with respect to a certain input measures the per cent change in output given a one per cent change in that particular input. In other words: how much does output increase if we increase the use of a particular input by one per cent? Intuitively, the coefficients α and β reflect the importance of each input in the production process. We assume that $\alpha + \beta = 1$.

If we assume, additionally, that factor and product markets are perfectly competitive, the coefficients α and β become equal to the (nominal) compensation shares of labour and capital (respectively) in output.

Growth accounting can also be performed under a gross-output based framework. The procedure looks very similar, but an additional class of inputs, intermediates, must be added to the production function.

vii. Why Measure Productivity?

The OECD (2001) highlights five objectives of productivity measurement:

- Measuring *technical change* – In economics, a production technique can be understood as a particular way of combining inputs (labour, capital, intermediate inputs, etc.) and transforming them into output. Technological improvements allow more output to be produced from a given amount of input (greater productivity). Technical change can be either disembodied (e.g. new organizational techniques) or embodied (e.g. better quality capital goods). Economists often try to capture the effects of technical change in the economy or in an industry by using some measure of multifactor productivity (MFP). It is important to emphasize, however, that the relationship between technical change and MFP is *not* straightforward. First, not all the effects of technical change are captured by MFP. If inputs are quality adjusted, for instance, MFP will not capture embodied technical change, only disembodied technical change. Second, MFP captures a variety of effects, not only technical change – thus, it is a mistake to attribute the entirety of MFP growth to technical change.

- Measuring *efficiency improvements* – From an engineering perspective, a production process is efficient if, **for a given technology**, it uses the least amount of inputs to produce one unit of output (or alternatively, if it produces the maximum amount of output for a given quantity of inputs). From an economist's perspective, however, allocative efficiency should also be taken into account, i.e. resources should be allocated across tasks / firms / industries / etc. in an optimal manner. As an example of allocative efficiency, the OECD (2001:11) notes that: "(…) when productivity measurement concerns the industry level, efficiency gains can either be due to improved efficiency in individual establishments that make up the industry or to a shift of production towards more efficient establishments". Productivity is a broader concept than efficiency in that it captures both efficiency given technology and the level of technology

- Measuring *real cost savings* – Closely related to the two objectives discussed above, understanding productivity matters because higher productivity allows firms to produce a given amount of output using less input, which implies, *ceteris paribus*, lower costs. In other words, productivity improvements generate real cost savings. Measuring productivity is an important step toward understanding and achieving productivity improvements.

- Measuring *improvements in living standards* – Productivity is linked to living standards via two channels: 1) Value added labour productivity has a direct link to GDP per capita,[11] which is a commonly used measure of living standards; 2) Long-term value added MFP growth can be used to evaluate the evolution of an economy's potential output.

- *Benchmarking* production processes – At the firm level, productivity measures can be used to identify distortions and inefficiencies across production units. Such measures are often expressed in physical units, e.g. a car company could compare the productivity of two (similar) factories by looking at the number of cars produced per day by each of the factories.

B. Overview of the Transportation and Warehousing Sector

For the purposes of this report, the transportation and warehousing sector is defined by the 2012 North American Industry Classification System (NAICS), as this the main classification Statistics Canada uses in disseminating data on economic performance at the industry level. The sector consists of NAICS sectors 48 and 49 and is defined as follows:

48-49 - Transportation and warehousing[12]

This sector comprises establishments primarily engaged in transporting passengers and goods, warehousing and storing goods, and providing services to these establishments. The modes of transportation are road (trucking, transit and ground passenger), rail, water, air and pipeline. These are further subdivided according to the way in which businesses in each mode organize their establishments. National post office and courier establishments, which also transport goods, are included in this sector. Warehousing and storage establishments are subdivided according to the type of service and facility that is operated.

i. Distinguishing Characteristics

There are several important features which characterize much of the transportation and warehousing sector and impact its economic performance:

Large Fixed Costs – Virtually all modes of transportation in the sector require very large fixed investments. Road, rail, and pipelines require the construction and maintenance of a vast stationary system of connections spanning the entire distance between the origin and destination. Road, rail, air, and ground transportation require vehicles capable of containing everything being

---

[11] Real GDP per capita is, by definition, equal to value added labour productivity multiplied by labour input
[12] Source: Details of the NAICS classification structure are available at:
http://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVDPage1&db=imdb&dis=2&adm=8&TVD=118464

transported. Large facilities are required to store vehicles and load and unload freight and passengers.

Limited Competition – The large fixed costs serve as a significant barrier to entry. Significant economies of scale have resulted in many subsectors of the transportation becoming oligopolistic. This is especially true of air, rail, and urban transit systems. Trucking and ground passenger transportation are much more competitive.

High Degree of Government Intervention – Government has historically been very involved in providing transportation infrastructure and regulating the transportation sector. Given the large expenditures required and its public good nature, government provision of transportation infrastructure may be justified. Environmental, security, and safety concerns which the private sector would be unlikely to fully internalize require considerable regulation. Transportation subsectors where competition is limited and the willingness of firms to provide adequate levels of service at reasonable prices have also been highly regulated historically, with government sometimes opting to provide services directly. There has been considerable privatization and deregulation in this sector since the 1980s.

Network Structure – Most transportation subsectors consist of a network of links (roads, tracks, routes) connecting a series of hubs or distribution centres (airports, depots, ports, etc.). The structure and design of the network can have important implications for the efficient choice of routes and timing of arrivals and departures.

Importance of Fuel as an Input – Almost all transportation services require fuel (gasoline or diesel). This makes the economics of the sector very sensitive to fluctuations in energy prices. It also means that concerns regarding greenhouse gas emissions are especially relevant for this sector.

ii. Economic Importance

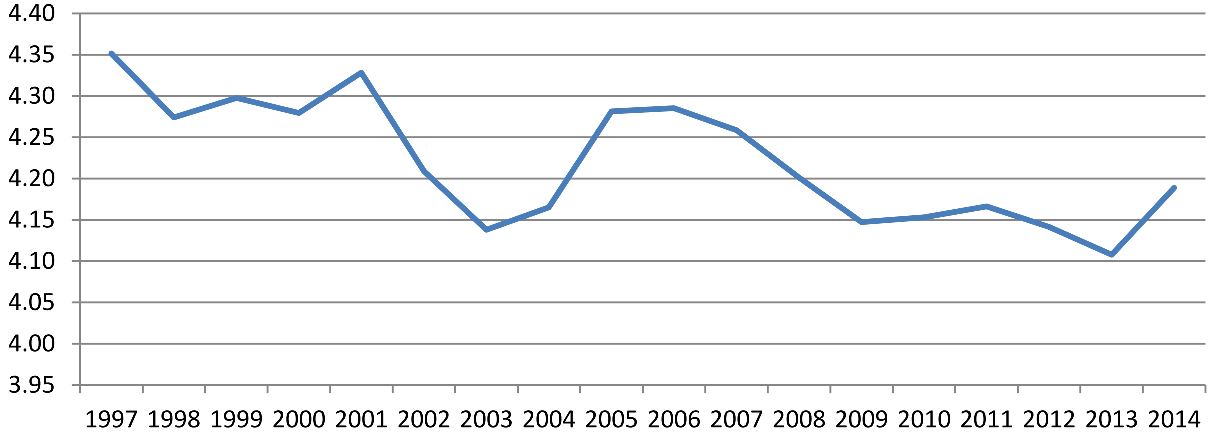
The transportation sector plays an important role in moving people and goods from one place to another. A large part of the total demand for transportation services represents a derived demand for freight. An efficient transportation system is critical to keeping the costs of goods and travel low for Canadian consumers and maintaining international competitiveness for Canadian exporters.

Transportation and warehousing generated 4.19 per cent of Canada's GDP in 2014 (Chart 2).[13] The relative importance of the sector in the Canadian economy has fallen slightly since 1997 when it was about 4.35 per cent. The importance of the sector has been reasonably stable over the period, but declined slightly in the aftermath of the 2001 and 2008 crises and recessions in the United States, which probably reflect temporary reductions in international trade. It is

[13] Based upon 2007 chained dollars. Nominal GDP is preferable for comparing a sector's share of output in GDP over time, but we use real GDP because the nominal GDP series only extends to 2011. Nominal GDP indicates a more consistent and pronounced decline from 4.65 per cent in 1997 to 4.12 per cent in 2011.

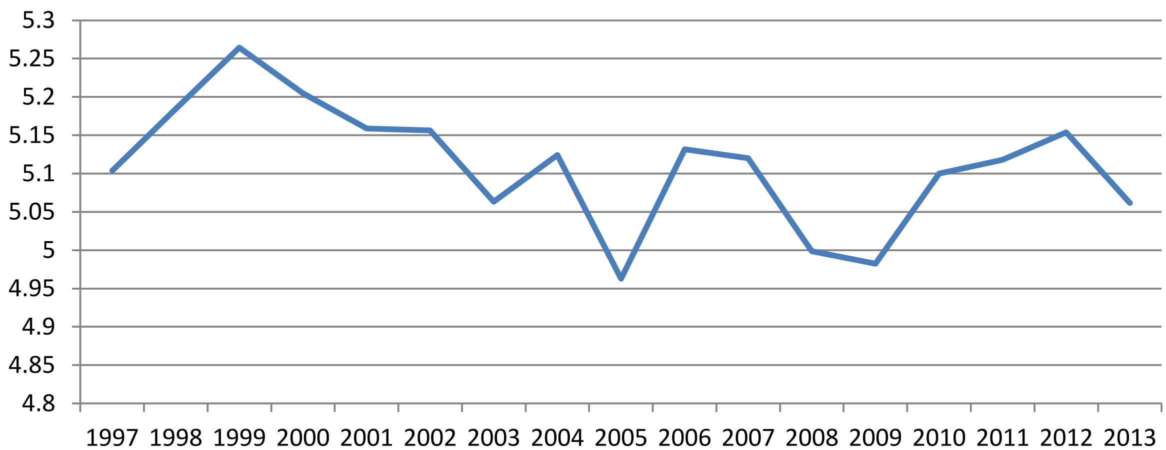
perhaps a little troubling that the sector has not recovered since 2008, however there is little evidence of a steep decline which would be cause for alarm.

Chart 2: Transportation and Warehousing as a Percentage of Total Economy Real GDP, Canada, 1997-2014



Source: Statistics Canada Cansim Table 379-0031. Based on Input-Output Accounts.

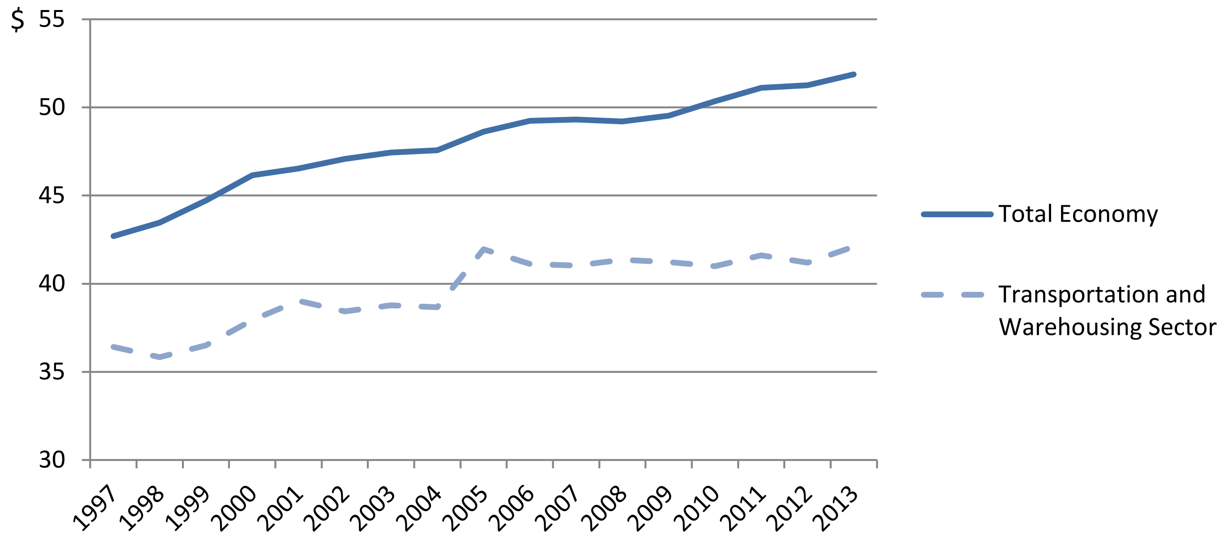
Chart 3: Transportation and Warehousing as a Percentage of Total Economy Hours Worked, Canada, 1997-2013



Source: Cansim Table 383-0031

Similarly, Chart 3 shows how the transportation and warehousing sector's share of total hours worked has changed from 1997-2013. Transportation and warehousing has almost the same share in hours worked in 2013 (5.06 per cent) as it had in 1997 (5.10 per cent). Perhaps the more interesting feature of this chart is that the sector's share of total employment is quite a bit larger than the sector's share of total output. This implies that the sector has a below average level of (real) labour productivity, which can be seen in Chart 4. Labour productivity in the sector was about $42 (2007 chained dollars) per hour in 2013 compared to $52 in the total economy. Moreover, although it is difficult to see directly in Chart 4, productivity growth has been relatively slow in transportation and warehousing, growing at an annual pace of 0.91 per cent over the 1997-2013 period, below the 1.22 per cent growth rate for the total economy.

Chart 4: Real Labour Productivity in Transportation and Warehousing and Total Economy, Canada, 2007 Chained Dollars per Hour, 1997-2013



Source: Calculated by CSLS with data from Statistics Canada Cansim Table 379-0031 383-0031. Based on Input-Output Accounts.

Table 2: Output and Employment in the Transportation and Warehousing Sector in the Canadian Provinces, 2013/14

Province	Transportation and Warehousing as a Share of GDP, 2014	Transportation and Warehousing as a Share of Hours Worked, 2013	Provincial Share of GDP in Transportation and Warehousing, 2014	Provincial Share of Hours Worked in Transportation and Warehousing, 2013	Growth Rate of GDP in Transportation and Warehousing, 1997-2014	Growth Rate of Hours Worked in Transportation and Warehousing, 1997-2013
Canada	4.19	5.06	100.00	100.00	2.30	1.25
Newfoundland and Labrador	2.51	4.18	0.99	1.11	0.92	0.26
Prince Edward Island	2.63	3.61	0.18	0.30	0.03	0.94
Nova Scotia	3.17	3.95	1.55	2.01	0.64	-0.78
New Brunswick	4.75	5.55	1.80	2.24	0.74	-0.99
Quebec	3.99	4.82	18.12	20.27	1.74	0.67
Ontario	3.80	4.72	33.27	36.15	2.12	2.00
Manitoba	6.38	6.76	4.92	4.86	2.06	-0.51
Saskatchewan	4.82	5.67	4.22	3.75	2.41	0.82
Alberta	3.93	5.20	17.50	13.84	3.72	2.20
British Columbia	5.49	5.99	16.29	15.03	2.26	1.15

Source: Statistics Canada Cansim Tables 379-0030, 379-0031, and 383-0031.

Table 2 presents information on the relative size of the transportation sector within each province and the distribution of hours worked and output in the sector across the provinces in 2014 (2013 for hours). The first two columns show that transportation and warehousing is a relatively large source of hours and output in Manitoba, British Columbia, New Brunswick and Saskatchewan when compared to the rest of Canada. The sector is not as large in the Atlantic provinces of Prince Edward Island, Nova Scotia, and Newfoundland and Labrador. The third and fourth columns show that about 85 per cent of both hours and output in the sector is concentrated in four provinces: Quebec, Ontario, Alberta, and British Columbia. This is more or less proportional to their share of the population (about 86 per cent).

The final two columns are indicative of how the sector has grown across the country between 1997 and 2013/14. Both output and hours growth have generally been stronger in the sector in western Canada. All four Atlantic provinces and Quebec exhibited below average growth rates. Growth in the sector has been strongest in Alberta.

What is driving the observed trends in output, hours, and productivity in the sector? Given that the transportation and warehousing sector is composed of several subsectors which have followed significantly different trends, we focus on a few of the major transportation subsectors in order to develop an understanding of what is happening in the sector.

iii. Transportation Subsectors

The transportation and warehousing sector can be broken down into 11 3-digit NAICS subsectors. This report will focus on productivity trends in four of them, specifically:[14]

481 - Air transportation

This subsector comprises establishments primarily engaged in for-hire, common-carrier transportation of people and/or goods using aircraft, such as airplanes and helicopters.

482 - Rail transportation

This subsector comprises establishments primarily engaged in operating railways. Establishments primarily engaged in the operation of long-haul or mainline railways, short-haul railways and passenger railways are included.

484 - Truck transportation

This subsector comprises establishments primarily engaged in the truck transportation of goods. These establishments may carry general freight or specialized freight. Specialized freight comprises goods that, because of size, weight, shape or other inherent characteristics, require specialized equipment for transportation. Establishments may

[14] Definitions from Statistics Canada's NAICS classification: http://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVDPage1&db=imdb&dis=2&adm=8&TVD=118464

operate locally, that is within a metropolitan area and its hinterland, or over long distances, that is between metropolitan areas.

485 - Transit and ground passenger transportation

This subsector comprises establishments primarily engaged in a variety of passenger transportation activities, using equipment designed for those purposes. These activities are distinguished based on process factors, such as whether routes are scheduled, run over fixed routes, and charged on a per-seat or per-vehicle basis.

Within Transit and Ground Passenger Transportation we are especially interested in urban transit systems.

4851 - Urban transit systems

This industry group comprises establishments primarily engaged in operating local and suburban mass passenger transit systems. Such transportation may involve the use of one or more modes of transport including light rail, subways and streetcars, as well as buses. These establishments operate over fixed routes and schedules, and allow passengers to pay on a per-trip basis (whether or not they also accept payment methods such as monthly passes).

Definitions of the remaining subsectors which we do not consider here are available in the appendix. They may be useful for readers interested in determining what is and is not included in the four subsectors of interest.

We also define a "transportation" sector which is an aggregate of the "traditional" modes of large-scale transportation of passengers and freight which is composed of air transportation, rail transportation, truck transportation, urban transit systems, water transportation and pipelines which we reference a few times.

Trucking is the largest subsector of transportation and warehousing with 26 per cent of nominal GDP and 34 per cent of hours worked in the sector. Support activities for transportation is the second largest subsector, followed by transit, ground passenger and scenic and sightseeing transportation. Air and rail are relatively small, each accounting for about 9 per cent of output and 7 and 5 per cent of hours worked respectively. Air transportation has declined somewhat, falling from about 11 per cent of the sector's GDP in 1997 to 8.5 per cent of GDP in 2011, but other shares have been fairly stable since 1997.

Those subsectors which have relatively large shares of output compared to their share of hours worked (pipelines, for example), will have above average labour productivity. Table 5 summarizes nominal GDP, hours worked, and productivity levels for each subsector in 2011. Productivity levels vary widely around the sectoral total of $44.7 per hour. Productivity in pipeline transportation is $570 per hour. Rail transport also has relatively high productivity of

$85.4 per hour. Air, water, and support activities hover in the $50-$55 per hour range. The remaining subsectors all have quite low labour productivity levels of between $30 and $35 per hour.

Table 3: Breakdown of Nominal GDP in the Transportation and Warehousing Sector, Per Cent, 2011

	Millions of Dollars	Per Cent of Transportation	Per Cent of Transportation and Warehousing
Truck transportation*	17,724	39.86	25.82
Support activities for transportation	11,505	..	16.76
Transit*, ground passenger and scenic and sightseeing transportation	8,303	11.94	12.10
Pipeline transportation*	7,289	16.39	10.62
Postal service, courier and messengers	7,158	..	10.43
Rail transportation*	6,530	14.68	9.51
Air transportation*	5,845	13.14	8.52
Warehousing and storage	2,513	..	3.66
Water transportation*	1,773	3.99	2.58
Transportation	**44,469**	**100.00**	**64.79**
Transportation and warehousing	**68,638**	**..**	**100.00**

Source: Statistics Canada Cansim Tables 379-0029.
*Included in the transportation sub-aggregate.

Table 4: Breakdown of Hours Worked in the Transportation and Warehousing Sector, Per Cent, 1997 and 2011

	1997		2011	
	Hours Worked (Thousands)	**Per Cent**	**Hours Worked (Thousands)**	**Per Cent**
Truck transportation	440,171	34.41	530,018	34.50
Transit, ground passenger and scenic and sightseeing transportation	201,435	15.75	268,493	17.48
Support activities for transportation	153,769	12.02	221,377	14.41
Postal service and couriers and messengers	203,618	15.92	210,617	13.71
Air transportation	95,288	7.45	105,853	6.89
Warehousing and storage	51,490	4.03	78,418	5.10
Rail transportation	91,030	7.12	76,469	4.98
Water transportation	28,490	2.23	32,309	2.10
Pipeline transportation	13,777	1.08	12,787	0.83
Transportation and warehousing	1,279,068	100.00	1,536,342	100.00

Source: Statistics Canada Cansim Table 383-0031

Sections 3, 4, 5, and 6 of this report are dedicated to examining productivity trends in the rail, air, trucking, and urban transportation subsectors with the goal of understanding what has happened to productivity since 1997, why, and how policymakers can strengthen transportation productivity going forward.

Table 5: Hours Worked, Nominal GDP, and Labour Productivity by Transportation and Warehousing Subsector, 2011

	Nominal GDP (millions)	Hours Worked (thousands)	Jobs	Productivity ($/hour)	Productivity ($/ job)
Pipeline transportation	7,289	12,787	6,840	570.0	1,065,643
Rail transportation	6,530	76,469	39,820	85.4	163,988
Air transportation	5,845	105,853	64,040	55.2	91,271
Water transportation	1,773	32,309	16,095	54.9	110,158
Support activities for transportation	11,505	221,377	116,995	52.0	98,338
Postal service and couriers and messengers	7,158	210,617	122,910	34.0	58,238
Truck transportation	17,724	530,018	237,945	33.4	74,488
Warehousing and storage	2,513	78,418	42,685	32.0	58,873
Transit, ground passenger and scenic and sightseeing transportation	8,303	268,493	150,500	30.9	55,169
Transportation and warehousing	**68,638**	**1,536,342**	**797,830**	**44.7**	**86,031**

Source: Statistics Canada Cansim Tables 379-0029 and 383-0031.

iv. International Comparison

We consider Canada's performance in the transportation and warehousing sector relative to Mexico and the United States. The data for this comparison were obtained from the North American Transportation Statistics Online Database. All of the data are based upon NAICS industrial classifications which were designed to facilitate comparison between Canada, the United States, and Mexico. Employment data for Mexico are based upon the number of full-time employment positions while the US and Canadian data are based on the number of employees.[15]

The transportation and warehousing sector is more important in Canada than in the United States. The GDP of this sector accounted for 4.2 per cent of the total economy in 2012, where as in the United States it accounted for only 2.9 per cent (Table 6). However, the transportation and warehousing subsector is less important in Canada than in Mexico, where

[15] Further details about the data used from each of the three countries are available at: http://nats.sct.gob.mx/technical-documentation/293-2/td-2-3-employment-in-transportation-and-related-industries-naics-basis/ and http://nats.sct.gob.mx/technical-documentation/technical-documentation-1/td-1-2-gross-domestic-product-by-industry-naics-basis/

transportation and warehousing made up 6.3 per cent of the total economy in 2012. In all three countries, the most important subsector is truck transportation.

Table 6: Gross Domestic Product by Subsector of the Transportation and Warehousing Sector, United States, Mexico, and Canada, Billions of Current U.S. Dollars, 2012

	GDP (billions of current US dollars)			Per Cent of Total Economy		
	U.S.	Mexico	Canada	U.S.	Mexico	Canada
Transportation and Warehousing (48-49)	469.3	71.8	71.4	2.9	6.3	4.2
Air Transportation (481)	77.8	2.1	6.5	0.5	0.2	0.4
Rail Transportation (482)	39.8	2.0	6.6	0.2	0.2	0.4
Water Transportation (483)	14.4	0.8	1.8	0.1	0.1	0.1
Truck Transportation (484)	126.0	34.8	18.4	0.8	3.0	1.1
Transit and Ground Transportation (485)	30.4	23.7	8.3	0.2	2.1	0.5
Pipeline Transportation (486)	24.4	0.6	8.0	0.2	0.1	0.5
Scenic and Sightseeing (487)		0.2		0.0	0.0	0.0
Support Activities (488)	110.2	5.3	12.3	0.7	0.5	0.7
Postal Service, Couriers and Messengers, Warehousing and Storage (491-493)	48.6	0.3	9.7	0.3	0.0	0.6
Total Economy	16,163.2	1,148.2	1,706	100.0	100.0	100.0

Source: North American Transportation Statistics, http://nats.sct.gob.mx/language/en/

Table 7: Employment in Transportation and Related Industries, United States, Mexico, and Canada, Thousands of Employees, 2014

	Employees (thousands)			Per Cent of Total Labour Force		
	U.S.	Mexico	Canada	U.S.	Mexico	Canada
Employed labor force, total	139,042	39,541	15,355	100.00	100.00	100.00
Transportation and Warehousing Sub-Total (48-49)	4,640	2076	730	3.34	5.25	4.75
Transportation (481-488)	3,329	1,985	n.a.	2.39	5.02	n.a.
Air Transportation (481)	442	27	75	0.32	0.07	0.49
Rail Transportation (482)	235	14	41	0.17	0.04	0.27
Water Transportation (483)	67	7	n.a.	0.05	0.02	n.a.
Truck Transportation (484)	1,416	929	193	1.02	2.35	1.26
Transit and Ground Transportation (485)	465	915	122	0.33	2.31	0.79
Pipeline Transportation (486)	47	7	n.a.	0.03	0.02	n.a.
Scenic and Sightseeing (487)	31	12	n.a.	0.02	0.03	n.a.
Support Activities (488)	625	73	115	0.45	0.18	0.75

Source: North American Transportation Statistics, http://nats.sct.gob.mx/language/en/

Similarly, the transportation and warehousing sector employs a higher percentage of the labour force in Canada than in the United States, but less than Mexico. In Canada, 4.75 per cent of the total employed labour force was employed in the transportation and warehousing subsector in 2014. In United States, 3.34 per cent of the total labour force is employed in transportation and warehousing, and 5.25 per cent in Mexico.

Labour productivity for the transportation and warehousing subsector is lower in Canada ($111,104 per worker) than in the United States ($116,247 per worker) but higher than in Mexico ($29,038 per worker) (Table 8).

Table 8: Labour Productivity in Transportation and Related Industries, United States, Mexico and Canada, Current U.S. Dollars per Worker, 2014

	U.S.	Mexico	Canada
Employed labor force, total	116,247	29,038	111,104
Transportation and Warehousing Sub-Total (48-49)	101,142	34,586	97,808
Transportation (481-488)	164,970	30,086	90,782
Air Transportation (481)	176,018	77,778	86,667
Rail Transportation (482)	169,362	142,857	160,976
Water Transportation (483)	214,925	114,286	n.a.
Truck Transportation (484)	88,983	37,460	95,337
Transit and Ground Transportation (485)	65,376	25,902	68,033
Pipeline Transportation (486)	519,149	85,714	n.a.
Scenic and Sightseeing (487)	n.a.	16,667	n.a.
Support Activities (488)	176,320	72,603	106,957

Source: CSLS Calculations using the data in Table 6 and Table 7.

C. Measurement Challenges in the Transportation Sector

This subsection briefly discusses a series of measurement difficulties which are particularly relevant for the transportation and warehousing sector.

i. Classification of Inputs and Outputs

There are several cases in which it is ambiguous how inputs and outputs should be classified in the transportation sector. Decisions regarding classification can impact productivity estimates and add noise to comparisons across jurisdictions and data sources. Major classification challenges include:

Classification by industry – It is sometimes unclear which industry inputs or outputs should be classified under. For example, many retail chains own and operate fleets of trucks which ship product to their stores from distribution centres. Should these trucks (and their drivers) be classified under the trucking subsector or under retail trade? This issue of how to treat own-account transportation services can have a significant impact. NAICS only includes for-hire transportation services in the transportation sector. This means that a significant amount of transportation by truck is not included in data for this sector. Corporate jets are another example of an own account transportation service which may not be classified in the transportation sector. Shifts in transportation activity in or out of for-hire services may have an impact on productivity.

Spatial classification – Most economic activity is associated with a fixed geographic location. Transportation across jurisdictions can create challenges as to where inputs and outputs should be counted. For example, if a plane flies from Toronto to Vancouver, how should output and inputs be allocated across provinces? For employment, the standard approach is to allocate the labour and employment income to where the individual lives. Capital can be more complicated. There are rules determining how rolling stock is divided amongst jurisdictions. Measurement of profits can also be challenging.

Ownership of capital inputs – It is quite common for firms in the transportation sector to not own some of the capital goods which they use. Leasing of vehicles, particularly airplanes, is commonplace and ownership of the capital stock is often by non-transportation sectors. Similarly, many important capital inputs such as highways, airports, and waterways are public goods provided by the government. Ownership outside the transportation sector can lead to an understatement of the importance of capital and biased productivity estimates. Conventional measures of capital inputs frequently only include capital inputs actually owned by the enterprise in constructing capital input series (Meyer and Gómez-Ibáñez, 1980).

ii. Quality

Comparisons of productivity across time and space can be complicated by changes in the quality of the service provided. Faster delivery, increased reliability, greater flexibility, safer, and friendlier service make output more valuable. Physical measures of output such as tonne-miles may not account for changes in quality. In principle, prices rise and fall reflecting the quality of service so that revenue-based approaches can control for quality to some extent. However, the ability of prices to correctly signal the value of outputs can be distorted by regulation and market power.

iii. Regulation

Closely related to the issue of output quality, the aggregation of inputs and outputs is typically performed using market prices as these reflect the values of inputs / outputs. Heavy regulation of transportation subsectors may distort prices, skewing the weightings. For example, Meyer and Gómez-Ibáñez (1980) suggest that profits are unusually low in transportation sectors due to regulation, leading to an underweighting of capital input when constructing productivity measures. Regulation has been significantly reduced in Canada's transportation sector beginning in the 1980s, so this is likely less of a concern than it once had been.

iv. Externalities

The value of outputs in the transportation sector may not be fully reflected in market prices even if there was perfect competition. This is part of the rationale for the high degree of regulation – to help firms internalize costs associated with safety risks and pollution and to encourage provision of services which would not normally be profitable but may be socially desirable. Most productivity measures do not capture these externalities, which may lead to incorrect assessments of productivity from a social welfare perspective.

v. Separating Line-Haul Operations from Terminal Services

Most transportation subsectors involve two distinct activities: the loading and unloading of goods and services (terminal services) and the actual transportation from one location to another (line-haul operations). This can create significant challenges for physical productivity measures. The cost of terminal services is largely determined by the number of passengers or shipments and the total weight/size of the objects being processed. On the other hand, the cost of line-haul operations is largely determined by the distance traveled and, to a lesser extent, by size and weight. This is problematic because the ideal physical measures for these two activities do not entirely coincide. Weighting physical productivity measures to obtain an overall physical productivity measure is difficult. Most pricing schemes bundle terminal and line-haul services, so using market prices as weights is problematic even in the absence of regulation (Meyer and Gómez-Ibáñez, 1980). This is not a significant problem when using revenue based output measures.

D. Data Sources

The major variables used throughout this report are listed in

Table 9. They include several measures of total output (nominal GDP, real GDP, and nominal gross output), data on labour (jobs[16] and hours) and capital inputs (investment, depreciation rate, and capital stock), and total factor productivity estimates from Transport Canada. Transport Canada has also provided underlying data on input and output quantities and prices. Our analysis employs the data from Statistics Canada because it generally has greater coverage in terms of both time and the share of the industry included in the data,[17] but we use the Transport Canada estimates for comparison where possible.[18] We will focus on the 1997-2014 time period as it is spanned by most of our time series. Several series are available much earlier, going back to about

[16] Most of the data on employment from Statistics Canada used in this report is based on the number of jobs rather than the number of workers. These concepts differ somewhat in that a worker may hold more than one job. In practice, the number of jobs and number of workers should not be all that different and are expected to follow similar trends. While we have endeavoured to make it clear in tables and charts when we are referring to jobs, the two terms are used interchangeably in the text.

[17] The Transport Canada data is based on the major firms in each sector, but often excludes smaller ones. For example, the freight rail data is only for the two Class I railways, CN and CP. The Statistics Canada data also includes smaller operations.

[18] Appendix B includes a table which compares the Transport Canada and Statistics Canada data on the major variables. For the most part a similar story emerges, although in some cases there are notable discrepancies between the two data sources.

1980 or sometimes 1961, but we focus on the post 1997 period which represents relatively recent trends.

Table 9: Major Variables Used in this Report and their Sources

Variable	Survey	CANSIM Table	Maximum Time Period Available
Nominal GDP	Input-Output Structure of the Canadian Economy in Current Prices - 1401	379-0023, 379-0029	1961-2011
Real GDP (national)	Gross Domestic Product by Industry - National (Monthly) - 1301	379-0031	1997-2015
Real GDP (provincial)	Gross Domestic Product by Industry - Provincial and Territorial (Annual) - 1303	379-0030	1997-2014
Investment	Flows and Stocks of Fixed Non-residential Capital - 2820	031-0002, 031-0003	1961-2013
Capital Stock	Flows and Stocks of Fixed Non-residential Capital - 2820; Transport Canada's Productivity Database	031-0002, 031-0003	1961-2013
Depreciation Rate	Flows and Stocks of Fixed Non-residential Capital - 2820	031-0002, 031-0003	1961-2013
Hours Worked	Labour Productivity Measures - Provinces and Territories (Annual) - 5103	383-0031	1997-2014
Number of Jobs	Labour Productivity Measures - Provinces and Territories (Annual) - 5103	383-0031	1997-2014
Total Factor Productivity	Transport Canada's Productivity Database	N/A	1981-2013
Nominal Gross Output	Productivity Measures and Related Variables - National and Provincial (Annual) - 1402	383-0032	1961-2011

Box 1: Employment Estimates

Employment data is available from three different sources: Survey of Employment, Payroll and Hours (SEPH), Labour Force Survey (LFS), and Canadian Productivity Accounts (CPA). This report uses the CPA estimates to calculate productivity. The tables below compare employment estimates from the SEPH, LFS and CPA.

Notice that the choice of employment data can sometimes have a significant impact on the estimated labour productivity levels and growth rates. For example, if we had used the LFS instead of the CPA, the labour productivity level would have been about 5 per cent lower in 2014 and the labour productivity growth rate between 2001 and 2014 would have increased by 0.73 percentage points.

Table 10: Employment, LFS, SEPH, CPA, 2001-2014

The Truck Transportation Subsector	2001	2014	2001-2014
SEPH	166.4	192.9	1.14
LFS	257.7	293.9	1.02
CPA	223.6	249.5	0.85

The Air Transportation Subsector	2001	2014	2001-2014
SEPH	62.0	75.3	1.50
LFS	58.1	61.9	0.49
CPA	63.3	66.9	0.43

The Rail Transportation Subsector	2001	2014	2001-2014
SEPH	42.3	40.8	-0.28
LFS	46.2	36.5	-1.80
CPA	42.6	40.2	-0.45

The Urban Transit Systems Subsector	2001	2014	2001-2014
SEPH	37.7	60.9	3.76
LFS	46.4	64.0	2.50
CPA	40.3	60.9	3.23

Note: SEPH and CPA refer to the number of jobs. LFS refers to the number of persons employed.

Section 3: The Trucking Subsector

The truck transportation industry is a key element of the North American economy. As trucking is part of the supply chain of goods production, it influences prices for all commodities. As such, the productivity of the trucking industry should be a concern to all, from producers and suppliers to sellers and, ultimately, to consumers. Part A provides a description of inputs, outputs, and productivity in the truck transportation subsector. These are based on Statistics Canada data, which will be compared to Transport Canada data when possible. Part B will then explain the drivers of productivity in the truck transportation subsector and part C will provide policy recommendations to promote productivity in the trucking industry.

Table 11: Number of Establishments[19] in the Truck Transportation Subsector by Province, December 2014

Province or Territory	Establishments
Ontario	42,616
Quebec	17,245
Alberta	17,106
British Columbia	13,269
Manitoba	4,936
Saskatchewan	4,385
New Brunswick	2,104
Nova Scotia	1,264
Newfoundland and Labrador	563
Prince Edward Island	283
Northwest Territories	45
Yukon Territory	4
Nunavut	6
Canada	103,867

Source: Industry Canada, from Statistics Canada, Canadian Business Patterns Database

Truck transportation (484) is a North American Industry Classification System (NAICS) three-digit subsector of transportation and warehousing (48-49). It pertains to the truck transportation of goods. The NAICS transportation sector includes for-hire services only, which are provided by firms who specialise in offering transportation services for a fee. It does not include own-account transportation services, which are transportation services produced by firms

[19] Statistics Canada established four levels for business surveys: the enterprise, the company, the establishment and the location. The establishment, as a statistical unit, is defined as the most homogeneous unit of production for which the business maintains accounting records from which it is possible to assemble all the data elements required to compile the full structure of the gross value of production, the cost of materials and services, and labour and capital used in production. Generally, the establishment corresponds to a plant, mill or factory. However, the establishments may comprise more than one plant if accounting records do not permit separate reports for each one. An establishment may also include ancillary or support units, such as sales offices or warehouses (from Industry Canada, Canadian Industry Statistics, Glossary of Terms, https://www.ic.gc.ca/eic/site/cis-sic.nsf/eng/h_00005.html).

to support their main activity. These are captured in the output of the industry producing them, rather than under the transportation industry. In 2000, such own-account transportation accounted for 41.7 per cent of total transportation.[20] (Statistics Canada, 2006). Assuming the share of own-account transportation has not changed, the values presented below for the truck transportation subsector account for less than two-thirds of total truck transportation.

In December 2014 (latest available data), there were 103,867 known establishments in Canada in the truck transportation subsector (Table 11). Most of these (78.4 per cent) were micro establishments with only 1 to 4 employees (Table 12).

Table 12: Number of Establishments by Employment Size and Province or Territory in the Truck Transportation Subsector, December 2014

Province or Territory	Employment Size Category (Number of Employees)					
	Micro 1-4	Small 5-99	Medium 100-499	Large 500+	Indeterminate	Total
Ontario	14,270	2,151	84	4	26,107	42,616
Quebec	5,612	1,851	46	1	9,735	17,245
Alberta	5,468	1,821	50	3	9,764	17,106
British Columbia	3,043	1,289	20	0	8,917	13,269
Saskatchewan	1,207	498	13	1	2,666	4,385
Manitoba	1,205	403	17	1	3,310	4,936
New Brunswick	683	254	9	0	1,158	2,104
Nova Scotia	392	181	5	0	686	1,264
Newfoundland and Labrador	198	113	2	0	250	563
Prince Edward Island	75	39	0	0	169	283
Northwest Territories	13	16	1	0	15	45
Yukon Territory	8	8	1	0	28	45
Nunavut	3	2	1	0	0	6
Canada	32,177	8,626	249	10	62,805	103,867
Percent Distribution	30.98%	8.30%	0.24%	0.01%	60.47%	100.00%

Note: Some establishments do not employ any individuals, and in some cases the employment type of an establishment cannot be determined (indeterminate). Non-employers are in effect owner operated and the owners do not pay wages or salaries to themselves as an employee of the company. Even though some establishments do not maintain employee payrolls, they may have work forces, which may consist of contracted workers, part-time employees, family members or business owners.
Source: Industry Canada, from Statistics Canada, Canadian Business Patterns Database

[20] Truck and delivery van services dominate own-account transportation, accounting for nearly 89%. The remaining 11% consists of small proportions of air, rail, water, bus and other ground transportation (Statistics Canada, 2006).

A. Economic and Productivity Performance

i. Output

a. Gross Output

The gross output refers to the total value of sales. In 2010, the latest year for which data are available, the nominal gross output in the truck transportation subsector was $ 41,009 million (Table 3-1 in CSLS Database[21]). The nominal gross output grew an average of 4.41 per cent per year from 2000, when total nominal gross output was $26,626 million. Nominal gross output grew in a similar manner in the transportation and warehousing sector as a whole, where the growth was 4.48 per cent per year for the same period, slightly higher than the 3.81 per cent growth of all industries.

According to Transport Canada data, real gross output has increased an average of 3.3 per cent per year between 2000 and 2008. This growth is slower than the growth of nominal gross output and nominal GDP for the same period provided by Statistics Canada (only nominal gross output is publicly available online from Statistics Canada, not real gross output).

In 2010, intermediate inputs accounted for 61 per cent of nominal gross output in the truck transportation subsector. This share of intermediate inputs increased 3.41 percentage points since 2000. Since 1997, the share of intermediate inputs was highest in 2008 (63 per cent of gross output) and lowest in 1998 (52 per cent of gross output). The largest intermediate input in the truck transportation subsector is diesel fuel. This accounted for 14.1 per cent of gross output in 2011 in nominal terms (Statistics Canada Cansim table 381-0022).[22] Diesel fuel as a share of gross output has increased 2.8 percentage points between 2009 and 2011.[23] Intermediate inputs accounted for less of the gross output in the transportation and warehousing as a whole, where they accounted for 53 per cent of gross output in 2010. In all industries, intermediate inputs accounted for even less of gross output, at 47 per cent in 2010.

b. Nominal GDP

The nominal GDP in the truck transportation subsector, defined as gross output minus intermediate goods, reached $17,724 million in 2011. Part of the large difference with the gross nominal output can be attributed to the cost of fuel as an intermediate good, nominal GDP

[21] The CSLS has put together a complete database for the four modes of transportation examined in this report. The database is available on-line at www.csls.ca/reports/CSLS-2016TransportData.xlsx

[22] Other important intermediate inputs, in order of importance, are: general freight and transportation services (8.8 per cent of gross output), specialized freight truck transportation services (7.4 per cent of gross output), freight transportation arrangement and customs brokering services (4.3 per cent of gross output), and motor vehicle rental and leasing services (1.9 per cent of gross output).

[23] Note that input-output tables are available for 2009-2011, however these are not fully consistent from the gross output table which was terminated in 2010 for truck transportation. This is why the gross output data provided stopped at 2010 but the growth rate of diesel as a share of output is available until 2011.

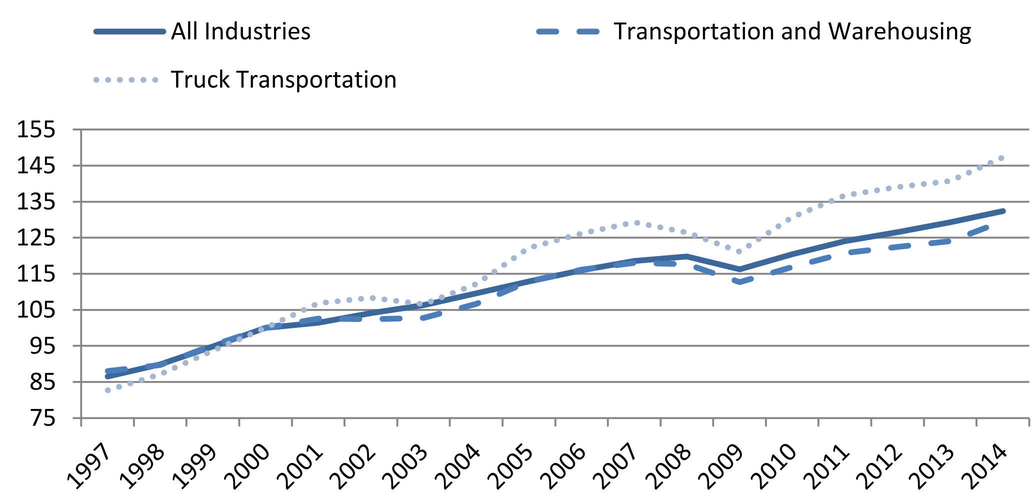
representing the value added. Nominal GDP grew at 4.13 per cent per year between 2000 and 2011 in the trucking subsector (Table 13). In the Transportation and Warehousing sector as a whole, nominal GDP grew slightly slower, at 4.05 per cent per year, where as in all industries it grew slightly faster, at 4.52 per cent per year.

c. Real GDP

Real GDP growth in the truck transportation subsector has been faster than in the transportation and warehousing sector as a whole (Table 13 and Chart 5). From 2000 to 2013, real GDP grew 2.81 per cent per year in the truck transportation subsector, compared to 1.87 per cent per year in the transportation and warehousing sector as a whole. In all industries, real GDP grew by 2.03 per cent per year for the same period.

Note that, over the 2000 to 2011 period, the nominal GDP grew slower in the truck transportation subsector than in all industries, but the real GDP grew faster in the truck transportation subsector than in all industries. This means that the trucking subsector performed better relative to all industries in real terms than in nominal terms. Chart 6 shows that over the 1997 to 2014 period, real GDP as a share of all industries has increased in the truck transportation subsector, whereas nominal GDP as a share of total industries has decreased. The prices for trucking services, which affect nominal output, have fallen because of increased competition within the sector as well as increased productivity. The increased competition is due to changes in regulations which will be discussed in section B. The truck transportation subsector performed better than the transportation and warehousing sector of which it is part both in real and nominal terms.

Chart 5: Real GDP, All Industries, Transportation and Warehousing Sector, and Truck Transportation Subsector, 2000=100, 1997-2014



Source: Calculated by CSLS with data from Statistics Canada Cansim Table 379-0031. Based on Input-Output Accounts.

Table 13: Nominal GDP, Implicit Prices, and Real GDP, All Industries, Transportation and Warehousing Sector, and Truck Transportation Subsector, 1997-2014

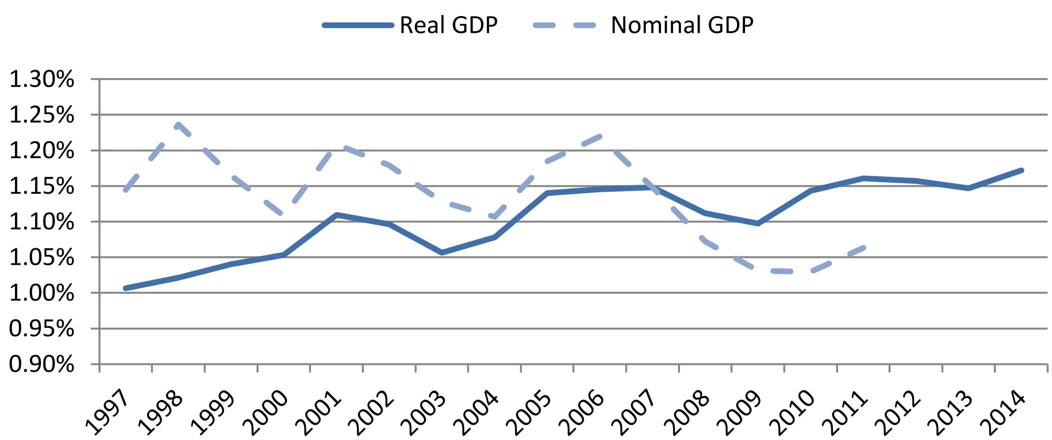
	Nominal GDP (Millions of Current Dollars)			Implicit Price Deflator			Real GDP (Millions of Chained 2007 Dollars)		
	All Industries	Transportation and Warehousing	Truck Transportation	All Industries	Transportation and Warehousing	Truck Transportation	All Industries	Transportation and Warehousing	Truck Transportation
1997	837,260	37,116	9,583	78.23	79.70	88.98	1,070,192	46,569	10,770
1998	867,786	38,969	10,727	78.08	82.04	94.50	1,111,384	47,498	11,352
1999	932,530	41,265	10,860	79.49	81.85	88.98	1,173,088	50,415	12,205
2000	1,025,033	43,318	11,359	82.88	81.84	87.20	1,236,822	52,929	13,026
2001	1,058,086	45,941	12,784	84.36	84.63	91.86	1,254,236	54,286	13,917
2002	1,095,600	47,758	12,921	85.11	88.15	91.54	1,287,248	54,179	14,115
2003	1,157,137	48,401	13,051	88.03	88.99	94.00	1,314,512	54,391	13,884
2004	1,231,468	50,687	13,630	90.87	89.80	93.31	1,355,222	56,443	14,607
2005	1,312,696	55,968	15,550	94.04	93.65	97.72	1,395,920	59,765	15,912
2006	1,388,359	59,719	16,933	96.75	97.12	103.04	1,434,935	61,489	16,434
2007	1,466,692	61,140	16,840	100.00	97.89[1]	100.00	1,466,691	62,458	16,840
2008	1,551,684	62,150	16,638	104.70	99.82	100.97	1,482,081	62,261	16,478
2009	1,473,183	59,576	15,192	102.43	99.88	96.25	1,438,301	59,649	15,783
2010	1,564,105	63,101	16,098	105.03	102.03	94.54	1,489,226	61,847	17,027
2011	1,667,007	67,020	17,724	108.64	104.84	99.50	1,534,440	63,929	17,813
2012	**...**	...	...	...	...	...	1,565,595	64,839	18,116
2013	**...**	...	...	...	...	...	1,598,734	65,667	18,332
2014	**...**	...	...	...	...	...	1,637,656	68,596	19,191
				Compound Average Annual Growth (Per Cent)					
2000-2011	4.52	4.05	4.13	2.49	2.28	1.21	1.98	1.73	2.89
2000-2013	...	...	...	...	...	...	1.99	1.67	2.66
2000-2014	...	...	...	...	...	...	2.03	1.87	2.81

Source: Statistics Canada Cansim Tables 379-0023 and 379-0029 (nominal GDP all industries), 383-0032 (nominal GDP for transportation and warehousing, and truck transportation) and 379-0031 (real GDP). Based on Input-Output Accounts. Implicit price deflator calculated by CSLS. Growth rates from 379-0023 (1997-2008) used to link the GDP from 379-0029(2007-2011) to create a longer time series (the growth rate between two years is applied to a value to obtain an estimate of the value for the previous year).

1. It is unclear why this value is not 100. The 2007 value for nominal GDP should be the same as the real GDP because the real GDP is in 2007 dollars. These values are from Statistics Canada.

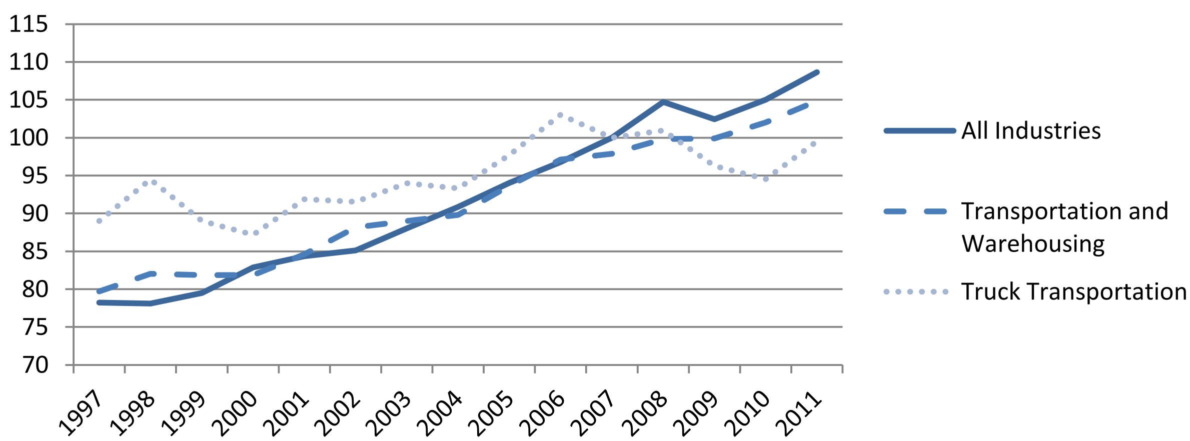
In 2014, truck transportation accounted for 1.17 per cent of the real GDP for all industries. This share has increased since 1997, when it was 1.01 per cent. In contrast, the output of the transportation and warehousing sector as a share of the real GDP of all industries has decreased. This share was 4.35 per cent of real GDP in 1997 and 4.19 per cent in 2014. Without the growth of the trucking subsector, the decline of the output of the transportation and warehousing sector as a share of all industries would have been greater.

Chart 6: Real and Nominal GDP as a Share of Total Industries, Truck Transportation Subsector, 1997-2014



Source: Calculated by CSLS with data from Statistics Canada Cansim Tables 379-0023 and 379-0029 (nominal GDP all industries), 383-0032 (nominal GDP for transportation and warehousing, and truck transportation) and 379-0031 (real GDP). Based on Input-Output Accounts.

Chart 7: Implicit Price Deflator, All Industries, Transportation and Warehousing Sector, and Truck Transportation Subsector, 2007=100, 1997-2011



Source: Calculated by CSLS with data from Statistics Canada Cansim Tables 379-0023 and 379-0029 (nominal GDP for all industries), 383-0032 (nominal GDP for transportation and warehousing and truck transportation) and 379-0031 (real GDP). Based on Input-Output Accounts.

d. Prices

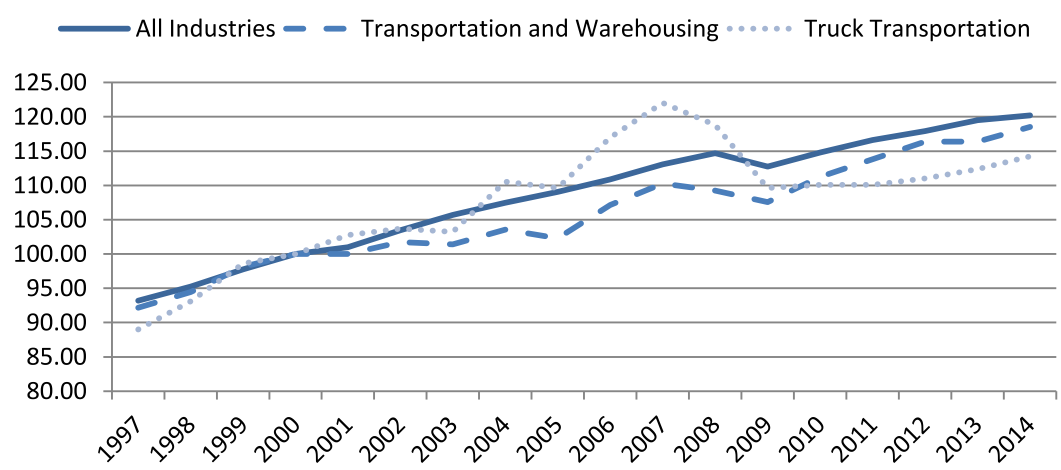
The implicit price deflator, defined as nominal GDP divided by real GDP, increased by 1.21 per cent per year from 2000 to 2011 in the truck transportation subsector (Chart 7). However, between 2006 and 2010 prices fell by an average of 3.2 per cent per year. Because of this, the growth of implicit prices was slower than in the transportation and warehousing sector as a whole, where the implicit price deflator grew by 2.28 per cent per year for the same period, as well as in all industries, where the implicit price deflator grew by 2.49 per cent per year. As mentioned when discussing the real GDP, prices in the trucking subsector fell compared to other industries because of increased competition in the subsector as well as increased productivity.

According to Transport Canada, prices have grown an average of 4.0 per cent per year between 2000 and 2008, which is much faster growth than the growth of the implicit price deflator calculated by CSLS from Statistics Canada data. Part of the difference may be attributable to the fact that the Transport Canada output price index is based on gross output, while the implicit price deflator calculated by the CSLS is based on real GDP (value added).[24]

ii. Inputs

a. Employment

Chart 8: Workers, All Industries, Transportation and Warehousing Sector, and Truck Transportation Subsector, 2000=100, 1997-2014



Source: Calculated by CSLS with data from Statistics Canada Cansim Table 383-0031. Based on Canadian Productivity Accounts.

Based on the Canadian Productivity Accounts, in 2014 4.59 per cent of jobs in all industries worked in transportation and warehousing. Of these, 29.9 per cent worked in the truck

[24] Statistics Canada does not provide a publicly available time series for the real gross output.

transportation subsector (Table 14). Employment in the truck transportation subsector grew an average of 3.19 per cent per year until 2007 and then decreased an average of 0.92 per cent per year until 2014. Over the full 2000 to 2014 period, employment grew an average of 0.95 per cent per year in the truck transportation subsector. The growth rate of employment was more rapid in the truck transportation subsector than in the transportation and warehousing sector until 2011, when it fell below it (Chart 8).

Table 14: Jobs and Hours Worked, All Industries, Transportation and Warehousing Sector, and Truck Transportation Subsector, Thousands, 1997-2014

	Jobs			Hours Worked		
	All Industries	Transportation and Warehousing	Truck Transportation	All Industries	Transportation and Warehousing	Truck Transportation
1997	14,038	647	194	25,060,353	1,279,068	440,171
1998	14,353	663	203	25,570,682	1,325,665	467,831
1999	14,730	689	215	26,237,389	1,381,263	496,160
2000	15,067	702	218	26,801,128	1,394,972	500,423
2001	15,216	702	224	26,955,303	1,390,612	508,414
2002	15,589	714	226	27,337,720	1,409,576	507,164
2003	15,923	712	225	27,704,314	1,402,757	508,460
2004	16,190	727	241	28,487,799	1,459,753	553,380
2005	16,431	718	239	28,703,810	1,424,551	544,655
2006	16,702	752	255	29,137,021	1,495,267	578,236
2007	17,038	774	266	29,668,182	1,513,348	593,855
2008	17,285	767	259	29,986,515	1,493,833	571,321
2009	16,986	755	239	28,893,597	1,432,868	508,484
2010	17,298	781	240	29,459,132	1,497,236	519,965
2011	17,572	799	240	29,866,008	1,521,242	527,901
2012	17,764	817	242	30,421,795	1,552,733	525,604
2013	18,003	817	245	30,735,028	1,535,770	528,247
2014	18,109	832	249	30,846,788	1,587,949	544,659
Compound Average Annual Growth (Per Cent)						
1997-2007	1.96	1.81	3.19	1.70	1.70	3.04
2007-2014	0.87	1.04	-0.92	0.56	0.69	-1.23
2000-2014	1.32	1.22	0.95	1.01	0.93	0.61

Source: Statistics Canada Cansim Table 383-0031. Based on Canadian Productivity Accounts.

From 2000 to 2014 hours worked in the truck transportation subsector grew more slowly than employment, at a rate of 0.61 per cent per year (Table 3-1 in CSLS Transportation Database). In the transportation and warehousing sector as a whole, hours worked grew at a rate of 0.93 per cent, which is slower than in all industries where hours worked grew at a rate of 1.01 per cent.

In 2014, workers in the truck transportation sector worked 42 hours per week on average, compared to 37 hours in the transportation and warehousing sector (Table 3-1 in CSLS Transportation Database). Since 2000, average hours worked decreased an average of 0.35 per cent per year in the truck transportation subsector. This is a slightly larger decrease than in the transportation and warehousing sector as a whole, where average hours worked decreased an average of 0.29 per cent per year for the same period, and than in all industries where the decrease was an average of 0.31 per cent per year.

Table 15: Total Compensation per Hour Worked, All Industries, Transportation and Warehousing, and Truck Transportation, 1997-2014

	All Industries	Transportation and Warehousing	Truck Transportation
1997	19.56	19.86	15.48
1998	20.22	20.38	16.21
1999	20.68	20.55	15.82
2000	21.90	21.51	16.97
2001	22.59	22.33	17.68
2002	23.12	22.46	17.78
2003	23.85	23.46	18.10
2004	24.50	24.01	18.87
2005	25.64	25.32	20.68
2006	26.94	25.98	21.84
2007	27.99	26.12	20.82
2008	28.94	26.69	21.64
2009	29.79	27.44	21.66
2010	30.13	27.29	21.43
2011	31.23	28.36	22.08
2012	31.99	29.00	22.93
2013	32.96	30.74	23.61
2014	34.01	31.24	23.96
	Compound Average Annual Growth (Per Cent)		
2000-2014	3.19	2.70	2.49

Source: Statistics Canada Cansim Table 383-0031. Based on Canadian Productivity Accounts.

According to Transport Canada data, labour quantity increased an average of 5.0 per cent per year between 2000 and 2008 in the truck transportation subsector. This growth is much faster than the Statistics Canada data. Much of the difference between Transport Canada and Statistics Canada is attributable to differences in data sources. Transport Canada's data is drawn from the Q4/Q5[25] Annual Motor Carriers of Freight Survey up to 2008[26] to estimate inputs of the trucking

[25] Q4 refers to quarterly values, Q5 to annual

[26] The Q4/Q5 surveys were discontinued and blended into the redesigned Annual Trucking Survey after 2008. While this new survey provides data up to 2012 (when it was discontinued), Transport Canada has not attempted to use the

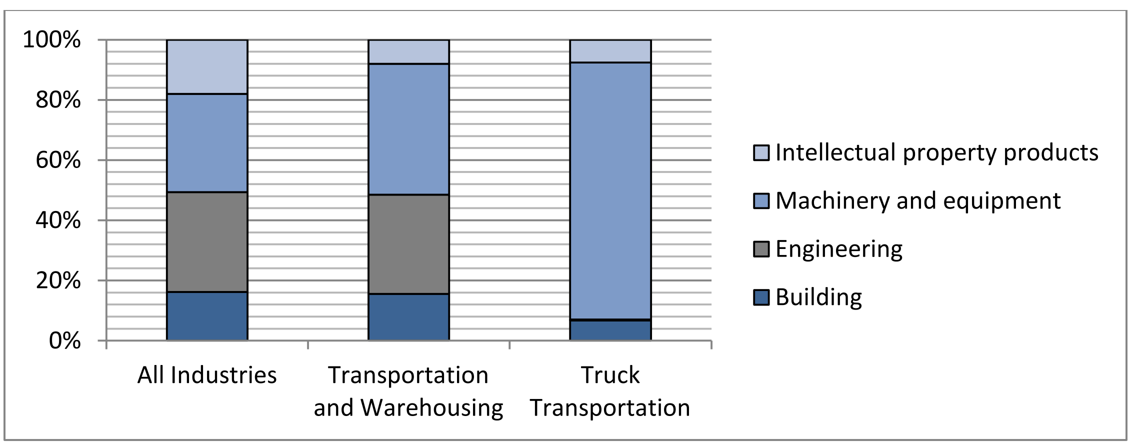
subsector. Review of this data shows that Transport Canada estimates 60% fewer people to be employed in the subsector than Statistics Canada.[27] Given such a divide in the estimated trucking employment level, it would be worrying if similar growth rates would be obtained.

Total compensation per hour worked in 2014 was $23.96 in the truck transportation subsector, which is less than in the transportation and warehousing sector as a whole ($31.24) and also less than in all industries ($34.01) (Table 15). The total compensation per hour worked grew an average of 2.49 per cent per year in the truck transportation subsector between 2000 and 2014, which is a slower growth than in the transportation and warehousing sector as a whole (2.70 per cent) and in all industries (3.19 per cent).

b. Investment

Real gross investment in the truck transportation subsector reached $2,181 million chained 2007 dollars in 2013, but real net investment only reached $196 million chained 2007 dollars, indicating a large depreciation of capital (Table 16). The growth rate of gross real investment for the period of 2000 to 2013 averaged 4.61 per cent per year, whereas the real net investment increased at an average of only 0.02 per cent per year for the same period. This means that most of the additional investment which occurred was necessary to replace depreciating capital. This could be due to an increase in the use of computers which depreciate more than twice as fast as trucks (a depreciation rate of 0.431 vs. 0.201 respectively according to Statistics Canada's depreciation rates for select machinery and equipment categories). In the transportation and warehousing sector as a whole, real gross investment grew at a rate of 3.90 per cent per year, whereas real net investment grew at a rate of 7.39 per cent per year.

Chart 9: Real Total Fixed Non-Residential Investment, All Industries, Transportation and Warehousing Sector, and Truck Transportation Subsector, Breakdown by Asset as a Share of Total Investment, 2013



Source: Calculated by CSLS with data from Statistics Canada Cansim Table 031-0002. Based on Stock and Consumption of Fixed Non-Residential Capital.

data to extend the time series. It is not certain that the surveys are comparable enough that this would even be feasible.

[27] Information obtained through correspondence with Transport Canada officials.

Table 16: Depreciation, Real and Net Total Fixed Non-Residential Investment, All Industries, Transportation and Warehousing Sector, Truck Transportation Subsector, Millions of Chained 2007 Dollars, 1997-2013

	Real Gross Investment			Depreciation			Real Net Investment		
	All Industries	Transportation and Warehousing	Truck Transportation	All Industries	Transportation and Warehousing	Truck Transportation	All Industries	Transportation and Warehousing	Truck Transportation
1997	149,863	9,664	984	125,677	7,803	665	24,185	1,861	318
1998	158,463	13,788	1,213	133,183	8,669	801	25,281	5,119	413
1999	167,359	15,086	1,251	140,857	9,793	933	26,502	5,294	318
2000	175,814	12,286	1,213	148,611	10,408	1,018	27,203	1,878	195
2001	180,948	12,244	1,190	155,583	10,735	1,072	25,365	1,508	117
2002	176,598	11,985	2,045	160,913	11,078	1,226	15,685	907	819
2003	188,065	9,789	1,293	165,579	11,180	1,339	22,486	-1,391	-46
2004	205,484	9,790	1,393	171,848	11,051	1,323	33,637	-1,261	71
2005	229,154	12,499	1,604	181,345	11,264	1,369	47,810	1,235	235
2006	248,386	14,249	2,282	193,042	11,815	1,526	55,344	2,434	756
2007	255,890	16,283	2,085	204,405	12,528	1,699	51,485	3,755	386
2008	267,824	19,924	2,036	214,535	13,406	1,791	53,289	6,518	245
2009	232,217	17,057	1,687	218,881	14,023	1,783	13,336	3,035	-97
2010	262,785	15,128	1,605	221,663	14,236	1,724	41,123	893	-119
2011	276,557	16,434	2,176	228,634	14,450	1,772	47,923	1,984	403
2012	286,560	18,204	2,318	236,207	14,873	1,897	50,353	3,331	421
2013	287,126	20,215	2,181	243,084	15,469	1,985	44,042	4,747	196
	Compound Average Annual Growth (Per Cent)								
2000-2013	3.85	3.90	4.61	3.86	3.10	5.27	3.78	7.39	0.02

Source: Statistics Canada Cansim Table 031-0002. Based on Stock and Consumption of Fixed Non-Residential Capital.

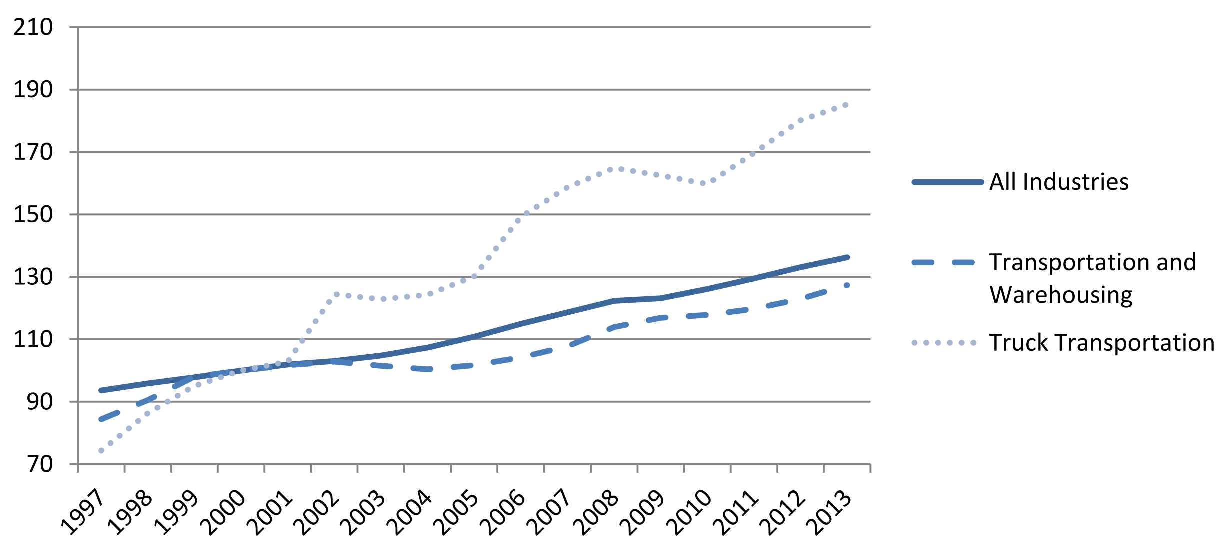
In 2013, machinery and equipment accounted for 85.75 per cent of investment in the truck transportation subsector (Chart 9). Intellectual property products and buildings accounted for 7.58 per cent and 6.78 per cent of investment, respectively. Only 0.25 per cent of investment went towards engineering.

Between 2000 and 2013, the fastest growth in investment was for buildings, with an average of 6.9 per cent per year (Table 3-3 in CSLS Transportation Database). The second fastest growth was in engineering, at an average of 5.9 per cent per year. This is followed by machinery and equipment, at 4.8 per cent per year, and intellectual property products, at 3.0 per cent per year.

c. Capital

Capital stock in the truck transportation subsector grew rapidly from 2000 to 2013, at a rate of 4.86 per cent per year (Table 17). The capital stock in the truck transportation subsector grew much faster than in the transportation and warehousing sector, which grew at a rate of 1.88 per cent per year for the same periods. By comparison, in all industries the capital stock grew at a rate of 2.41 per cent per year (Chart 10).

Chart 10: Real Total Fixed Non-Residential Geometric End of Year Net Stock, All Industries, Transportation and Warehousing Sector, and Truck Transportation Subsector, 2000=100, 1997-2013



Source: Calculated by CSLS with data from Statistics Canada Cansim Table 031-0002. Based on Stock and Consumption of Fixed Non-Residential Capital.

Machinery and equipment accounts for most of the capital stock in the truck transportation subsector, while engineering is marginal. Most machinery and equipment in the truck transportation subsector is made up of trucks and forklifts. Capital stock in the form of machinery and equipment made up 66.3 per cent of the truck transportation capital stock in 2013 (Table 3-4 in CSLS Transportation Database). This is followed by buildings, at 26.1 per cent, intellectual property products, at 6.6 per cent, and finally engineering at 1.1 per cent.

Capital stock in the form of machinery and equipment has experienced rapid growth from 2000 to 2013, at a rate of 5.1 per cent per year, although in 2009 and 2010 the growth was negative, indicating a decline in the stock of machinery and equipment during these years. Intellectual property products also experienced rapid growth from 2000 to 2013, at a rate of 4.9 per cent per year. [28] This growth was fastest until 2007. This is likely due to the deployment of on board computers and the purchase of accompanying software, which is discussed further below..

Table 17: Real Total Fixed Non-Residential End of Year Gross Stock and Geometric End of Year Net Stock, Millions of Chained 2007 Dollars, All Industries, Transportation and Warehousing Sector, and Truck Transportation Subsector, 1997-2013

	End of Year Gross Stock			Geometric End of Year Net Stock		
	All Industries	Transportation and Warehousing	Truck Transportation	All Industries	Transportation and Warehousing	Truck Transportation
1997	2,840,265	215,377	6,125	1,317,326	88,523	3,014
1998	2,910,565	224,598	7,016	1,347,976	94,880	3,504
1999	2,978,531	236,613	7,806	1,376,679	102,760	3,857
2000	3,050,963	242,524	8,418	1,407,019	104,861	4,058
2001	3,120,137	247,762	8,891	1,434,355	106,691	4,174
2002	3,176,095	251,971	10,172	1,450,191	107,876	5,052
2003	3,233,818	252,982	10,537	1,474,036	106,453	4,981
2004	3,299,222	253,356	10,878	1,509,779	105,193	5,043
2005	3,381,391	256,330	11,378	1,559,783	106,636	5,283
2006	3,477,036	260,756	12,543	1,616,688	109,188	6,054
2007	3,572,845	266,769	13,396	1,668,675	113,016	6,440
2008	3,671,527	275,718	14,050	1,721,451	119,466	6,687
2009	3,724,916	281,418	14,261	1,733,028	122,504	6,593
2010	3,804,615	284,787	14,313	1,773,755	123,475	6,479
2011	3,889,710	288,998	14,899	1,821,693	125,514	6,886
2012	3,977,473	294,585	15,579	1,872,074	128,852	7,309
2013	4,058,877	301,718	15,974	1,916,594	133,534	7,515
	Compound Average Annual Growth (Per Cent)					
2000-2013	2.22	1.69	5.05	2.41	1.88	4.86

Source: Statistics Canada Cansim Table 031-0002. Based on Stock and Consumption of Fixed Non-Residential Capital.

Exchange rates play an important role in the capital investment behaviour of firms in the trucking subsector as much of the equipment capital employed by firms is imported. A strong Canadian dollar may stimulate companies to advance their investment schedule and renew the fleet sooner than necessary rather than miss out of significant savings (as for example by Landon

[28] In the truck transportation subsector, intellectual property products consist for the most part of software. It also consists of research and development.

and Smith, 2006). Consequently, capital investment figures should be considered in the context of opportunism and not simply firms investing when trucks need replacing.

According to Transport Canada data, capital has increased an average of 5.9 per cent per year between 2000 and 2008. This is a slower increase than measured by Statistics Canada for the real total fixed non-residential geometric end of year net stock.

iii. Productivity

a. Labour Productivity

Table 18: Labour Productivity, Chained 2007 Dollars, All Industries, Transportation and Warehousing Sector, and Truck Transportation Subsector, 1997-2014

	Real GDP per Hour Worked			Real GDP per Job		
	All Industries	Transportation and Warehousing	Truck Transportation	All Industries	Transportation and Warehousing	Truck Transportation
1997	$42.7	$36.4	$24.5	$76,235	$72,025	$55,400
1998	43.5	35.8	24.3	77,430	71,597	55,817
1999	44.7	36.5	24.6	79,638	73,218	56,849
2000	46.1	37.9	26.0	82,087	75,408	59,648
2001	46.5	39.0	27.4	82,428	77,339	62,245
2002	47.1	38.4	27.8	82,573	75,879	62,453
2003	47.4	38.8	27.3	82,552	76,363	61,609
2004	47.6	38.7	26.4	83,706	77,606	60,704
2005	48.6	42.0	29.2	84,958	83,192	66,711
2006	49.2	41.1	28.4	85,913	81,799	64,536
2007	49.4	41.3	28.4	86,082	80,744	63,273
2008	49.4	41.7	28.8	85,743	81,227	63,697
2009	49.8	41.6	31.0	84,677	79,037	66,089
2010	50.6	41.3	32.7	86,092	79,234	70,993
2011	51.4	42.0	33.7	87,322	79,967	74,174
2012	51.5	41.8	34.5	88,133	79,379	74,903
2013	52.0	42.8	34.7	88,806	80,401	74,731
2014	53.1	43.2	35.2	90,432	82,482	76,933
	Compound Average Annual Growth (Per Cent)					
2000-2014	1.0	0.9	2.2	0.7	0.6	1.8

Source: Calculated by CSLS with data from Cansim Tables 379-0031 and 383-0031. Based on Input-Output Accounts and Canadian Productivity Accounts.

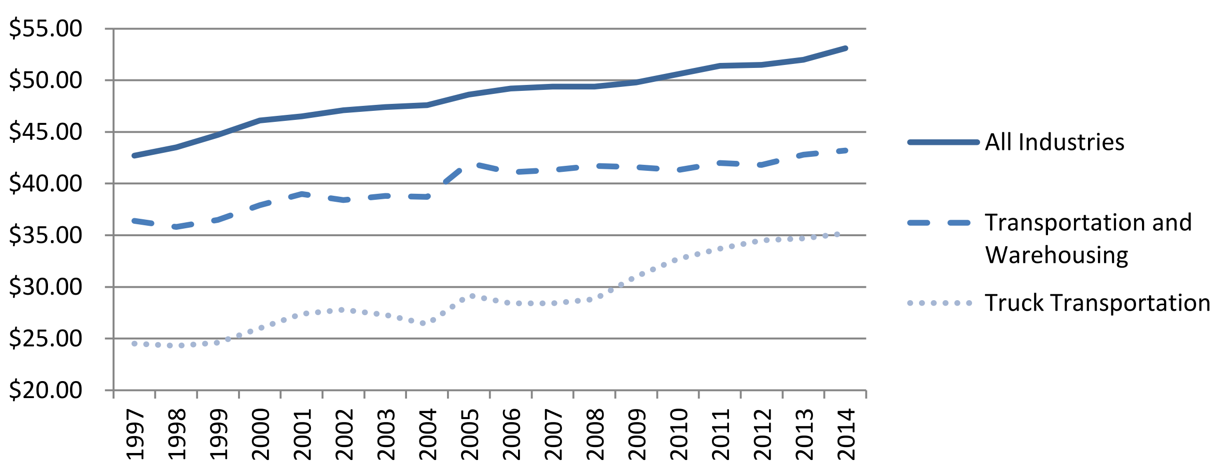
Labour productivity in the truck transportation subsector, defined as real GDP (in chained 2007 dollars) per hour worked, reached $35.2 in 2014 (Table 18). Labour productivity in the truck transportation subsector is lower than in the transportation and warehousing sector as a whole, where it reached $43.2 in 2014. Over the period of 2000 to 2014, labour productivity (defined as real GDP per hour worked) grew by 2.19 per cent per year, a more rapid growth than for the transportation and warehousing sector as a whole which grew by 0.93 per cent per year for the same period. This reflects the fact that in the truck transportation subsector real GDP grew 2.81 per cent per year between 2000 and 2013, while hours worked only grew 0.61 per cent per year.

Table 19: Labour Productivity Relative to All Industries, Transportation and Warehousing, Truck Transportation, Per Cent, 1997-2014

	Real GDP per Hour Worked		Real GDP per Job	
	Transportation and Warehousing	Truck Transportation	Transportation and Warehousing	Truck Transportation
1997	85.26	57.30	94.48	72.67
2000	82.21	56.40	91.86	72.66
2010	81.62	64.62	92.03	82.46
2014	81.36	66.29	91.21	85.07
	Compound Average Annual Growth (Per Cent)			
2000-2010	-0.07	1.37	0.02	1.27
2000-2014	-0.07	1.16	-0.05	1.13

Source: Calculated by CSLS with data from Cansim Tables 379-0031 and 383-0031. Based on Input-Output Accounts and Canadian Productivity Accounts.

Chart 11: Labour Productivity Defined as Real GDP per Hour Worked, All Industries, Transportation and Warehousing, and Truck Transportation, Chained 2007 Dollars, 1997-2014



Source: Calculated by CSLS with data from Cansim Tables 379-0031 and 383-0031. Based on Input-Output Accounts and Canadian Productivity Accounts.

In 2000, real GDP per hour worked in the truck transportation subsector was 55.4 per cent relative to all industries and in 2014 it was 66.3 per cent (Table 19). Labour productivity defined as real GDP per hour worked in the truck transportation subsector relative to all industries increased by 9.89 percentage points between 2000 and 2014. Conversely, in the transportation and warehousing sector as a whole, this ratio decreased by 0.86 percentage points for the same period.

Table 20: Labour Productivity (Real GDP per Worker), Chained 2007 Dollars, Truck Transportation. Canadian Provinces, 2000-2014

	Newfoundland and Labrador	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia
1997	47,949	46,667	33,834	64,003	57,497	55,423	46,486	55,735	64,208	56,944
1998	47,078	50,411	33,697	57,355	55,845	56,338	47,626	55,577	68,418	58,437
1999	44,924	56,615	39,949	60,708	62,684	53,578	47,116	54,398	70,702	57,126
2000	45,326	51,538	43,993	62,026	69,521	57,082	46,055	57,545	71,516	55,930
2001	52,784	58,197	49,346	59,306	72,638	59,504	47,145	63,392	76,860	55,145
2002	53,598	58,955	45,283	62,045	68,750	61,727	48,972	66,222	76,446	55,492
2003	51,350	58,440	49,036	61,363	71,135	61,007	48,732	61,067	70,785	54,000
2004	54,550	62,500	45,092	60,963	66,235	60,766	46,056	57,796	73,329	53,538
2005	57,300	55,972	51,074	65,618	70,871	65,269	51,967	64,390	82,847	60,928
2006	53,046	63,750	53,037	76,318	65,889	59,373	58,760	61,018	80,534	62,393
2007	77,163	52,375	51,405	70,195	59,110	62,080	52,414	51,869	86,918	63,089
2008	76,274	53,611	54,138	70,548	59,561	60,641	53,897	55,301	90,632	64,792
2009	87,105	60,313	61,768	76,292	65,595	62,783	59,028	50,770	89,396	70,905
2010	73,711	61,088	66,077	85,550	70,794	68,035	60,663	53,441	96,985	70,030
2011	73,754	60,599	65,439	87,137	74,230	70,580	62,455	58,640	103,695	77,632
2012	77,380	66,625	67,140	83,824	73,145	69,803	65,446	61,046	110,207	83,952
2013	75,015	62,210	64,931	86,639	71,532	65,606	68,089	62,358	127,981	85,145
2014	70,453	65,683	60,783	82,514	74,656	66,778	68,043	66,154	131,791	86,874
					Compound Average Annual Growth					
2000-2014	3.20	1.75	2.34	2.06	0.51	1.13	2.83	1.00	4.46	3.20

Source: Calculated by CSLS with data from Cansim Tables 379-0030 and 383-0031. Based on Input-Output Accounts and Canadian Productivity Accounts.

Labour productivity can also be defined as GDP per worker, although real GDP per hour worked is more reflective of the productivity of the industry since average hours worked can fluctuate. Real GDP (in chained 2007 dollars) per worker reached $76,933 in 2014 in the truck transportation subsector (Table 18). In the transportation and warehousing sector as a whole, real GDP per worker was $82,842 in 2013. Labour productivity per worker had a weaker growth rate over the 2000 to 2014 period than labour productivity per hour worked, averaging 1.83 per cent per year in the truck transportation subsector and 0.64 per cent in the transportation and warehousing sector.

Table 20 shows a breakdown of labour productivity (real GDP per worker) in the truck transportation subsector by province. Growth in labour productivity between 2000 and 2014 was strongest in the province of Alberta, at an average of 4.46 per cent per year. Alberta has also had the highest level of labour productivity every year between 2000 and 2014.

The previous values for labour productivity were calculated by CSLS from Statistics Canada data. Statistics Canada also provides labour productivity measures, in the form of indexes for labour productivity per hour worked (Table 21). There are no absolutes available; therefore the CSLS calculated measures of labour productivity. The growth rates of labour productivity according to these indexes from Statistics Canada for the period of 2000 to 2010 are similar to those calculated by CSLS discussed above.

Table 21: Labour Productivity (per Hour Worked) in Canada, Business Sector, Transportation and Warehousing, and Truck Transportation, 2007=100, 1997-2013

	Business Sector	Transportation and Warehousing	Truck Transportation
1997	84.03	87.71	86.22
1998	86.18	86.98	84.36
1999	89.34	89.09	86.78
2000	92.59	91.82	92.44
2001	94.06	94.45	98.90
2002	95.53	94.76	103.92
2003	96.04	95.07	101.19
2004	96.14	94.36	94.47
2005	98.54	102.60	102.56
2006	99.84	100.39	100.13
2007	100.00	100.00	100.00
2008	99.33	100.90	101.38
2009	99.25	100.53	108.19
2010	101.22	100.04	113.98
2011	102.83	101.42	...
2012	103.04	...	...
2013	104.26	...	...
		Compound Average Annual Growth	
2000-2010	0.90	0.86	2.12
2000-2013	0.92	...	...

Source: Cansim Table 383-0032 and 383-0021. Based on Canadian Productivity Accounts.

As a contrast to the Statistics Canada data, according to Transport Canada data, labour productivity decreased an average of 2.4 per cent per year between 2000 and 2008. For the same period, the CSLS calculated from Statistics Canada data an average increase in labour productivity of 1.4 per cent per year when considering hours worked and of 1.0 per cent when considering workers. The difference is in part due to the difference in the estimation of labour employed in the trucking subsector discussed above. (see section ii.a employment).

For comparison, in the United States labour productivity grew 1.04 per cent per year between 2000 and 2010 in the truck transportation subsector (Table 22). This is slower growth than in Canada. Conversely, the labour productivity of the business sector grew 2.60 per cent per year for the same period, which is faster growth than in Canada.

Table 22: Labour Productivity (per Hours Worked) in the United States, Business Sector and Truck Transportation Subsector, 2007=100, 1997-2014

	Business Sector	Truck Transportation
1997	75.42	92.68
1998	77.74	92.35
1999	80.45	93.24
2000	83.19	94.64
2001	85.51	94.61
2002	89.17	95.09
2003	92.60	97.88
2004	95.56	96.39
2005	97.57	97.97
2006	98.53	99.11
2007	100.00	100.00
2008	100.80	99.19
2009	104.11	95.12
2010	107.55	104.91
2011	107.61	106.55
2012	108.40	105.50
2013	108.87	105.83
2014	109.52	109.54
	Compound Average Annual Growth (Per Cent)	
2000-2010	2.60	1.04
2000-2014	1.98	1.05

Source: United States Bureau of Labor Statistics. http://www.bls.gov/data/

b. Capital Productivity

Unlike labour productivity, capital productivity did not grow over the 2000 to 2013 period. In fact, capital productivity, defined as real GDP per thousand dollars of end-year net stock (both in chained 2007 dollars), went from $3,210 in 2000 to $2,439 in 2013 (Table 23). This represents a fall of 2.09 per cent per year for the period. In the transportation and warehousing sector as a whole, productivity of the capital stock also decreased, but at a slower rate of 0.20 per cent per year. This trend is mirrored in all industries, where productivity of the capital stock decreased at a rate of 0.40 per cent per year. However, unlike labour productivity, capital productivity is higher in the truck transportation subsector than in transportation and warehousing as a whole, where it went from $505 in 2000 to $492 in 2013.

Table 23: Real Capital Stock Productivity, Value Added Produced per $1000 of Real Capital Stock, Chained 2007 Dollars, All Industries, Transportation and Warehousing Sector, and Truck Transportation Subsector, 1997-2013

	Absolute			Relative to All Industries (Per Cent)	
	All Industries	Transportation and Warehousing	Truck Transportation	Transportation and Warehousing	Truck Transportation
1997	812	526	3,574	64.75	439.89
1998	824	501	3,240	60.72	392.95
1999	852	491	3,164	57.58	371.34
2000	879	505	3,210	57.42	365.21
2001	874	509	3,334	58.19	381.33
2002	888	502	2,794	56.58	314.79
2003	892	511	2,787	57.29	312.55
2004	898	537	2,896	59.78	322.67
2005	895	560	3,012	62.62	336.55
2006	888	563	2,715	63.45	305.87
2007	879	553	2,615	62.88	297.52
2008	861	521	2,464	60.53	286.23
2009	830	487	2,394	58.67	288.45
2010	840	501	2,628	59.66	312.99
2011	842	509	2,587	60.47	307.11
2012	836	503	2,478	60.17	296.36
2013	834	492	2,439	58.95	292.43
Compound Average Annual Growth (Per Cent)					
2000-2013	-0.40	-0.20	-2.09	0.20	-1.70

Source: Calculated by CSLS with data from Statistics Canada Cansim Tables 379-0031, 031-0003, and 031-0002. Based on Input-Output Accounts and Stock and Consumption of Fixed Non-Residential Capital.

According to Transport Canada data, capital productivity decreased an average of 3.3 per cent per year between 2000 and 2008, which is similar to Statistics Canada data where this decrease is 3.0 per cent per year. Part of the difference is due to a difference in the estimation of capital stock (see part ii.c capital).

c. Multifactor Productivity

Statistics Canada provides estimates of multifactor productivity for the truck transportation subsector, the transportation and warehousing sector and the business sector. Multifactor productivity can be based on gross output or value-added. Multifactor productivity based on gross output measures the efficiency with which all inputs including capital, labour and intermediate inputs are used in production. Multifactor productivity based on value-added measures the efficiency with which labour and capital are used in production. Multifactor productivity based on value-added has increased by an average of 1.49 per cent per year between 2000 and 2010 (Table 24). Multifactor productivity increased faster in the truck transportation subsector than in the transportation and warehousing sector as a whole, where multifactor productivity decreased by an average of 0.31 per cent per year for the same period, and it greatly out-performed the business sector, where it decreased by 0.45 per cent per year for the period.

Table 24: Multifactor Productivity Based on Value-Added, Index, 2007=100, Transportation and Warehousing, Truck Transportation, 1997-2008

	Business Sector	Transportation and Warehousing	Truck Transportation
1997	97.1	100.4	91.0
1998	97.8	94.9	88.8
1999	100.1	94.9	91.1
2000	102.0	97.3	96.2
2001	101.9	98.6	101.2
2002	103.0	98.1	102.5
2003	102.6	98.7	102.2
2004	102.0	99.2	96.2
2005	102.1	104.6	103.6
2006	101.3	102.6	100.3
2007	100.0	100.0	100.0
2008	98.0	97.0	100.1
2009	95.8	93.0	105.3
2010	97.5	94.3	111.5
2011	98.4	95.5	…
2012	97.7	…	…
2013	98.2	…	…
	Compound Average Annual Growth (Per Cent)		
2000-2010	-0.45	-0.31	1.49
2000-2011	-0.32	-0.17	…
2000-2013	-0.29	…	…

Source: Statistics Canada Cansim Table 383-0032 and 383-0021. Based on Canadian Productivity Accounts.

Unlike Statistics Canada, Transport Canada found a decrease in total factor productivity in the truck transportation subsector. This decrease averaged 1.5 per cent per year between 2000 and 2008. The difference is once again primarily attributable to the different datasets used by either organization.

B. Explaining Productivity Trends

Part A described in detail outputs and inputs in the truck transportation subsector and how this sector compares to the transportation and warehousing sector as a whole as well as to all industries. Part A also described labour and capital productivity in the truck transportation subsector and how they compare to other industries. However, part A was only descriptive and did not analyze the factors behind the productivity performance of the subsector.

To develop policies that focus on maximizing productivity, it is important to understand what drives the productivity growth. Section B provides a detailed explanation of the possible drivers of productivity growth in Canada.

i. Labour Productivity Growth Decomposition

Table 25: Labour Productivity Growth Decomposition Based on Gross Output, Index, 2007=100, Truck Transportation Subsector, 1997-2010

		Contribution to Growth in Labour Productivity			
	Labour Productivity	Multifactor Productivity	Capital Intensity	Intermediate Input Intensity	Labour Composition
1997	82.4	96.6	99.5	87.1	98.5
1998	78.9	95.8	99.5	84.1	98.6
1999	80.5	96.9	99.4	84.7	98.8
2000	84.3	99.1	99.7	86.3	98.8
2001	87.8	101.3	100.1	87.3	99.1
2002	90.1	102.1	101.4	87.7	99.2
2003	88.5	101.9	100.5	87.1	99.2
2004	96.6	98.6	100.0	98.7	99.4
2005	100.1	101.5	99.9	99.0	99.8
2006	101.2	100.0	100.2	101.3	99.8
2007	100.0	100.0	100.0	100.0	100.0
2008	100.5	100.1	100.3	100.0	100.2
2009	106.0	101.9	101.0	103.0	100.0
2010	106.1	104.3	100.8	101.0	99.9
		Compound Average Annual Growth (Per Cent)			
2000-2010	2.33	0.51	0.11	1.58	0.11
		Per Cent Distribution			
2000-2010	100	22	5	68	5

Source: Cansim Table 383-0032. Based on Canadian Productivity Accounts.

Labour productivity represents the amount of output a worker produces in a given amount of time. Output does not only depend on the size of the work force. It also depends on factors such as capital intensity, intermediate input intensity, and labour composition. The focus of this section is to understand the contribution of these factors to labour productivity growth. The contribution of capital intensity to labour productivity represents the effects of capital investments on labour productivity growth. The contribution of intermediate inputs to labour productivity growth represents the effects of intermediate inputs on labour productivity. An increase in the intensity of intermediate goods increases the intermediate goods per unit of labour. The contribution of labour composition to labour productivity growth represents the effects of skill upgrading as measured by increases in the experience and education composition of the workforce on labour productivity growth. Section A presents data on labour productivity. This section will focus on data from Statistics Canada on the contribution of the various inputs to the growth in labour productivity (Tables 25, 26, and 27).

Table 26: Labour Productivity Growth Decomposition Based on Gross Output, Index, 2007=100, Transportation and Warehousing Sector, 1997-2011

		Contribution to Growth in Labour Productivity			
	Labour Productivity	Multifactor Productivity	Capital Intensity	Intermediate Input Intensity	Labour Composition
1997	87.0	100.0	94.3	93.7	98.3
1998	86.2	97.0	96.6	93.4	98.6
1999	86.6	96.7	98.0	92.7	98.6
2000	88.2	97.9	98.1	92.9	98.8
2001	89.7	98.6	98.6	93.2	99.1
2002	89.5	98.3	98.7	92.9	99.4
2003	90.2	98.6	98.6	93.3	99.3
2004	95.2	99.7	97.6	98.2	99.7
2005	100.6	102.3	99.0	99.4	99.9
2006	99.8	101.4	98.9	99.7	99.9
2007	100.0	100.0	100.0	100.0	100.0
2008	101.8	98.5	102.0	101.2	100.1
2009	102.5	96.4	104.0	101.9	100.3
2010	102.5	97.2	102.8	102.1	100.4
2011	103.4	97.8	102.7	102.4	100.6
		Compound Average Annual Growth (Per Cent)			
2000-2010	1.51	-0.08	0.47	0.95	0.17
		Per Cent Contribution			
2000-2010	100	-5	31	63	11

Source: Cansim Table 383-0032. Based on Canadian Productivity Accounts.

In the truck transportation subsector, capital intensity contributed an average of 0.11 percentage points annually to growth in labour productivity based on gross output from 2000 to 2010. As such, capital intensity contributed around 5 per cent of the total growth in labour productivity over the period of 2000 to 2011. This growth is slower than in the transportation and warehousing sector as a whole, where the contribution of capital intensity to growth in labour productivity was an average of 0.47 per cent per year for the same period. Capital intensity accounted for 5 per cent of the growth in labour productivity over the 2000 to 2010 period in the truck transportation subsector. The contribution of intermediate input intensity to the growth in labour productivity based on gross output grew an average of 1.58 per cent per year from 2000 to 2010. This growth is faster than in the transportation and warehousing sector where the growth was an average of 0.95 per cent per year. Intermediate input intensity account for 68 per cent of the growth in labour productivity in the truck transportation subsector. The contribution of labour composition to growth in labour productivity based on gross output in the truck transportation subsector was an average of 0.11 per cent per year from 2000 to 2010. This is slightly slower than in the transportation and warehousing sector as a whole, where the growth was an average of 0.17 per cent per year. The contribution of labour composition accounted for 5 per cent of the growth in labour productivity in the truck transportation subsector over the 2000-2010 period. Multifactor productivity accounts for 22 per cent of the growth of labour productivity in the truck transportation subsector for the same period.

Table 27: Labour Productivity Growth Decomposition Based on Value Added, Index, 2007=100, Business Sector, 1997-2013

		Contribution to Growth in Labour Productivity		
	Labour Productivity	**Multifactor Productivity**	**Capital Intensity**	**Labour Composition**
1997	84.0	97.1	89.2	97.0
1998	86.2	97.8	90.6	97.3
1999	89.3	100.1	91.6	97.4
2000	92.6	102.0	92.6	98.0
2001	94.1	101.9	93.7	98.5
2002	95.5	103.0	94.0	98.7
2003	96.0	102.6	94.5	99.0
2004	96.1	102.0	95.0	99.2
2005	98.5	102.1	96.9	99.6
2006	99.8	101.3	98.8	99.8
2007	100.0	100.0	100.0	100.0
2008	99.3	98.0	101.2	100.2
2009	99.2	95.8	103.1	100.5
2010	101.2	97.5	103.0	100.9
2011	102.8	98.4	103.4	101.0
2012	103.0	97.7	104.0	101.3
2013	104.3	98.2	104.8	101.4
		Compound Average Annual Growth		
2000-2010	0.90	-0.45	1.06	0.29
2000-2013	0.92	-0.29	0.95	0.26
		Per Cent Distribution		
2000-2010	100	-50	120	33
2000-2013	100	-32	104	29

Source: Statistics Canada Cansim Table 383-0021. Based on Canadian Productivity Accounts.
Note: The previous two tables for labour productivity in the transportation and warehousing sector and truck transportation subsector were based on gross output, but this one is based on value-added, therefore they are not comparable.

ii. Policy

a. Deregulation

The trucking industry in Canada originally had regulations covering proposed acquisitions and licences. At a provincial level, firm entry, routes, fare levels, capacity, service quality etc. were also regulated. This is despite an absence of the typical market problems that lead to these regulations. Regulations were also in place for safety and road maintenance reasons. The federal government put an end to economic regulations in 1987 through the Motor Vehicle Transportation Act. By 2001, all provinces had also deregulated the industry. As a result, the trucking industry is no longer subject to entry or tariff regulation in Canada. However, safety (such as hours worked, condition of trucks) and truck weight and size regulations are still in place.[29]

The OECD produces an index of the degree of regulation in the road transportation sector for freight which is based on entry regulation and price controls. The index ranges from a high of 6.00 (most regulation) to a low of 0.00 (least regulation). Historically the index had been at a level of 5.00 in Canada between 1975 and 1986 before falling to a level of 0.75 in 1988. Over the 1988-2013 period, the index was stable at 0.75. Internationally, the index suggests that Canada has had relatively light regulation in this sector. In the 1970s, Canada had the 7th lowest index out of 32 countries. Canada had the 2nd lowest index value of 44 countries as of 2013. Canada has had the second lowest ranking since 2001.[30]

The deregulation of the truck transportation industry led to a greater degree of competition that was never seen before in the Canadian trucking industry. This forced firms to innovate and increase their productivity. Industry deregulation in Canada is a factor that has helped increase the productivity of the truck transportation subsector.

b. Thickening of the Canada-United States Border

The events of September 11, 2011, have led to increased security measures for the transportation of goods across the Canada-United States Border. This thickening of the border has led to delays at the border and increased compliance costs, which caused an increase in the cost of transporting goods over the border. In fact, according to a Statistics Canada study, from 1994 to 2000, it cost on average 16 per cent more to move goods across the border than to move them the same distance within the country (Brown, 2015). After 2000, the added cost of transporting goods across the border rose to 25 per cent in 2005 and has remained at that level until 2009 (the last year analyzed) (Brown, 2015). These delays and increased costs lower the productivity of the trucking industry.

[29] For more information on deregulation, see Monteiro (no date) or Transportation Research Forum (2010)
[30] For further details on the OECDs product market regulation index in this sector, see Appendix C or Koske et al. (2014).

iii. Capital

a. Capital Intensity

Real capital stock has been increasing in the truck transportation subsector much faster than in other industries. In fact, capital stock in the truck transportation subsector has increased by 4.89 per cent per year between 2000 and 2013, whereas employment and hours worked only grew 0.85 and 0.50 per cent per year during the same period. This means that workers have more capital to work with.

Table 28 shows the evolution of capital stock per worker. In 2013, capital stock per worker had nearly doubled since 1997. Inevitably an increase in capital stock per worker will lead to an increase in labour productivity.

Table 28: Net Capital Stock per Job, All Industries, Transportation and Warehousing, Truck Transportation, Chained 2007 dollars, 1997-2013

	All Industries	Transportation and Warehousing	Truck Transportation
1997	$93,839	$136,912	$15,502
1998	93,913	143,019	17,228
1999	93,459	149,238	17,966
2000	93,383	149,395	18,580
2001	94,265	151,999	18,667
2002	93,025	151,083	22,351
2003	92,571	149,457	22,104
2004	93,253	144,635	20,959
2005	94,931	148,437	22,149
2006	96,795	145,253	23,772
2007	97,712	145,874	24,552
2008	99,145	155,799	26,199
2009	101,542	162,077	27,901
2010	102,107	158,539	27,326
2011	103,149	157,319	28,939
2012	104,999	157,911	30,196
2013	106,215	163,555	30,809
	Compound Average Annual Growth (Percent)		
2000-2013	1.00	0.70	3.97

Source: Calculated by CSLS with data from Statistics Canada Cansim Tables 031-0002 and 383-0031. Based on Stock and Consumption of Fixed Non-Residential Capital and Canadian Productivity Accounts.

The main capital stock of the truck transportation industry is in machinery and equipment, mainly trucks. However, a single truck driver cannot drive more than one truck at once. How then can the capital stock increase so rapidly? It is mainly due to more expensive trucks and more trailers, as well as an increased use of on-board computers. These will be discussed below.

In the truck transportation subsector, total fixed non-residential investment has grown the most for building construction and engineering. Examples of building construction are factories and offices, and examples of engineering construction are roads and dams. These types of investments have a positive effect on trucking productivity.

b. Extensive Network of Roads

Canada has an extensive road system which contributes to trucking productivity. Canada has more than a million kilometres of roads, and 38,000 of these make up the National Highway System (Transport Canada, 2012). The National Highway System is a strategic network of highways and freeways which connects capital cities to major population and commercial centers in Canada as well as with other transportation modes directly served by trucks (such as ports) and with major entry sites to the United States (Transport Canada, 2011). The National Highway System also includes more than 8,700 bridges. Table 29 shows the length of the NHS over time. Note that few new roads are being built in Canada, but highways are being expanded to have multiple lanes which is favorable to the trucking industry.

The funding for road infrastructure is shared by the federal, provincial and municipal governments. Truckers use and degrade this infrastructure, but the replacement and repair of road infrastructure is the responsibility of governments. Investment in Canada's road network therefore increases the productivity of the truck transportation industry. The more divided highways are available, the better it is for the trucking industry.

Table 29: Network Length (KM) of the National Highway System, Canada, 2006-2012

	2006	2007	2008	2009	2010	2011	2012
Core	27,613	27,631	27,625	27,601	27,656	27,673	27,670
Feeder	4,493	4,495	4,496	4,492	4,493	4,491	4,491
Northern/Remote	5,922	5,921	5,917	5,917	5,920	5,920	5,918
Total	38,026	38,047	38,038	38,010	38,069	38,084	38,078

Source: Council of Ministers Responsible for Transportation and Highway Safety, 2012

iv. Technical Progress

a. On-Board Computers

On-board computers are computers that are installed in the cab of a truck. They serve multiple uses such as trip recording, location tracking, and facilitating deliveries by replacing paperwork. The trip recording keeps a record of when the truck was turned on or off, the speed over time and the incidence of hard breaking. This allows monitoring of drivers' activities and identification of occurrences of speeding or unauthorized breaks. That alone could increase productivity. On-Board computers can also be connected to sensors that track fuel efficiency, necessary repairs, etc. The tracking of speed and fuel consumption allows for an assessment of fuel utilization. This leads to identifying speeds that maximize fuel efficiency. Fuel being the main intermediate input, this reduces the cost of truck transportation. The collection of data on vehicle performance can help diagnose issues before they become a problem. Preventative maintenance improves the performance of trucks. This leads to increased output and therefore increased productivity.

Location tracking means a truck can be followed from pick-up to delivery. Combined with the development of two-way communication between truckers and dispatchers, this allows for real-time coordination of routing and dispatching. Software has also been developed to help optimize dispatching and routing. This reduces the time and cost of truck transportation. This improvement in dispatchers' resource allocation decisions increases the loads of trucks, because a truck that is not full can stop along the way to pick up freight destined for a similar location to where the truck is headed. This increase in the load of a truck per mile increases capacity utilization. Similarly, better routing and dispatching reduces unnecessary trucks on the road which also increases capacity utilization. Hubbard (2003) analyzed the relationship between capacity utilization changes in the trucking industry and changes in on-board computer use between 1992 and 1997. He found that electronic management systems (trip recorders which also record trucks' geographic locations and provide almost real-time data connections between trucks and dispatchers) increased capacity utilization by 13 per cent on adopting trucks.

On board computers also help increase the productivity of the driver. They can be used to facilitate billing and receipt acknowledgements. This diminishes the load of paperwork for the driver and therefore the related cost of labour, which in turn increases productivity.

b. Length of Trucks

A truck's configuration can either be a single-unit truck, where the cargo-carrying units are mounted on the same chassis as the engine, or a combination vehicle, where separate cargo-carrying trailers or semitrailers are pulled by a truck or a truck-tractor. In Canada, any combination of vehicles more than 25 meters in overall length is considered a long combination vehicle (LCV).

In 1994, the United States General Accounting Office released a report on the economic impact of LCVs (United States General Accounting Office, 1994). They report that LCVs transport cargo at a lower cost per unit than shorter trucks, because fewer drivers and tractors are needed, as well as less fuel. Because they use less fuel, LCVs also lower greenhouse gas emissions. The trade-off is that LCVs increase highway costs because their weight causes a larger deterioration of highways which increases the need for maintenance, and are a threat to traffic safety. In the same way, LCVs deteriorate bridges and increase the need for bridge replacements. Therefore, LCVs lower transportation costs, but generate a cost for the governments to provide and maintain the infrastructure used by the trucking industry. Safety is also a concern of LCVs. These have operational characteristics which make manoeuvring in traffic more difficult than with a single trailer truck. As an example of these operational characteristics, LCVs have more trailer sway. Hewitt et al. (1999) examined the impact of changes in truck weight limits in Montana, estimating that the resulting reductions in transportation costs exceeded the increased infrastructure costs by at least an order of magnitude.[31]

Use of LCVs requires permits. Because LCVs lower transportation costs and are better for the environment, in Canada these are now allowed on some roads in all provinces and territories except for Newfoundland and Labrador, Prince Edward Island, Yukon, and Nunavut (Transport Canada, 2012). The province of Ontario, for example, is now allowing up to 400 LCVs on designated highways. All carriers within the Ontario LCV program are eligible for two permits each for their first year of operations, and on the one year anniversary of receiving LCV permits, a carrier will be eligible for up to four permits (Ontario Ministry of Transportation, 2009). Certain conditions come along with a LCV permit, such as the time of day/year the LCV can be driven, and speed restrictions.

Notably, freight railways are and will remain key opponents to LCV vehicles in both Canada and the United States. LCV vehicles are seen as a direct threat to the freight rail sector, representing a close substitute in the long haul transportation which could cut into market share and revenue streams.

c. Fuel Efficiency

In section A we have seen that intermediate inputs account for 61 per cent of gross output in the truck transportation subsector. In this subsector, fuel is the largest intermediate input. The following chart focuses on the evolution of the average retail prices for diesel. Diesel prices have doubled in Canada from an average of $0.67 per litre in 2000 to an average of $1.36 per liter in 2014 (Chart 12).

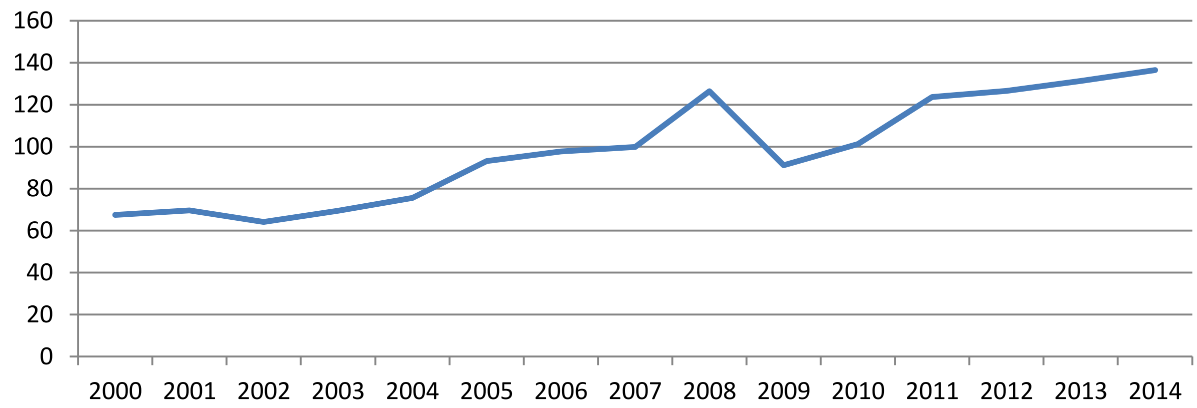
With the importance of fuel as an input in the trucking industry, increases in fuel efficiency are important to improve trucking productivity, especially at a time where fuel prices grow faster than trucking prices can keep up. In nominal terms, diesel fuel accounted for 14.1 per cent of gross output in 2011 (Statistics Canada Cansim table 381-0022).[32]

Fuel efficiency has increased in the trucking industry in a number of ways. First, the use of on-board computers to determine the ideal cruising speed has already been described above as a factor improving fuel efficiency. Second, in section A we have identified large increases in

[31] The safety of allowing longer trucks on the roads is also potentially a matter of concern. However, several studies have argued that LCVs increase safety. For example, Lemp et al. (2011) find that while LCVs are associated with more severe injuries when crashes occur, they are also less likely to be in crashes per vehicle-mile travelled so that they result in lower accident costs. This may be because they are regulated more strictly, requiring better-trained drivers, and are sometimes restricted from driving on certain roads and in poor conditions. LCVs also can reduce the total number of trucks on the roads, which can reduce the total number of accidents.
[32] See footnote 22 for other important intermediate outputs.

capital stock in recent years. This would include newer engines that are more fuel efficient than in the past. The uptake of improved engine technology raises the efficiency of intermediate inputs. Third, from 1985 to 2001, the average length of hauls increased steadily over time in the United States (Apostolides, 2009). The length of haul increased because shipments traveling over 250 miles have grown faster than local and short-haul shipments (United States Department of Transportation, no date). We can expect that a similar pattern occurred in Canada and that this trend has continued since 2001. Longer truck trips increase fuel efficiency as well as other inputs such as engine oils. These improvements in efficiency of intermediate inputs due to reallocation of resources toward longer trips contribute to increasing productivity in the truck transportation sector.

Chart 12: Average Retail Prices for Diesel Fuel at Self Service Filling Stations (Cents per Litre), Average of Select Urban Centers, Annual, Canada, 1997-2014



Source: Calculated by CSLS with data from Statistics Canada Cansim Table 326-0009. Based on Consumer Price Index sample survey.
Note: This is the average of prices in the following urban centers: St. John's, Newfoundland and Labrador; Charlottetown and Summerside, Prince Edward Island; Halifax, Nova Scotia; Saint John, New Brunswick; Québec, Quebec; Montréal, Quebec; Ottawa-Gatineau, Ontario part, Ontario/Quebec; Toronto, Ontario; Winnipeg, Manitoba; Regina, Saskatchewan; Saskatoon, Saskatchewan; Edmonton, Alberta; Calgary, Alberta;Vancouver, British Columbia; Victoria, British Columbia; Whitehorse, Yukon; Yellowknife, Northwest Territories

Canada is committed to increasing fuel efficiency in trucking and reducing greenhouse gas emissions. Natural Resources Canada administers two programs geared towards improving fuel efficiency in the trucking industry. The SmartWay program is designed to help businesses reduce fuel costs while transporting goods in the cleanest most efficient way possible. SmartWay works with freight carriers and shippers to benchmark their operations, track their fuel consumption and improve their annual performance.[33] This program was originally launched in 2004 by the United States Environmental Protection Agency in 2004, and has been administered in Canada by Natural Resources Canada since 2012. The other program is FleetSmart which

[33] See https://www.nrcan.gc.ca/energy/efficiency/transportation/commercial-vehicles/smartway/15541 for more information.

offers free training and information on technologies and practices that encourage fuel reduction and related GHG emissions. It is available to all commercial and institutional truck fleets.[34]

In fact, Transport Canada data show that the quantity of fuel as an input has increased 2.0 per cent per year between 2000 and 2008, while total input quantities have increased an average of 4.9 per cent per year for the same period. Fuel quantities growing slower than total inputs reflects increases in fuel efficiency.

One finally area of technological progress in fuel efficiency for trucking is changes in fuel types. Both Statistics Canada and Transport Canada report their fuel statistics in terms of litres of diesel consumed, and diesel remains the main fuel source in long-haul trucking, so heterogeneous fuel sources do not affect any of the statistics reported.

Some alternatives to diesel have shown promise in recent years, particularly the use of liquefied natural gas (LNG). LNG fuel is significantly less expensive per unit than diesel, however it also generates fewer miles per unit than diesel. The experience of Bison Transport from Winnipeg was that LNG costs about $1.50 less per gallon (around $0.39 less per litre) than diesel and was initially expected to be around 10 percent less efficient. Were it the case that the cost savings outweighed the efficiency loss, labour productivity could be improved by switching fuel sources. Unfortunately, Bison estimates the efficiency loss to be around 18 percent rather than 10 percent and has experienced significant increases in maintenance costs for LNG trucks.[35] Nonetheless, the use of LNG in the trucking subsector is one possible area for future productivity gains through technological advancement.

d. Mobile Backhaul Applications

Mobile applications are making an appearance in the trucking industry. These aid truckers in finding a backhaul. A backhaul is a load truckers can pick up during their return trip which helps cover the cost of their return trip. Traditionally, truckers look for paper ads on truck-stop bulletins and call around looking for a haul. This can be time consuming and cause truckers to have to wait if they do not find a haul. Truckers also go through the intermediary of brokers who help match truckers with loads for a cut of what the shippers pay the trucker. Mobile applications work in a similar manner as Uber, but for trucks. These apps match truckers with loads easily and typically at a lower cost than a broker.

An example of these apps is Keychain Logistics. This app has been downloaded by more than 20,000 drivers and uses geo-location information to match carriers with loads (Whelan, 2015). Another app example is Trucker Path Inc which has been downloaded 200,000 times by drivers and has launched a marketplace function which allows drivers to find loads on their phones (Whelan, 2015). UShip is another example.

---

[34] See https://www.nrcan.gc.ca/energy/efficiency/transportation/commercial-vehicles/fleetsmart/16930 for more information.

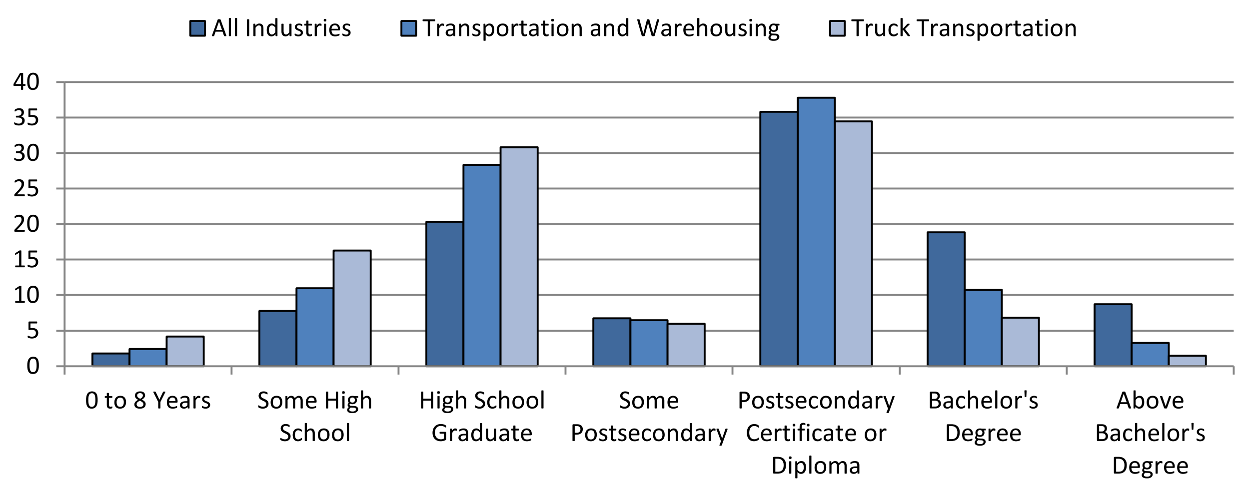
[35] See http://www.trucknews.com/products/early-lng-adopters-experience-mixed-results/ and http://www.reuters.com/article/lng-transportation-trucking-idUSL1N0MT10M20140409 for more information.

By matching drivers with backhaul loads, mobile applications facilitate the finding of loads by drivers so they can return home without the added inefficiency of an empty run. These apps also eliminate the need for a middleman, the broker, and they increase the haul of trucks as they return home. For these reasons, these applications increase the productivity of the trucking industry. Given that these applications are recent, the potential for increased productivity in the next years is high.[36]

v. Human Capital

The education level of workers can be linked to productivity. This section shows the state of formal education by providing a breakdown of workers by their highest educational attainment level in 2014.

Chart 13: Employed by Highest Level of Educational Attainment, Per Cent of Total, All Industries, Transportation and Warehousing, Truck Transportation, 2014



Source: Calculated by CSLS with data from the Labour Force Survey

The truck transportation subsector does not have a highly educated workforce. It has a higher percentage of workers whose highest level of educational attainment is high school and a lower percentage of workers having completed at least some postsecondary education than in the transportation and warehousing sector as a whole and in all industries.

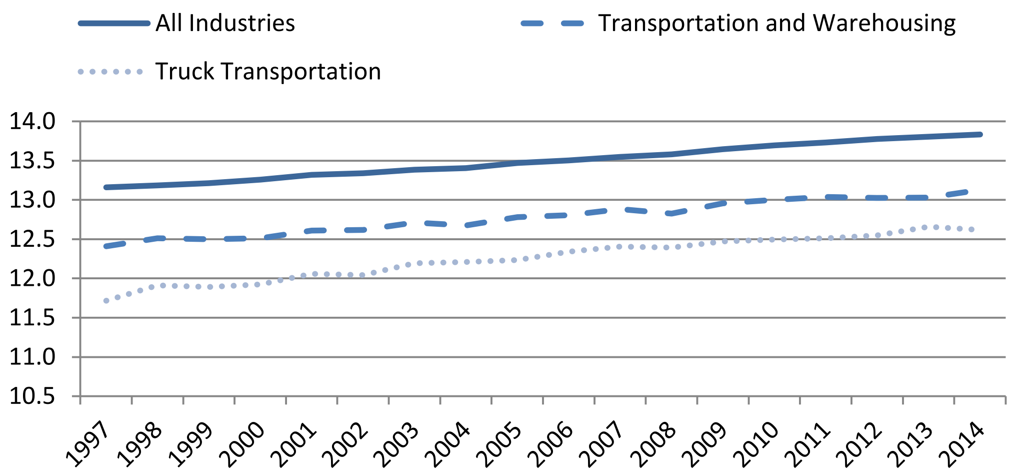
The lower educational attainment of workers in the transportation and warehousing sector is expected. The skills required by this sector do not require post-secondary education. It is interesting to note that 20 per cent of workers are not high school graduates. Because workers with no high-school diploma may have relatively weak literacy and numeracy skills, this can affect worker productivity in the truck transportation subsector.

---

[36] For more information on backhaul applications, see Whelan in the Wall Street Journal, 2015, or Singh in Forbes, 2015.

In 2014, the average worker in the truck transportation subsector had 12.6 years of schooling, which is 0.5 per cent less than in the transportation and warehousing sector as a whole, where the average worker had 13.1 years of schooling (Chart 14).[37] The average of years of schooling in the truck transportation subsector was also lower than in all industries where the average worker had 13.8 years of schooling. Between 2000 and 2014, the average years of school grew 0.69 years in truck transportation, 0.62 years in transportation and warehousing, 0.58 years in all industries.

Chart 14: Average Years of School per Worker, All Industries, Transportation and Warehousing, Truck Transportation, 1997-2014



Source: Calculated by CSLS with data from the Labour Force Survey

vi. Organizational Factors

a. Driver Shortage

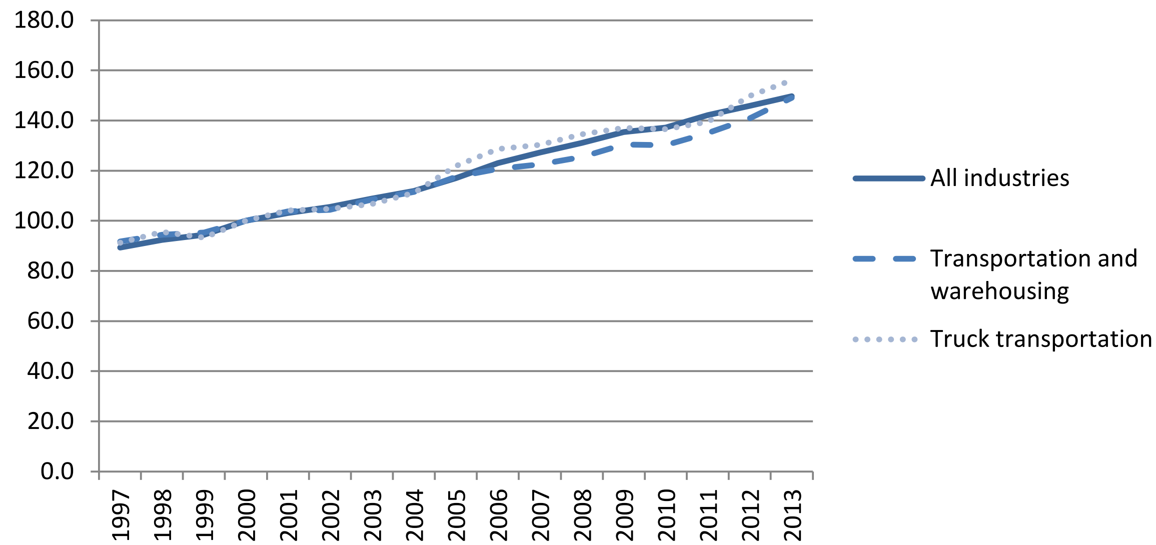
Not directly related to trucking productivity but worth mentioning is that the truck transportation subsector has been said to be experiencing a driver shortage (Gill & Macdonald, 2013, and Logistics Solution Builders Inc., 2005). The shortage is due in part to the aging labour force in general, but also to the fact that truck drivers have been wearing out more rapidly than the rest of the labour force because of long hours and irregular schedules (Dube & Pilon, 2006). The aging and wearing out of workers lead to their departure, and this created a shortage. These departing workers are not being fully replaced by younger workers. Gill & Macdonald (2013) expect that by 2020, the gap between the supply and demand of truck drivers will be 25,000 workers.

[37] Average years of schooling were calculated by attributing values for years of schooling in each category and computing the average of all cases. The following values were used: 0 to 8 years -8 years, some high school-10 years, high school graduate-12 years, some postsecondary-13 years, postsecondary certificate or diploma-14 years, bachelor’s degree-16 years, and above bachelor degree-18 years.

A shortage of truck drivers can lead to bottlenecks in the industry. This means, for example, that dispatchers may have the demand to dispatch a hundred trucks, but only 80 truck drivers are available. This can create added overhead labour costs and a stagnation of goods awaiting transport, which can affect many industries, especially for just-in-time inventory, where workers may be left sitting around waiting for shipments.

In the truck transportation subsector, the driver shortage does not directly affect productivity in an unambiguous way. Productivity is defined per unit of labour, therefore a lower output produced by a smaller amount of labour does not affect the productivity of these workers. The driver shortage causes more of an output problem for the trucking industry because firms do not have the labour necessary to provide their services and grow, as they are missing labour as an input. However, the shortage may indirectly reduce productivity by creating bottlenecks as described above. This can occur not only because there are not enough workers, but also because firms respond to the shortage by hiring or retaining less skilled or reliable workers.[38]

Chart 15: Total Compensation per Hour Worked in Current Dollars, All Industries, Transportation and Warehousing Sector, and Truck Transportation Subsector, 2000=100, 1997-2013



Source: Calculated by CSLS with data from Statistics Canada Cansim Table 383-0030. Based on Canadian Productivity Accounts.

A shortage of drivers can also affect wages. In a market, a demand that is larger than the supply raises prices. In the market for truck drivers, this means a shortage causes an increase in wages. Higher wages mean the cost of labour is increased, which in turn will raise prices. Chart 15 shows the growth in hourly compensation in the truck transportation subsector compared to the transportation and warehousing sector and all industries. Although the growth of hourly wage has been similar between the truck transportation subsector and all industries, the truck

[38] Alternatively, a shortage may also raise labour productivity. For example, if labour productivity is measured by output per worker, labour productivity may rise if a firm responds to a shortage of workers by offering its workers longer hours (ie. overtime).

transportation subsector has had a larger growth of the hourly wage in recent years than the transportation and warehousing sector of which it is part. The compound average annual growth has been 5.81 per cent per year between 2011 and 2013 in the truck transportation subsector, compared to 5.06 per cent per year in the transportation and warehousing sector as a whole, and 2.62 per cent per year in all industries. We can also note that wages have grown rapidly in 2012-2013. This is a symptom of the truck driver shortage and the trend will continue.

b. Intermodal Containers

Intermodal containers are not specific to the trucking industry, as they are related to intermodal transport, that is truck to rail transport or truck to ship transport. However, as they improve the productivity of intermodal transportation, they are worth discussing here. Intermodal containers allow the transportation of freight along multiple modes of transportation (truck, rail, air, and ship) without the freight itself being handled while changing modes. This reduction in the handling of freight speeds the transportation process and reduces costs. The reduction in handling time also means less time needed for yard workers to transfer one unit of goods between transport modes, which represents a significant improvement in productivity.

A container is a large box built to carry freight that is easily stackable, and made to be transferrable between modes. An example of intermodal transportation chain follows: A loaded container is transported by truck from the shipping facility to a train terminal. There, the container is loaded on a train and sent to a train terminal by a dock. From there, the container is loaded onto a ship and shipped overseas.

Containers make loading, unloading, and freight transferring more efficient. By doing this, they increase the productivity of intermodal transportation (Barnhart & Laporte, 2006). Due to the ubiquitous nature of these intermodal containers, truckers face far less of a risk of making “empty” return trips home.

C. Policies to Promote Productivity Growth

Part A described the state of the truck transportation subsector in Canada, which has experienced above average labour productivity growth. Section B addressed the drivers of this productivity growth. The goal of the current section is to put forward policies that promote the growth of the truck transportation subsector. These include continuing deregulation of the industry, allowing more LCVs on the roads, encouraging the use of more fuel efficient engines, promoting the trucking industry to fill the driver gap, continued enlarging of highways, and working with the US to alleviate border traffic.

i. Deregulation of the Industry

Section B has shown that deregulations in the trucking industry increased competition which stimulated productivity. It is important for policymakers to keep a deregulated approach to the trucking industry to sustain above average productivity growth in this industry. Relaxing truck weight regulations could further increase productivity in the truck transportation subsector, but the trade-off is increased costs for road and bridge maintenance.

Another policy alternative involving increased deregulation is slackening cabotage legislation. In the trucking transportation subsector, cabotage is an American driver hauling a load from a Canadian source to a Canadian destination despite not being a legal worker in Canada. As discussed below in the air transportation section, one benefit of cabotage is adding competition, which in turn puts pressure on firms to improve their productivity. However, unlike the air transport subsector, the trucking subsector is already fairly competitive. Consequently, the productivity benefits from cabotage are likely much smaller than other policies could muster.

ii. Increasing the Number of Long Combination Vehicles on Roads

Section B describes long combination vehicles (LCVs). These are combinations of vehicles which are more than 25 metres in length. As explained in section B, LCVs increase productivity because the cost per unit of transportation using LCVs is lesser than with regular trucks, due to fewer labour and fuel inputs.

LCVs are currently regulated and require permits to be operated. These permits are not easily accessible. For example, as described in section B, carriers in Ontario are eligible for two permits their first year of operations and four the next year. LCVs are banned in Newfoundland and Labrador, Prince Edward Island, Yukon, and Nunavut.

The trade-off of using LCVs is that these increase the need for road maintenance. However, the trucking industry is not responsible for the cost of road maintenance; therefore increasing the use of LCVs by relaxing restrictions would increase productivity in the trucking industry. Because safety is also a concern of LCVs, for example because these have more trailer sway, providing educational materials for potential drivers of LCVs could further increase their productivity.

Relaxing restrictions on LCVs could also have spillover effects on productivity in other transportation subsectors. As discussed in section B, LCVs are close substitutes to freight rail in the market for long haul transportation. By applying competitive pressure on freight railways, LCVs may indirectly promote productivity advancements in the freight rail subsector in addition to the trucking subsector.

iii. Encouraging Fuel Efficiency

When fuel prices are growing faster than trucking prices, increased fuel efficiency has the potential to increase productivity in the trucking industry. Fuel efficiency has the added benefit of having a positive impact on the environment by reducing polluting emissions. Programs (described in section B) are already in place in Canada to encourage fuel efficiency. Continued administration of these programs can continue to improve fuel efficiency in the trucking industry.

An important way that the fuel efficiency of trucks is increased is through improved engine technology. Policies that encourage the use of more fuel-efficient engines would raise productivity of the truck transportation subsector. For example, a tax deduction for truckers who replace their engine with a more fuel efficient model could provide the necessary incentive to increase fuel efficiency in the industry and therefore increase productivity. Offering accelerated capital cost allowances on purchases and upgrades of trucks and trailers would also encourage investment in more efficient technologies. Promoting the use of on-board computers and other such technology is another way by which fuel efficiency can be increased, as on-board computers that record activity have helped increase fuel efficiency, as described in section B.

iv. Enlarging of Highways

Road construction is one of the most important drivers of productivity in the truck transportation industry because roads are an essential input to trucking but the investment is not made by trucking firms, unlike in other transportation sectors. Canada has an extensive network of roads, described in section B, which has had its part in making the trucking industry more productive than the business sector average.

Policies that continue to increase the network of roads in Canada are favourable to the productivity of the trucking industry. Specifically, road enlargements by turning single lane highways into divided highways facilitate truck transportation and the use of LCVs. This, in turn, increases truck transport productivity.

v. Alleviating Traffic at Canada-United States Borders

Section B described that a thickening of Canada-United States borders following the events of September 11, 2011 that led to delays and increased costs in the trucking industry. Policies that can alleviate border traffic, such as developing a system to facilitate border crossing for trucks, or enlarging some of the most problematic borders and creating additional border crossings, could have a great impact on the productivity of truck transportation.

vi. Promoting the Trucking Industry

Although, as explained in section B, the driver shortage does not create a productivity problem in the trucking industry but only an output problem, policies to increase the proportion of young drivers and reduce the driver shortage are important because the bottlenecks caused by the truck driver shortage can affect the productivity of many other industries, particularly those with just in time inventory.

To become a trucker, individuals need a licence, a clean driving record, a clean criminal record, training, a written test, and a road test. There are also minimum age requirements. To promote the trucking industry among young adults, policies should address the costs of acquiring the necessary qualifications and licence to become a truck driver. Policies could also offer an incentive for the necessary training to operate a truck. Additionally, policies addressing the safety concerns of trucking, such as policies to regulate rest and break times, can help make the industry more attractive to prospective drivers.

Section 4: The Air Transportation Subsector

Air transportation plays an integral part in Canada's competitiveness and prosperity (Gill, Raynor & Neil, 2013). The air transportation subsector (481) is a North American Industry Classification System (NAICS) three digit subsector of transportation and warehousing (48-49). This subsector consists of establishments engaged in for-hire, common-carrier transportation of people and/or goods using aircrafts, such as airplanes or helicopters. It is worth noting that this subsector classification does not include support activities for air transportation, such as air traffic control, renting hangar space, baggage and cargo handling, aircraft parking services, servicing, maintentance, repair, inspection, and testing. These obviously contribute to the productivity of the air transportation subsector but fall under the NAICS code 488, support activities for transportation. Airport operations therefore do not fall under the air transportation subsector. More precisely, they fall under the NAICS 4881, support activities for air transportation.[39]

Table 30: Operating Profit/Loss, Air Transportation Subsector, Millions, 1999-2013

Year	Operating Profit/Loss
1999	575
2000	-130
2001	-570
2002	222
2003	-535
2004	-18
2005	1,048
2006	1,084
2007	1,270
2008	676
2009	-28
2010	1,158
2011	1,070
2012	1,321
2013	1,367
Compound Average Annual Growth (Per cent)	
1999-2013	6.38

Source: Statistics Canada Cansim Table 180-0003. Based on financial and taxation statistics for enterprises.

In December 2014, there were 647 air carriers in Canada.[40] The air transportation subsector in Canada is dominated by Air Canada. In 2003, this carrier filed for bankruptcy, which had an important impact on productivity in the subsector. This will be discussed in Section

[39] We have considered the effects of airport operations when identifying potential causes of productivity trends and policy implications. However, it is difficult to back these with data or to determine how including support activities for air transportation would have affected our productivity estimates as the required labour and output data are not available for this subsector on CANSIM.

[40] The air transportation subsector is made up of 2,619 establishments. It is unclear what an establishment is in the case of the air transportation subsector since this subsector does not include factory type establishments.

B. Many low cost carriers have tried to enter the market, but most fail after a short period. Examples of these are CanJet, JetsGo, Royal, and Canada 3000 (Competition Bureau, 2014). WestJet is an exception. It has grown to become the second largest carrier in Canada. In 2014, Air Canada had 55 per cent of the domestic market based on available seat-kilometers, while WestJet had 36 per cent (Transport Canada, 2014). Porter Airlines, which was established in 2009, has also emerged. Porter has the advantage of operating out of the Billy Bishop Toronto City Airport, located in downtown Toronto.

Profits are not always positive in this subsector. Losses started in 2000, leading to Air Canada's bankruptcy in 2003 (Table 30). Positive profit returned in 2005. Over the entire 1999-2013 period, profit grew an average of 6.38 per cent per year.

The air transportation subsector encompasses both passenger and freight travel. In 2014, 124.5 million enplaned and deplaned passengers were reported at Canadian airports, while Canadian and foreign air carriers at Canadian airports loaded and unloaded an estimated 1.1 million tonnes of freight (Transport Canada, 2015).

The goal of part A is to understand productivity in the Canadian air transportation subsector. Part A will describe the outputs, inputs, and productivity of the air transportation subsector. This will be done using Statistics Canada data and compared to Transport Canada data when possible. Part B will explain the drivers of productivity growth and part C will put forward policy recommendations to increase productivity growth in this subsector.

A. Economic and Productivity Performance

i. Output

a. Gross Output

Nominal gross output, the total value of sales, was $19.4 billion in 2011 in air transportation. The nominal gross output grew an average of 2.73 per cent per year between 2000 and 2011, from $14.4 billion in 2000 (Table 5-1 in the CSLS transportation database).[41] The growth of nominal gross output was slower in air transportation than in the transportation and warehousing sector of which it is part, where nominal gross output grew an average of 4.67 per cent per year for the same period. It was also slower than the growth in all industries, which averaged 4.06 per cent per year. The growth of nominal gross output has outpaced that of real GDP, which only increased at a rate of 1.94 per cent per year between 2000 and 2011.This is due to a slight growth in the share of intermediate inputs.

Transport Canada calculates a real gross output index. This is based on revenues deflated by a price index. According to this, real gross output grew an average of 1.09 per cent per year between 2000 and 2013. This growth is slower than the growth of nominal gross output

[41] The CSLS has put together a comprehensive database for the four modes of transportation examined in this report. The database will be posted with this report.

calculated from Statistics Canada data. Unfortunately, Statistics Canada does not provide a publicly available time series of real gross output. As such, the two measures of growth are not directly comparable.

Intermediates make up a very large share of value added in the air transportation subsector – around 70 per cent in most years over the 2000 to 2011 period. This share of intermediate goods has fluctuated somewhat between 2000 and 2011. It was lowest in 2000 (67.12 per cent) and highest in 2004 (74.20 per cent), while in 2011 it was 69.80 per cent. Therefore, between 2000 and 2011, the share of intermediate goods grew 2.68 percentage points. However, it is interesting to note that the share of intermediate goods jumped from 1999 to 2000 by 3.41 percentage points, so 2000 does not by any means represent a global low point for the share of intermediate goods in air transportation. The largest intermediate input is jet fuel, which accounted for 28 per cent of gross output in 2011 (Statistics Canada Cansim table 381-0022).[42,43] Intermediate inputs account for more of gross output in air transportation than in transportation and warehousing as a whole, where they accounted for 53 per cent of gross output in 2011, and than in all industries, where they accounted for 47 per cent in 2011.

b. Nominal GDP

Growth in nominal GDP was relatively slow in the air transportation subsector compared to other industries and the transportation sector more generally. In the air transportation subsector, nominal GDP only grew at a pace of 1.94 per cent from $4.9 billion to $5.8 billion, while the transportation and warehousing sector as a whole grew 4.05 per cent annually from 2000 to 2011 (Table 31). Output in the air transportation subsector declined every year from 1999 to 2003, even before the recession hit and while other sectors were recovering. Growth was considerably stronger after 2003 with a slight slowdown in 2008/9 coinciding with the global financial crisis. It took until 2010 to regain the 1999 level of output.

As in the truck transportation subsector, the large difference between nominal and gross output of the air transportation subsector is driven by the intermediate outputs accounting for a relatively large portion of gross output.

[42] Other important intermediate inputs are air transportation support services (15% of gross output), aircraft parts and equipment (4% of gross output), commercial and industrial machinery and equipment renting and leasing services (4% of gross output), and prepared meals (2% of gross output).
[43] The air transportation industry also uses gasoline which account for 0.08 per cent of gross output.

Table 31: Nominal GDP, Implicit Prices, and Real GDP, Air Transportation, 1997-2014

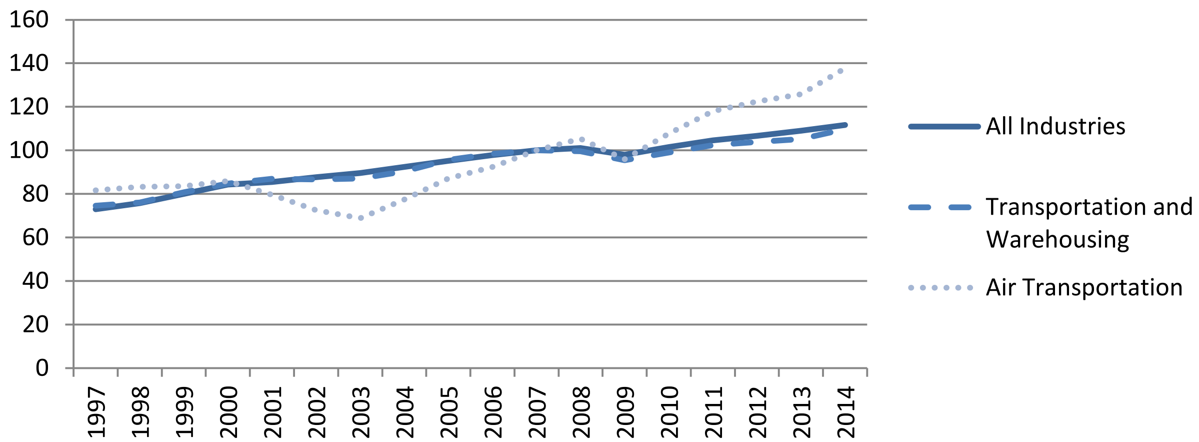
	Nominal GDP (Millions of Current Dollars)			Implicit Price Deflator			Real GDP (Millions of Chained 2007 Dollars)		
	All Industries	Transportation and Warehousing	Air Transportation	All Industries	Transportation and Warehousing	Air Transportation	All Industries	Transportation and Warehousing	Air Transportation
1997	837,260	37,116	…	78.23	79.70	…	1,070,192	46,569	3,963
1998	867,786	38,969	…	78.08	82.04	…	1,111,384	47,498	4,046
1999	932,530	41,265	4,944	79.49	81.85	121.74	1,173,088	50,415	4,061
2000	1,025,033	43,318	4,732	82.88	81.84	113.37	1,236,822	52,929	4,174
2001	1,058,086	45,941	4,014	84.36	84.63	103.79	1,254,236	54,286	3,867
2002	1,095,600	47,758	3,936	85.11	88.15	111.77	1,287,248	54,179	3,521
2003	1,157,137	48,401	3,200	88.03	88.99	95.58	1,314,512	54,391	3,348
2004	1,231,468	50,687	3,409	90.87	89.80	90.71	1,355,222	56,443	3,758
2005	1,312,696	55,968	4,202	94.04	93.65	99.35	1,395,920	59,765	4,230
2006	1,388,359	59,719	4,560	96.75	97.12	101.65	1,434,935	61,489	4,486
2007	1,466,692	61,140	4,856	100.00	97.89[1]	100.00	1,466,691	62,458	4,856
2008	1,551,684	62,150	4,573	104.7	99.82	89.40	1,482,081	62,261	5,115
2009	1,473,183	59,576	4,705	102.43	99.88	101.05	1,438,301	59,649	4,656
2010	1,564,105	63,101	5,531	105.03	102.03	105.74	1,489,226	61,847	5,231
2011	1,667,007	67,020	5,845	108.64	104.84	101.97	1,534,440	63,929	5,732
2012	**…**	…	…	…	…	…	1,565,595	64,839	5,945
2013	**…**	…	…	…	…	…	1,598,734	65,667	6,112
2014	**…**	…	…	…	…	…	1,637,656	68,596	6,686
				Compound Average Annual Growth (Per Cent)					
2000-2011	4.52	4.05	1.94	2.49	2.28	-1.13	1.98	1.73	2.93
2000-2013	…	…	…	…	…	…	1.99	1.67	2.98
2000-2014	…	…	…	…	…	…	2.03	1.87	3.42

Source: Statistics Canada Cansim Tables 379-0023 and 379-0029 (nominal GDP all industries and air transportation), 383-0032 (nominal GDP transportation and warehousing), and 379-0031 (real GDP) Based on Input-Output Accounts. Implicit price deflator calculated by CSLS. Growth rates from 379-0023 (1997-2008) used to link the GDP from 379-0029(2007-2011) to create a longer time series (the growth rate between two years is applied to a value to obtain an estimate of the value for the previous year).

1. It is unclear why this value is not 100. The 2007 value for nominal GDP should be the same as the real GDP because the real GDP is in 2007 dollars. These values are from Statistics Canada.

c. Real GDP

Chart 16: Real GDP, All Industries, Transportation and Warehousing Sector, and Air Transportation Subsector, 2000=100, 1997-2014



Source: Calculated by CSLS with data from Statistics Canada Cansim Table 379-0031. Based on Input-Output Accounts.

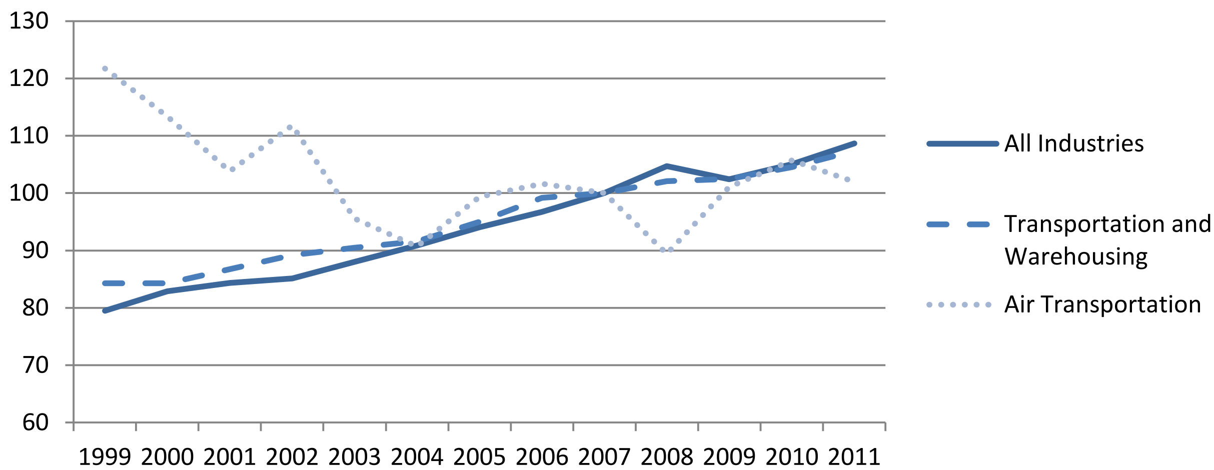
Real GDP is what is more relevant than nominal GDP for productivity assessment through time. One can see from Table 31 that real GDP in the sector was fairly stagnant between 1997 and 2003, falling from $3.9 billion to $3.3 billion. Performance was especially poor during the United States recession of 2001 and the aftermath of the September 11th attacks. However, growth in the sector has been very strong since 2003. By 2014, output had doubled, boasting an impressive average annual growth rate of 6.5 per cent between 2003 and 2014. Growth was consistently strong over the entire period with the exception of a slight decline during the recession of 2009.

In 2014, air transportation accounted for 0.41 per cent of the real GDP for all industries. This share has increased by 0.07 percentage points since 2000, which is a faster increase than in transportation and warehousing, which accounted for 4.19 per cent of the real GDP of all industries in 2014. In fact, transportation and warehousing decreased as a share of the real GDP of all industries, by 0.09 percentage points since 2000.

d. Prices

The ratio between nominal and real GDP provides an implicit price deflator which can be used to assess price movements in the sector through time. Between 2000 and 2011, the implicit price deflator decreased an average of 1.13 per cent per year (Table 31). Comparatively, in the transportation and warehousing sector as a whole as well as in all industries, the implicit price deflator grew over the same period. Interestingly, there were rapid declines in prices in the sector (a 25 per cent reduction) between 1999 and 2004. This decline in prices seems to have been specific to air travel as prices were rising in the aggregate transportation and warehousing sector over this period.

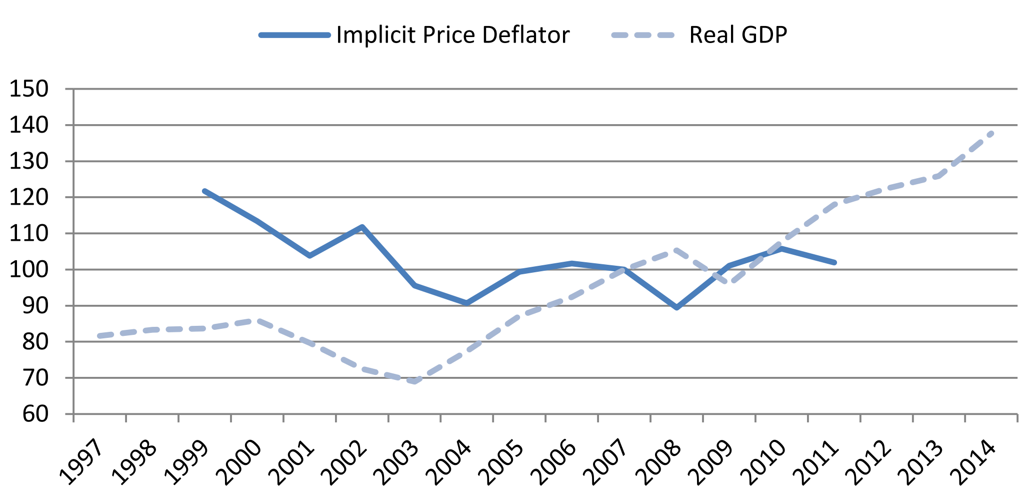
Chart 17: Implicit Price Deflator, All Industries, Transportation and Warehousing Sector, and Air Transportation Subsector, 2007=100, 1999-2011



Source: Calculated by CSLS with data from Statistics Canada Cansim Tables 379-0023 and 379-0029 (nominal GDP for all industries and air transportation), 383-0032 (nominal GDP for transportation and warehousing), and 379-0031 (real GDP). Based on Input-Output Accounts.

Transport Canada calculates an output price index. According to Transport Canada, output prices have grown 0.99 per cent per year between 2000 and 2013. This positive growth in prices contrasts with the negative growth of the implicit price deflator calculated from Statistics Canada data. The difference is, in part, because the Transport Canada output price index is based on gross output, while the implicit price deflator is calculated from GDP.[44] Chart 18 shows that the real GDP grew between 2000 and 2014, while nominal prices fell. The falling prices are due to two factors, cost cutting and more efficiency. This means a lower cost per unit of input as well as a more efficient use of inputs. This will be explored in Section B.

Chart 18: Implicit Price Deflator and Real GDP, Air Transportation Subsector, 2007=100, 1997-2014



Source: Calculated by CSLS with data from Statistics Canada Cansim Tables 379-0029, 379-0023 and 379-0031.

[44] The difference between Transport Canada data and Statistics Canada data will have to be explored further.

ii. Inputs

a. Employment

Employment in air transportation was growing at a faster pace than the broader economy between 1997 and 2000, but after 2000 there was a decline in employment in the industry (Table 32). This is likely linked to the falling prices and reduced demand for air transportation over this period. Employment continued to fall until 2004. Recall that this is when output in the sector began to surge. Interestingly, employment levels remained largely stagnant – one suspects that this was partly the result of significant restructuring in the industry which took place following Air Canada`s declaration of bankruptcy.

Table 32: Jobs and Hours Worked, All Industries, Transportation and Warehousing Sector, and Air Transportation Subsector, Thousands, 1997-2014.

	Jobs			Hours Worked		
	All Industries	Transportation and Warehousing	Air Transportation[1]	All Industries	Transportation and Warehousing	Air Transportation
1997	14,038	647	55	25,060,353	1,279,068	95,288
1998	14,353	663	59	25,570,682	1,325,665	101,634
1999	14,730	689	61	26,237,389	1,381,263	104,768
2000	15,067	702	65	26,801,128	1,394,972	112,223
2001	15,216	702	63	26,955,303	1,390,612	109,437
2002	15,589	714	61	27,337,720	1,409,576	105,115
2003	15,923	712	57	27,704,314	1,402,757	96,445
2004	16,190	727	54	28,487,799	1,459,753	90,970
2005	16,431	718	45	28,703,810	1,424,551	76,917
2006	16,702	752	48	29,137,021	1,495,267	81,459
2007	17,038	774	48	29,668,182	1,513,348	79,945
2008	17,285	767	47	29,986,515	1,493,833	76,365
2009	16,986	755	47	28,893,597	1,432,868	77,010
2010	17,298	781	55	29,459,132	1,497,236	94,320
2011	17,572	799	63	29,866,008	1,521,242	104,187
2012	17,764	817	66	30,421,795	1,552,733	107,718
2013	18,003	817	67	30,735,028	1,535,770	104,763
2014	18,109	832	67	30,846,788	1,587,949	111,313
	Compound Average Annual Growth (Per Cent)					
2000-2014	1.3	1.2	0.2	1.0	0.9	-0.1

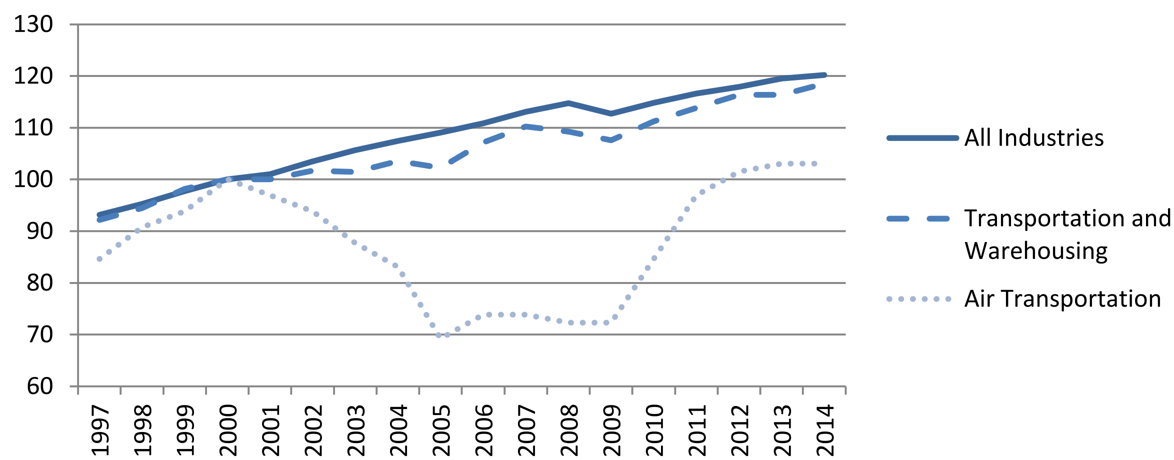
Source: Statistics Canada Cansim Table 383-0031. Based on Canadian Productivity Accounts.
[1]The fall in employment between 2004 and 2005 is not found in LFS and SEPH estimates. See Box 1 for more information about the LFS and SEPH estimates.

Employment remained more or less constant until 2009, after which it expanded rapidly. By 2011, employment in the subsector was more or less the same as it had been at its peak in

2000, although hours worked were 0.1 per cent lower. This implies a growth in part time work or a decrease in average hours worked per week which we will see below. Employment held steady at this level up to 2014, the most recent year for which data are available. Notice that employment remained virtually unchanged in 2013 compared to 2000 while real GDP grew nearly 50 per cent. The implication is that there was a large increase in labour productivity in the sector, which we will see in the next section.

One interesting fact about labour in the air transportation subsector is that jobs are associated with fewer hours of work on average than those in the general economy or the transportation and warehousing sector. For example, a pilot can only fly a maximum of 112 hours over 28 day period, which averages to 28 hours a week (Transport Canada, 2014).[45] In 2014, average weekly hours worked in the sector was 31.9 hours (Table 5-1 in CSLS Transportation Database). This compares to 36.6 hours in the transportation and warehousing sector and 32.6 hours in all industries. Hours have fallen considerably in the sector from 33.4 in 1997.

Chart 19: Jobs, All Industries, Transportation and Warehousing Sector, and Air Transportation Subsector, 2000=100, 1997-2014



Source: Calculated by CSLS with data from Statistics Canada Cansim Table 383-0031. Based on Canadian Productivity Accounts.

Transport Canada calculates a labour quantity index.[46] According to this, labour in air transportation has decreased an average of 2.45 per cent per year between 2000 and 2013. This is a stronger decrease than the small increase in workers (0.06 per cent per year) and the decrease in hours worked (0.65 per cent per year) from the Statistics Canada data. The large decrease in the Transport Canada dataset can be in part attributable to the restructuring of Air Canada, which

[45] Note that this is only a restriction on time in flight. In practice, pilots may work substantially longer hours on duty.

[46] The Transport Canada labour quantity index is based on a change in quantity of employees, weighted by the share in each category of employees (pilots, flight attendant personnel, administration staff, maintenance, aircraft servicing personnel, other) of the total wage expense (Gregory, 2012).

resulted in the spinning off of the aircraft maintenance division. Clerically, the division which was formerly counted as labour in their dataset became an intermediate (service) input, artificially creating a strong decrease in employees in the air transport subsector as a whole.[47]

Total compensation per hour worked in 2014 was $43.09 in the air transportation subsector, which is more than in the transportation and warehousing sector as a whole ($31.24) and than in all industries ($34.01) (Table 33). The total compensation per hour worked grew an average of 2.39 per cent per year in the air transportation subsector between 2000 and 2014, which is a slower growth than in the transportation and warehousing sector as a whole (2.70 per cent) and than in all industries (3.19 per cent). Therefore, while hours worked decreased in the air transportation subsector, wages increased.

Table 33: Total Compensation per Hour Worked, Dollars, All Industries, Transportation and Warehousing and Air Transportation, 1997-2014

	All industries	Transportation and warehousing	Air transportation
1997	19.56	19.86	27.31
1998	20.22	20.38	27.99
1999	20.68	20.55	30.10
2000	21.90	21.51	30.97
2001	22.59	22.33	31.88
2002	23.12	22.46	32.08
2003	23.85	23.46	33.98
2004	24.50	24.01	36.56
2005	25.64	25.32	35.69
2006	26.94	25.98	36.57
2007	27.99	26.12	40.71
2008	28.94	26.69	42.98
2009	29.79	27.44	44.38
2010	30.13	27.29	39.35
2011	31.23	28.36	38.77
2012	31.99	29.00	40.16
2013	32.96	30.74	44.61
2014	34.01	31.24	43.09
	Compound Average Annual Growth (Per Cent)		
2000-2014	3.19	2.70	2.39

Source: Statistics Canada Cansim Table 383-0031.

[47] Information obtained through correspondence with Transport Canada officials.

Table 34: Depreciation, Real and Net Total Fixed Non-Residential Investment, All Industries, Transportation and Warehousing Sector, and Air Transportation Subsector, Millions of Chained 2007 Dollars, 1997-2013

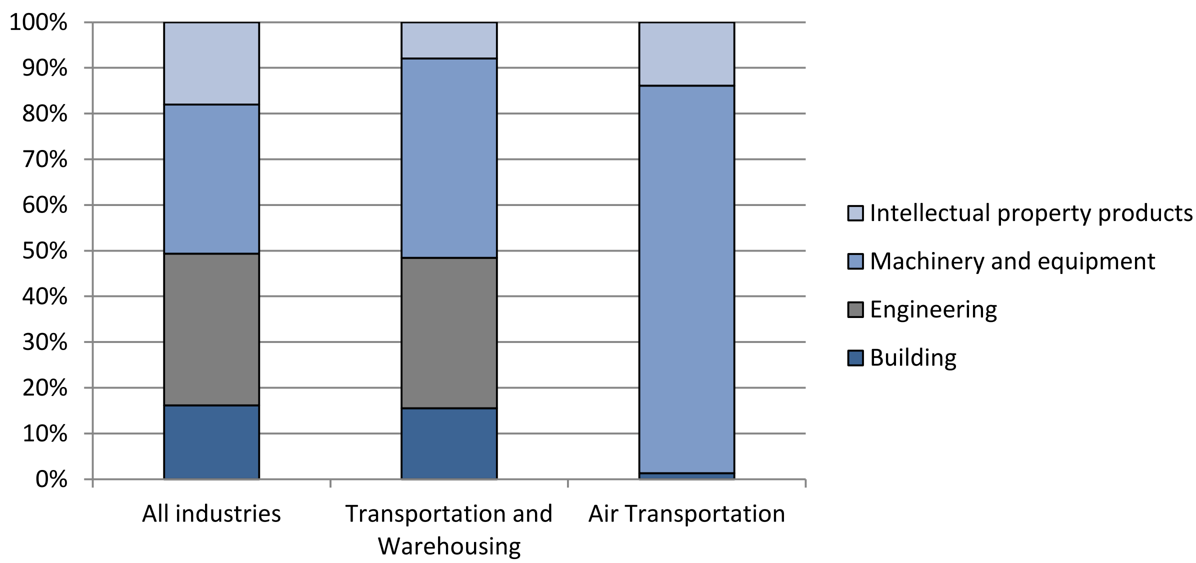
	Real Investment			Depreciation			Real Net Investment		
	All Industries	Transportation and Warehousing	Air Transportation	All Industries	Transportation and Warehousing	Air Transportation	All Industries	Transportation and Warehousing	Air Transportation
1997	149,863	9,664	2,200	125,677	7,803	1,521	24,185	1,861	678
1998	158,463	13,788	2,171	133,183	8,669	1,692	25,281	5,119	478
1999	167,359	15,086	3,148	140,857	9,793	1,907	26,502	5,294	1,241
2000	175,814	12,286	2,386	148,611	10,408	2,089	27,203	1,878	297
2001	180,948	12,244	3,381	155,583	10,735	2,247	25,365	1,508	1,134
2002	176,598	11,985	2,433	160,913	11,078	2,379	15,685	907	54
2003	188,065	9,789	1,681	165,579	11,180	2,338	22,486	-1,391	-657
2004	205,484	9,790	1,639	171,848	11,051	2,234	33,637	-1,261	-594
2005	229,154	12,499	3,284	181,345	11,264	2,310	47,810	1,235	974
2006	248,386	14,249	2,321	193,042	11,815	2,432	55,344	2,434	-111
2007	255,890	16,283	4,114	204,405	12,528	2,599	51,485	3,755	1,515
2008	267,824	19,924	3,627	214,535	13,406	2,843	53,289	6,518	785
2009	232,217	17,057	2,235	218,881	14,023	2,883	13,336	3,035	-647
2010	262,785	15,128	1,576	221,663	14,236	2,727	41,123	893	-1150
2011	276,557	16,434	1,399	228,634	14,450	2,509	47,923	1,984	-1,110
2012	286,560	18,204	1,792	236,207	14,873	2,367	50,353	3,331	-575
2013	287,126	20,215	2,165	243,084	15,469	2,322	44,042	4,747	-157
				Compound Average Annual Growth (Per Cent)					
2000-2013	3.85	3.90	-0.75	3.86	3.10	0.81	3.78	7.39	…

Source: Statistics Canada Cansim Table 031-0002. Based on Stock and Consumption of Fixed Non-Residential Capital.

b. Investment

Alongside labour, capital serves as the other major input in production. Although capital is often leased in the air transportation subsector, the stock of capital is also accumulated over time through investment net of depreciation. In 2013, real investment in air transportation was $2.17 billion (Table 34). Historically, investment as a share of real GDP was very high in air transportation compared to the share in the total economy and the transportation and warehousing sector, with investment even reaching 87 per cent of real GDP in 2001 in air transportation. In 2013, real investment was 35.4 per cent of real GDP in the air transportation subsector, compared to 30.9 per cent in transportation and warehousing and 18.0 per cent in all industries. In 2013, depreciation in the air transportation subsector was even larger than investment, $2.3 billion, so that real investment net of depreciation was -$157 million. This contrasts with the 1997-2002 period in which net investment in the sector was always positive and averaged $647 million annually.

Chart 20: Real Total Fixed Non-Residential Investment in the Air Transportation Subsector, Breakdown by Asset as a Share of Total Investment, 2013



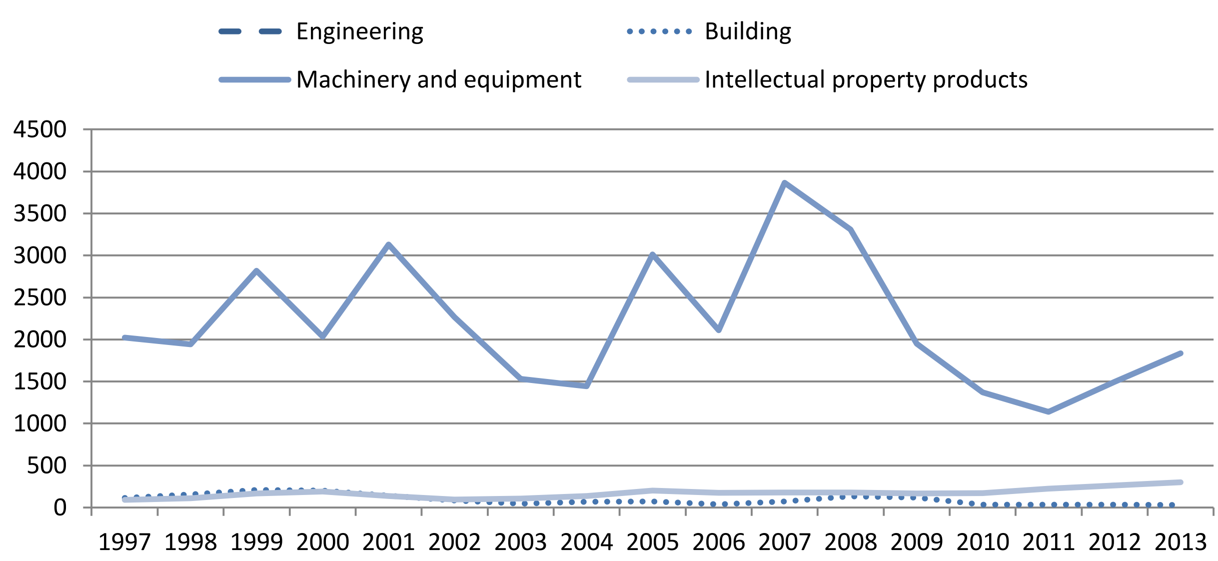
Source: Calculated by CSLS with data from Statistics Canada CANSIM table 031-0002. Based on Stock and Consumption of Fixed Non-Residential Capital.
Note: Statistics Canada does not publish estimates for engineering in the air transportation sector due to concerns about reliability.

Investment can take several forms. The largest investments in the air transportation subsector are related to machinery and equipment, most notably airplanes which are expensive. Machinery and equipment represented 85 per cent of total investment in the sector in 2013, a far greater share than is typical in transportation and warehousing or the total economy (44 per cent and 33 per cent respectively) (Chart 20). Engineering investment was negligible and investment in buildings was very low (1.3 per cent). This low percentage of investment for buildings is expected since airports are part of another subsector, support activities for air transportation.

Chart 21 shows how investment in the four components has changed over time. Notice that the volatility in machinery and equipment investment is far greater than the total value of investment in the other components. Investment in this category has fluctuated around $2.5 billion over most of the 1997-2013 period, although it notably low over the 2003-2004 period when Air Canada was in trouble financially and in every year since the global financial crisis. This prolonged period of low investment is of some concern, as new machinery and equipment which embodies technological progress is critical for productivity in the industry going forward.

Investments in intellectual property and buildings have also varied quite a bit through time. Generally, intellectual property has seen increased investment since about 2003 and is currently at its highest level since 1997. Investment in buildings has been very low through most of the 2000s. It was slightly elevated in 2008 and 2009, but investment in this category had been notably greater in the late 1990s.

Chart 21: Real Total Fixed Non-Residential Investment in the Air Transportation Subsector, Breakdown by Asset, Millions of Chained 2007 Dollars, 1997-2013



Note: Statistics Canada does not publish estimates for engineering in the air transportation sector due to concerns about reliability.
Source: Calculated by CSLS with data from Statistics Canada CANSIM table 031-0002. Based on Stock and Consumption of Fixed Non-Residential Capital.

c. Capital

Investment is important in that it is a driver of changes in the capital stock. However, the total size of the capital stock is what is more relevant for understanding output and productivity trends. The capital stock is the cumulative impact of net investment over an extended period of time. The net capital stock of air transportation was $11,365 as of 2013 (Table 35). While it has grown compared to 1997, it has been shrinking at an annual rate of -0.17 per cent since 2000. As mentioned earlier, capital is frequently leased by airlines. A decrease in capital stock may be due to an increase in planes being leased.

Compared to the transportation and warehousing sector and the total economy, the capital stock in air transportation has been volatile. It grew considerably early in the time period until about 2001/2002. Strong investment in 2007 and 2008 pushed the capital stock to an all-time high ($14,996 million chained 2007 dollars in 2008), but it has fallen considerably since 2008 to $11,365 million chained 2007 dollars, which is lower than in 2000. Like the stagnant employment growth since 2000, this lack of capital accumulation while output growth has been strong suggests that there has been significant growth in capital productivity in this sector.

Table 35: Real Total Fixed Non-Residential Geometric End of Year Gross Stock and Geometric End of Year Net Stock, Millions of Chained 2007 Dollars, All Industries, Transportation and Warehousing Sector, and Air Transportation Subsector, 1997-2013

	End of Year Gross Stock			Geometric End of Year Net Stock		
	All Industries	Transportation and Warehousing	Air Transportation	All Industries	Transportation and Warehousing	Air Transportation
1997	2,840,265	215,377	25,570	1,317,326	88,523	9,356
1998	2,910,565	224,598	26,880	1,347,976	94,880	9,918
1999	2,978,531	236,613	29,119	1,376,679	102,760	11,270
2000	3,050,963	242,524	30,456	1,407,019	104,861	11,626
2001	3,120,137	247,762	32,673	1,434,355	106,691	12,888
2002	3,176,095	251,971	33,695	1,450,191	107,876	13,008
2003	3,233,818	252,982	33,723	1,474,036	106,453	12,368
2004	3,299,222	253,356	33,521	1,509,779	105,193	11,774
2005	3,381,391	256,330	34,905	1,559,783	106,636	12,792
2006	3,477,036	260,756	35,204	1,616,688	109,188	12,685
2007	3,572,845	266,769	37,214	1,668,675	113,016	14,212
2008	3,671,527	275,718	38,607	1,721,451	119,466	14,996
2009	3,724,916	281,418	38,516	1,733,028	122,504	14,359
2010	3,804,615	284,787	37,657	1,773,755	123,475	13,218
2011	3,889,710	288,998	36,543	1,821,693	125,514	12,122
2012	3,977,473	294,585	35,782	1,872,074	128,852	11,543
2013	4,058,877	301,718	35,362	1,916,594	133,534	11,365
			Compound Average Annual Growth			
2000-2013	2.22	1.69	1.16	2.41	1.88	-0.17

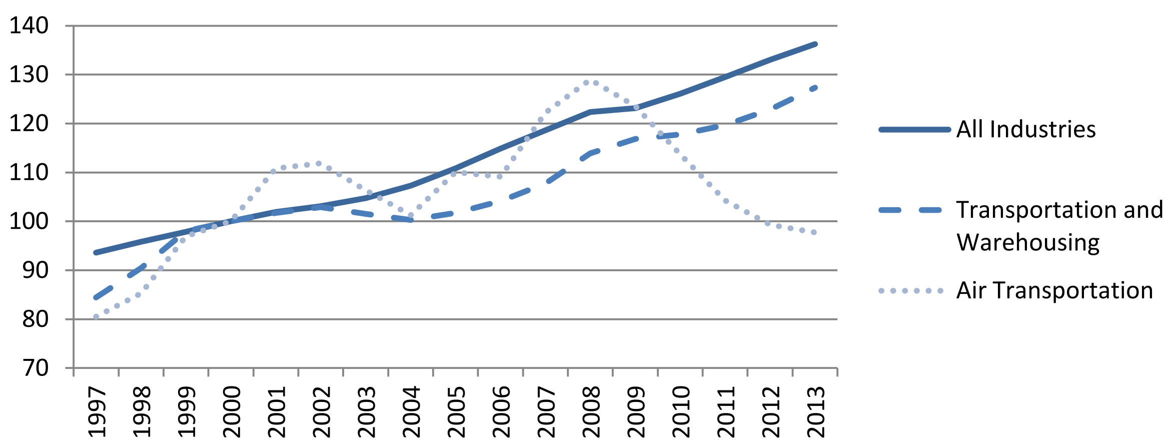
Source: Statistics Canada Cansim Table 031-0002. Based on Stock and Consumption of Fixed Non-Residential Capital.

Exchange rates may also have a significant effect on the capital investment behaviour of firms in the air transportation subsector as much of the capital employed by firms is imported. For example, a strong Canadian dollar may stimulate companies to buy planes outright rather than lease them if new planes are purchased abroad (in foreign currency) and leasing is primarily from domestic firms (in Canadian currency), thereby increasing their capital stock. Even if both leasing and purchasing of aircraft occur in foreign currency, a strong dollar may encourage firms to lock in purchases (a larger, long term expenditure) rather than leasing short term. The opposite effect may be observed when the Canadian dollar is performing poorly.

Transport Canada finds a slight increase in the capital stock, of an average of 0.03 per cent per year between 2000 and 2013, which is similar to the 0.17 per cent decrease found by Statistics Canada.

The breakdown of the capital stock into its components bears some resemblance to that of investment, but buildings are a larger component (9.1 per cent in 2013) while intellectual property is somewhat smaller (2.9 per cent in 2013). Since 2000, the capital stock in buildings has shrunk at a rate of 0.9 per cent annually and machinery and equipment has declined by 0.3 per cent annually. Meanwhile, engineering capital has grown by 1.7 per cent annually, although most of this growth has occurred since 2010 – it had actually fallen by over 20 per cent between 2000 and 2010. Intellectual property products, which have historically been a relatively small part of the capital stock experienced the strongest growth of 3.3 per cent annually over the 2000-2013 period.

Chart 22: Real Total Fixed Non-Residential Geometric End of Year Net Stock, Air Transportation Subsector, 2000=100, 1997-2013



Source: Calculated by CSLS with data from Statistics Canada Cansim Table 031-0002. Based on Stock and Consumption of Fixed Non-Residential Capital.

iii. Productivity

a. Labour Productivity

Labour productivity is the ratio of output to labour input. Labour productivity, based on real GDP per hour worked, is fairly high in air transportation, generating $60.1 of output per hour compared to $43.2 in the transportation and warehousing sector and $53.1 in the total economy in 2014 (Table 36). Labour productivity in the air transportation subsector was 113 per cent relative to all industries in 2014, indicating an above-average performance. Comparatively, in transportation and warehousing labour productivity was 81.4 per cent relative to all industries. Notice that in 1997, labour productivity in air transportation had actually been below the all economy average, indicating that there have been large improvements. Indeed, productivity growth occurred at an impressive rate of 3.48 per cent between 2000 and 2014 in air transportation compared to the dismal rate of 1.00 per cent in the total economy. Labour productivity in air transportation has been performing extremely well, in part due to the fact, as mentioned earlier, that workers in air transportation work less hours than average.

Table 36: Labour Productivity, Air Transportation Subsector, Chained 2007 Dollars, 1997-2014

	Real GDP per Hour Worked			Real GDP per Job		
	All Industries	Transportation and Warehousing	Air Transportation	All Industries	Transportation and Warehousing	Air Transportation
1997	42.7	$36.4	$41.6	76,235	$72,025	$72,556
1998	43.5	35.8	39.8	77,430	71,597	68,541
1999	44.7	36.5	38.8	79,638	73,218	66,487
2000	46.1	37.9	37.2	82,087	75,408	63,857
2001	46.5	39.0	35.3	82,428	77,339	61,066
2002	47.1	38.4	33.5	82,573	75,879	58,059
2003	47.4	38.8	34.7	82,552	76,363	59,032
2004	47.6	38.7	41.3	83,706	77,606	69,793
2005	48.6	42.0	55.0	84,958	83,192	93,625
2006	49.2	41.1	55.1	85,913	81,799	93,468
2007	49.4	41.3	60.7	86,082	80,744	100,789
2008	49.4	41.7	67.0	85,743	81,227	108,265
2009	49.8	41.6	60.5	84,677	79,037	98,280
2010	50.6	41.3	55.5	86,092	79,234	94,388
2011	51.4	42.0	55.0	87,322	79,967	90,948
2012	51.5	41.8	55.2	88,133	79,379	90,185
2013	52.0	42.8	58.3	88,806	80,401	91,868
2014	53.1	43.2	60.1	90,432	82,482	99,880
	Compound Average Annual Growth (Per Cent)					
2000-2010	0.9	0.85	4.08	0.5	0.50	3.99
2000-2014	1.0	0.93	3.48	0.7	0.64	3.25

Source: Calculated by CSLS with data from Cansim Tables 379-0031 and 383-0031. Based on Input-Output Accounts and Canadian Productivity Accounts.

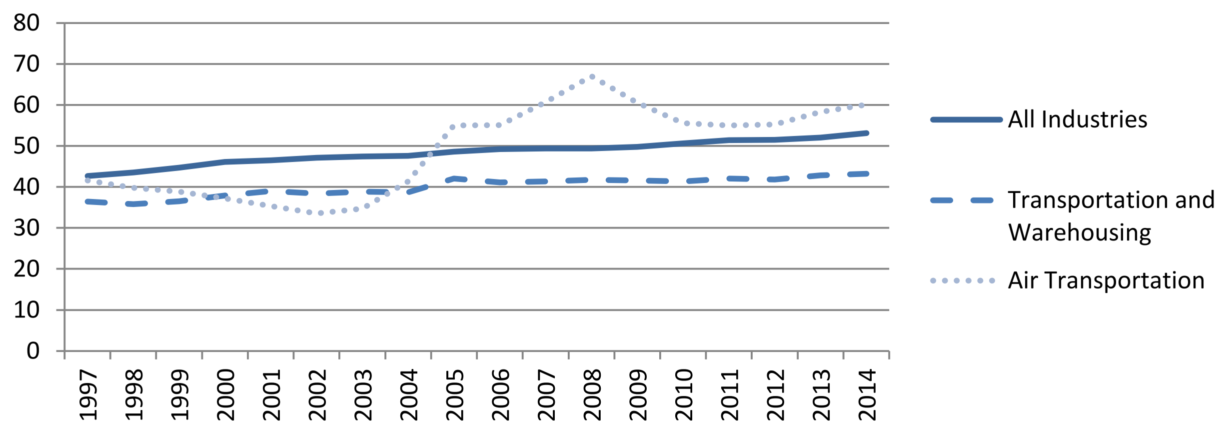
It is interesting to note that most of the growth in labour productivity (defined as real GDP per hour worked) is concentrated between 2003 and 2005 (Chart 23). Labour productivity in the subsector had gradually been in decline between 1997 and 2002 as employment was slow to fall compared to output. However, labour productivity surged in 2005. Recall that employment in the sector was falling until 2005 while there was significant growth in output between 2003 and 2005. The natural suspicion is that the financial difficulties facing the airline industry, especially Air Canada, at this time forced it to cut non-essential staff and to use existing resources more effectively.

Table 37: Labour Productivity Relative to All Industries, Transportation and Warehousing, Air Transportation, Per Cent, 1997-2014

	Real GDP per Hour Worked		Real GDP per Job	
	Transportation and Warehousing	Air Transportation	Transportation and Warehousing	Air Transportation
1997	85.25	97.42	94.48	95.17
2000	82.21	80.69	91.86	77.79
2010	81.62	109.68	92.03	109.64
2014	81.36	113.18	91.21	110.45
	Compound Average Annual Growth (Per Cent)			
2000-2010	-0.07	3.12	0.02	3.49
2000-2014	-0.07	2.45	-0.05	2.54

Source: Calculated by CSLS with data from Cansim Tables 379-0031 and 383-0031. Based on Input-Output Accounts and Canadian Productivity Accounts.

Chart 23: Labour Productivity Defined as Real GDP per Hour Worked, All Industries, Transportation and Warehousing, and Air Transportation, Chained 2007 Dollars, 1997-2014



Source: Calculated by CSLS with data from Cansim Tables 379-0031 and 383-0031. Based on Input-Output Accounts and Canadian Productivity Accounts.

Between 2005 and 2008, this labour productivity growth slowed, but continued until productivity reached $67.0 per hour in 2008. Since then, productivity has declined. Recall that output temporarily dropped in 2009 and that there was a very strong increase in the number of hours worked in the sector between 2009 and 2011, increasing from 79,000 to 106,000 in just two years, after years of holding labour input steady. Meanwhile, weak investment has lead to a declining capital-labour ratio since 2008. The two big mysteries which need to be unravelled to understand labour productivity trends in the sector seem to be:

i. Why did labour productivity rise so drastically (nearly 65 per cent) between 2003 and 2005?
ii. Why, after so many years of high output growth with no change in employment did labour input suddenly increase 35 per cent between 2009 and 2011?

Labour productivity can also be defined as real GDP per worker. This tells a similar story as real GDP per hour, although it is less representative of productivity of the sector since hours can fluctuate more than employment. Real GDP per worker was $99,880 in 2014 in air transportation, compared to $82,842 in transportation and warehousing and $90,432 in all industries. Between 2000 and 2014, real GDP per worker increased an annual average of 3.99 per cent, which is much more than in transportation and warehousing (0.64 per cent) and all industries (0.69 per cent).

Table 38: Labour Productivity (per Hours Worked) in the United States, Business Sector and Air Transportation Subsector, 2007=100, 1997-2014

	Business Sector	Air Transportation
1997	75.4	51.8
1998	77.7	50.2
1999	80.5	56.5
2000	83.2	59.0
2001	85.5	56.4
2002	89.2	62.5
2003	92.6	69.0
2004	95.6	78.1
2005	97.6	84.3
2006	98.5	95.4
2007	100.0	100.0
2008	100.8	107.2
2009	104.1	104.9
2010	107.6	102.1
2011	107.6	101.7
2012	108.4	107.9
2013	108.9	114.3
2014	109.5	114.0
Compound Average Annual Growth (Per Cent)		
2000-2010	2.60	5.64
2000-2014	1.98	4.82

Source: United States Bureau of Labor Statistics. http://www.bls.gov/data/

According to Transport Canada data, labour productivity (based on workers) increased an average of 2.63 per cent per year between 2000 and 2013. This is a slower increase than the increase in labour productivity calculated from Statistics Canada data.

Unfortunately, GDP and employment data for the air transportation subsector from Statistics Canada are suppressed at the provincial level, making a provincial labour productivity comparison impossible.

In the United States, the Bureau of Labor Statistics produces indexes of labor productivity for air transportation (Table 38). Similarly to Canada, labour productivity in the air transportation subsector grew much faster than in the business sector in general, by an annual average of 5.64 per cent between 2000 and 2010 in air transportation compared to 2.60 per cent in the overall business sector.

b. Capital Productivity

Table 39: Real Capital Stock Productivity, Value Added Produced by $1000 of Real Capital Stock, Chained 2007 Dollars, All Industries, Transportation and Warehousing, and Air Transportation Subsector, 1997-2013

	All Industries	Transportation and Warehousing	Air Transportation
1997	812	526	424
1998	824	501	408
1999	852	491	360
2000	879	505	359
2001	874	509	300
2002	888	502	271
2003	892	511	271
2004	898	537	319
2005	895	560	331
2006	888	563	354
2007	879	553	342
2008	861	521	341
2009	830	487	324
2010	840	501	396
2011	842	509	473
2012	836	503	515
2013	834	492	538
Compound Average Annual Growth (Per Cent)			
2000-2013	-0.40	-0.20	3.16

Source: Calculated by CSLS with data from Statistics Canada Cansim Tables 379-0031, 031-0003, and 031-0002. Based on Input-Output Accounts and Stock and Consumption of Fixed Non-Residential Capital.

Similar to labour productivity, it is also possible to develop a partial measure of how many dollars of output have been produced per thousand dollars of the capital stock. Notice that capital productivity is quite low compared to all industries, indicating that air transportation is a relatively capital intensive activity. In 2013, capital productivity was $538 in air transportation but $834 in all industries (Table 39). However, capital productivity was lower in the transportation and warehousing sector as a whole than in air transportation, at $492 in 2013. From 1997 to 2003, capital productivity fell from $424 to $271. This generally coincides with the period of high investment and non-increasing output. Capital productivity rebounded somewhat following the restructuring of Air Canada, but remained around 335 over the 2004 to 2009 period. However, capital productivity in the sector spiked between 2009 and 2013, rising from 324 up to 538. This is not so surprising given that output continued to grow strongly over this period while net investment was negative. Over the 2000 to 2013 period, capital productivity increased by an annual average of 3.16 per cent in air transportation, while in the transportation and warehousing sector it decreased by an annual average of 0.20 per cent and in all industries it decreased by an average of 0.40 per cent. Note that capital productivity started higher in transportation and warehousing than in air transportation in 1997, and subsequently decreased until it was lower in 2013.

Table 40: Capital Productivity in the United States, Air Transportation, 1997-2013

	Air Transportation
1997	91.62
1998	82.63
1999	78.76
2000	75.74
2001	67.37
2002	67.50
2003	71.92
2004	82.64
2005	91.30
2006	94.63
2007	100.00
2008	98.52
2009	95.40
2010	96.42
2011	98.79
2012	102.30
2013	104.49
Compound Average Annual Growth (Per Cent)	
2000-2013	2.51

Source: United States Bureau of Labor Statistics. http://www.bls.gov/data/

As mentioned earlier, airlines frequently lease rather than own their aircraft, and leased aircraft may not show up in the capital stock. It is possible that the share of planes being leased has changed significantly over time which would skew the capital stock and hence the output-capital ratio.

Transport Canada also calculated an estimate of capital productivity. According to Transport Canada, capital productivity has increased an average of 1.06 per cent per year between 2000 and 2013. This is a much slower increase than what was calculated using Statistics Canada data. The difference is in part due to Transport Canada estimating a faster growth of capital stock than Statistics Canada (see section ii. c capital).

In the United States, the growth of capital productivity was also strong, at an annual average of 2.51 per cent per year, although not as strong as in Canada (Table 40).

c. Multifactor Productivity

Statistics Canada data on total factor productivity is not available at the disaggregated level for the air transportation subsector.[48] However, Transport Canada calculates estimates of total factor productivity. According to Transport Canada, total factor productivity has increased 2.30 per cent per year between 2000 and 2013 in the air transportation subsector.

B. Explaining Productivity Trends

Part A described in detail outputs and inputs of the air transportation subsector as well as its productivity. Section A showed drastic growth of labour productivity and above-average growth of capital productivity. The goal of the present section is to explain the drivers of the productivity growth in the air transportation subsector.[49]

i. Policy

a. Deregulation

Deregulation of the air transportation subsector has lead to increased productivity. This section will first provide a timeline of air transportation deregulation in Canada and then describe regulations still in place which limit productivity growth.

Air Canada came into existence in 1937 as TransCanada Air Lines when the federal government founded it as a crown corporation to provide air transportation across the country (Oum, Waters & Yu, 1991). Following this and until the early 1970s, the airline industry was heavily regulated. In 1978, the Air Canada Act came into effect. This transformed Air Canada into a wholly owned subsidiary of the Canadian government and ended the government's direct control over routings, fares, and services, bringing Air Canada more fully into competition with other airlines (Funding Universe, no date). In 1987, the National Transportation Act brought complete deregulation of the Canadian airline industry and privatization of Air Canada (Funding Universe, no date). The goal of this deregulation was to stimulate competition among airline

[48] It is only available for an aggregate of air, rail, water and scenic and sightseeing transportation and support activities for transportation.

[49] Note that, unlike for truck transportation and urban transit systems, it will not be possible to report on labour productivity growth decomposition as Statistics Canada does not provide these data for the air transportation subsector.

carriers and place a greater emphasis on the market (Bergeron-Oliver, 2013).[50] Such policies have put decision-making in the right place, with the air carriers, air navigation system operators, or airports (Gill, Raynor & Neil, 2013). According to Iacobacci & Schulman (2009), industry deregulation led to an above average productivity growth in the air transportation subsector from 1981 to 2006.

The OECD produces an index of the degree of regulation in the airline industry between 1975 and 2013 based on entry barriers and the degree of public ownership. The index ranges from a maximum of 6.00 (high regulation) to a low of 0.00 (low regulation). Canada had the maximum score of 6.00 from 1975 to 1987. The index fell to 3.00 by 1989. It further fell from 3.00 in 1994 to 1.00 by 1997 where it has remained since. Canada's international ranking was the fifth-lowest out of 35 countries in 1990 (indicating low regulation), but has since regressed to 22nd out of 44 as of 2013 (as other countries went further in deregulating).[51]

Of course, a few legitimate exceptions to deregulation exist, regarding safety, bilingualism, and foreign control. An example of a foreign control policy is the prohibition of cabotage. Cabotage is the right to operate within the domestic borders of another country. This prohibition means a foreign airline cannot serve people in Canada by flying between two Canadian cities. This is done for reasons of economic protectionism, national security and public safety. However, this is not favourable to productivity growth because it limits competition for Canadian airlines.

Another policy which affects productivity growth is the night time constraints of Canadian airports. These are to avoid excessive airplane noise in residential neighbourhoods near airports at night. For example, the Pearson airport in Toronto has a night flight restriction program between 12:30 and 6:30 am (Toronto Pearson, no date). Because planes are expensive, these should be used as often as possible to maximize efficiency. Night time restrictions therefore affect productivity. At Billy Bishop airport, on the Toronto Island, regulations prohibit the use of Bombardier CSeries jets by Porter to preserve the Island's waterfront (Owram, 2015). This type of regulation restricts Porter's growth and limits productivity growth in the air transportation subsector.

b. Restructuring Following Air Canada's Bankruptcy

Air Canada's bankruptcy and the resulting restructuring have improved productivity in the air transportation subsector, especially because Air Canada is Canada's largest airline.

---

[50] The amount of competition in the industry varied substantially over the 2000 to 2014 period. Westjet had only entered the market in 1996 and gradually gained market share through time to become the major competitor of Air Canada. In 2001, Air Canada acquired the second largest airline in the country, Canadian Airlines. Recently, Toronto-based Porter Airlines has been fairly successful. Several other smaller airlines have entered the market, but most have failed.

[51] As presented in Appendix tables 9 and 12, Canada's fall in international ranking does not reflect increased regulation as its index values do not change between 1997 and 2013. Rather, Canada slipped in the international rankings due to deregulation in other countries. For further details on the OECDs product market regulation index in this sector, see Appendix C or Koske et al. (2014).

In 2001 and 2002, linked to a fall in passenger travel following the terrorist events of September 11, 2001, Air Canada suffered net losses of $1.32 billion and $828 million respectively (Funding Universe, no date). This led to a declaration of bankruptcy in 2003. This forced Air Canada to cut inefficiencies. A series of restructuring efforts followed Air Canada's bankruptcy. New labour agreements with the unions involved wage cuts and layoffs (Funding Universe, no date). Wages were reduced: for pilots by 5-30 per cent, for flight attendants by 13 per cent, for mechanics by 3.9 per cent, for management by 5.7 per cent, and for executives by 12.5-20 per cent (Air Canada: Fundamentally Reinvented? 2004).

Restructuring efforts following Air Canada's declaration of bankruptcy also led to the outsourcing of aircraft servicing personnel, beginning in 2001, which is another cause for the large contractions of labour (Gregory, 2012). Outsourcing to other countries resulted in lower labour costs and increased productivity. However, in 2013 the Quebec Superior Court found Air Canada guilty of violating the Air Canada Public Participation Act and ruled that Air Canada must maintain its heavy-maintenance operations in Canada (Marowits, 2013).

The steps taken as Air Canada emerged from bankruptcy likely account in part for the productivity growth experienced by the air transportation subsector. This can in part explain the decline in workers and hours worked described in Section A. The decline in employment decreases number of inputs which increases productivity.

c. Liberalization of International Air Transportation Links

The liberalization of international air markets maximizes competition and increases benefits for all stakeholders (consumers, governments, cities, the tourism industry, airports, and airlines) (Gill, Raynor & Neil, 2013). This is done through open skies type agreements which call for a liberalization of rules and regulations of the international aviation industry. The increase in competition brought by such measures contributes to increasing the productivity of the air transportation subsector. In Canada, the 2006 Blue Sky Policy supports air liberalization.

d. Measures that Facilitate Travel

The easier it is for passengers to travel, the higher the load factor on airplane which, in turn, increases air transportation productivity. The transit without visa program increases traffic in Canadian airports.

This program allows foreigners from certain nationalities to transit through Canada without a Canadian visa on their way to and from the United States. According to the Conference Board of Canada (2013), since the requirement to obtain one visa is already a burden for potential travellers, needing two visas for a single trip is a great obstacle. The transit without visa program offers a solution making travel through Canada more attractive. This increases traffic through Canadian airports and can increase revenues and the load factor of airplanes.

ii. Capacity Utilization

This section focuses on increases in capacity utilization of major Canadian Airlines which has had a positive impact on productivity measures.

The load factor, the number of seats filled divided by the number of seats available, is a measure of capacity utilization. Higher capacity utilization will lead to a higher productivity as the same inputs produce more output. The load factor has increased from an average of 79.5 per cent in 2005 to an average of 83.2 per cent in 2014 for Air Canada and from an average of 76.2 per cent in 2000 to an average of 81.4 per cent in 2014 for WestJet (Table 41).

An increase in the load factor leads to an increase in productivity since capacity is more fully utilized. The marginal cost of filling a seat is virtually zero, which means that operating costs per passenger are lowered. As the load factor increases, output increases while costs remain constant, which increases productivity.

Table 41: Load Factors, WestJet and Air Canada, Per Cent, 1997-2014

	WestJet	Air Canada
1997	70.6	...
1998	71.6	...
1999	72.3	...
2000	76.2	...
2001	74.7	...
2002	73.2	...
2003	70.6	...
2004	70.0	...
2005	74.6	79.5
2006	78.2	80.2
2007	80.7	80.6
2008	80.1	81.3
2009	78.7	80.5
2010	79.9	81.5
2011	79.7	81.4
2012	82.8	82.6
2013	81.7	82.6
2014	81.4	83.2
	Compound Average Annual Growth	
2000-2014	0.47	...
2005-2014	0.97	0.51

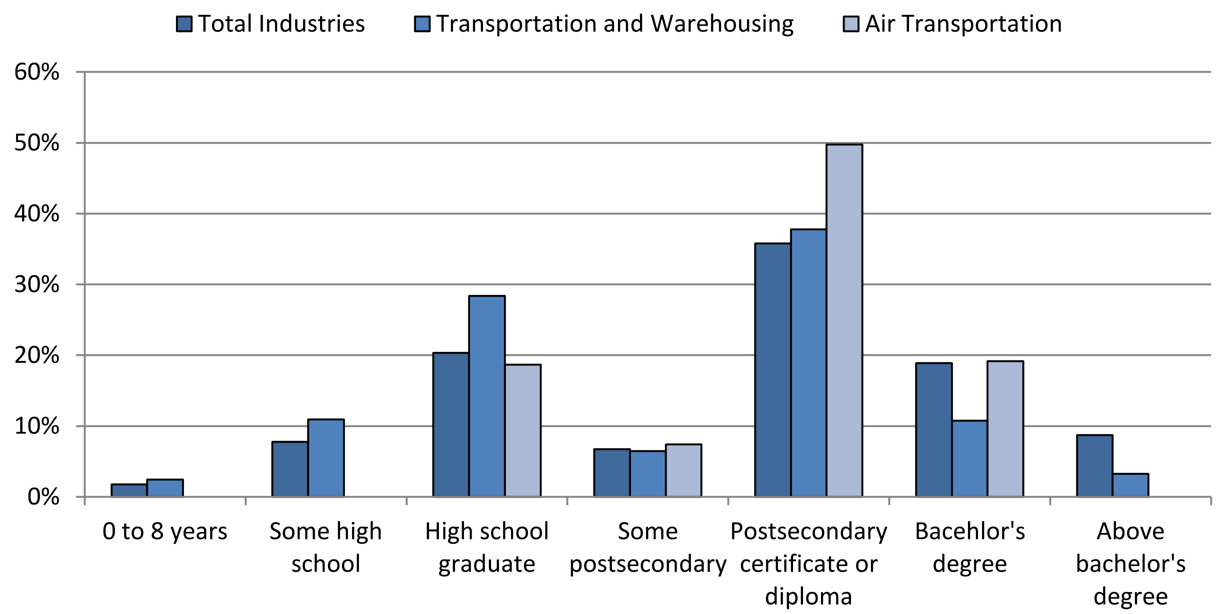
Note: Air Canada reports not available prior to 2005.
Source: Air Canada annual reports retrieved from http://www.aircanada.com/en/about/investor/reports.html and WestJet annual reports retrieved from http://www.westjet.com/guest/en/media-investors/annual-reports.shtml.

The increase in the load factor is due to better big data and overbooking. Big data helps detect patterns to schedule flights while demand is highest. Overbooking of flights solves the problem of no shows. Big data helps determine the best amount by which to overbook. Pricing algorithms also help with better management of the load factor. This is because tourist travelers are less likely to have strong time preferences and are able to adapt their plans to take advantage of lower fares, which increases the load on planes during down times. According to Dana & Orlov (2014), part of the increase in load factors is due to an increase in the share of tourist travelers.

iii. Human Capital

The employment level of those employed in the air transportation subsector impacts their productivity. The goal of this section is to show the educational attainment of workers in the air transportation subsector.

Chart 24: Employed by Highest Level of Educational Attainment, Per Cent of Total, All Industries, Transportation and Warehousing, Air Transportation, 2014



Source: Calculated by CSLS with data from the Labour Force Survey
Note: Data that show 0% are suppressed because they are below the confidentiality threshold.

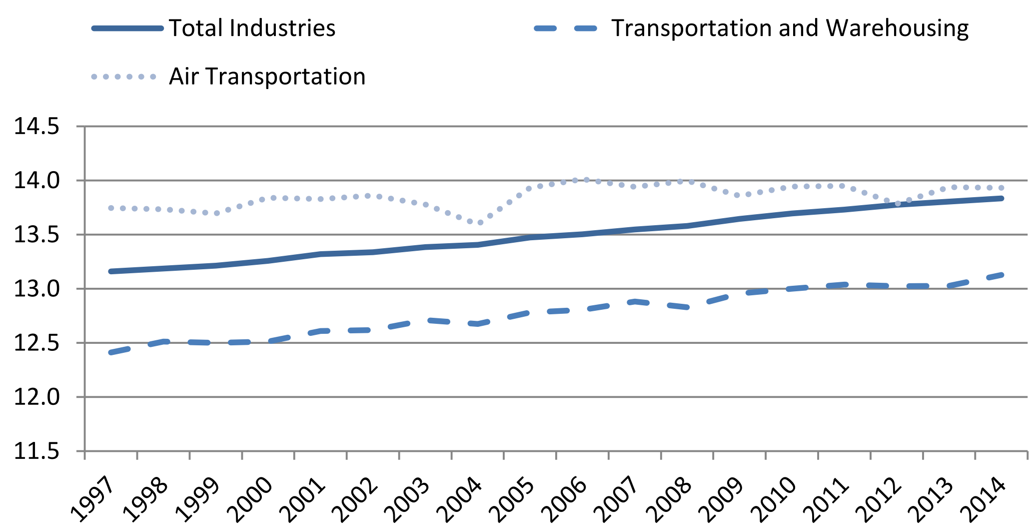
Chart 24 shows a breakdown of workers by their highest level of educational attainment in 2014. Most workers (49.7 per cent) highest educational attainment is a postsecondary certificate or diploma.

In 2014, the average worker in the air transportation subsector had 13.9 years of schooling (Chart 25).[52] This is more than in the transportation and warehousing sector as a whole

[52] Average years of schooling were calculated by attributing values for years of schooling in each category and computing the average of all cases. The following values were used: 0 to 8 years -8 years, some high school-10 years, high school graduate-12 years, some postsecondary-13 years, postsecondary certificate or diploma-14 years, bachelor's degree-16 years, and above bachelor degree-18 years. To compute the average, the total of all education levels provided by the LFS was used for all industries as well as for transportation and warehousing. However, for

(13.1 years and than the average for all industries (13.8 years). Educational attainment is linked to productivity therefore the higher educational attainment of workers in the air transportation subsector could be a factor in the above average productivity growth. Average years of schooling in the air transportation subsector increased an average of 0.05 per cent per year between 2000 and 2014, which is a slower growth than in the transportation and warehousing sector as a whole (0.34 per cent per year between 2000 and 2014) and than in all industries (0.30 per cent per year between 2000 and 2014).

Chart 25: Average Years of School per Worker, All Industries, Transportation and Warehousing, Air Transportation, 1997-2014



Source: Calculated by CSLS with data from the Labour Force Survey

iv. Technical Progress

a. Fuel Efficiency

Jet fuel is the most important intermediate input for air transportation (28 per cent of gross output as described in part A).[53] Increases in fuel efficiency can affect total factor productivity. This section focuses on increases in fuel efficiency in the air transportation subsector.

Jet fuel prices are higher in 2015 than they were in 2000 (Table 42). They have increased by an average of 2.08 per cent per year between 2000 and 2015. Prices peaked in 2008 at $3.11 per gallon, but are now down to $1.98 per gallon.

air transportation, because of data suppression, for some years this total was much higher than that found when adding each category manually, therefore the manual total was used to ensure consistency of the time series.

[53] Some airplanes also use aviation gasoline, but the input-output table used here only shows jet fuel. This section focuses on fuel efficiency in general.

Fuel productivity (usually defined as gross output/fuel used) is all the more important given increasing fuel prices. Fuel productivity in the air transportation subsector has increased an average of 0.85 per cent per year between 2000 and 2013 (Table 42). This demonstrates a growth in output generated per unit of fuel.

Fuel efficiency has increased a number of ways in the air transportation subsector.

Technological innovations have made airplanes more efficient. For example, Duke, Torres & Kern (2005) report that the Boeing 777 family, developed in the 1990s, burns one third less fuel than the earlier generation of 747s although these have a similar passenger capacity. Large turbofan engines developed in the 1990s have been important to the increase in fuel efficiency of airplanes as these engines are much more fuel efficient (Duke, Torres & Kern, 2005). Investments to replace old aircrafts with more efficient models increase fuel productivity.

Table 42: Jet Fuel Price, Canadian Dollar per Gallon, and Fuel Productivity Index for Air Transportation Subsector, 2000=100, 2000-2015

Year	Price	Fuel Productivity Index
2000	1.46	100
2001	1.12	98
2002	1.08	102
2003	1.16	101
2004	1.49	103
2005	2.07	97
2006	2.18	102
2007	2.27	107
2008	3.11	109
2009	1.87	108
2010	2.21	107
2011	2.96	109
2012	3.05	110
2013	3.01	112
2014	2.97	n.a.
2015 (11 months)	1.98	n.a.
Compound Average Annual Growth (Per Cent)		
2000-2013	n.a.	0.85
2000-2015	2.08	n.a.

Source: Jet duel Price- http://www.indexmundi.com/commodities/?commodity=jet-fuel&months=180&currency=cad. From U.S. Energy Information Administration
Fuel Productivity: Data obtained from Transport Canada

Measures such as lowering cruise speeds, using computers to determine optimum fuel loads, and using flight simulators instead of aircrafts to train pilots have also decreased the use of fuel (Duke, Torres & Kern, 2005). Larger planes flying longer and more direct routes may have raised productivity as well by lowering labour and fuel required per passenger-kilometer.

Such increases in fuel productivity have contributed to the growth of total factor productivity in the air transportation subsector. Recognizing this, as well as the importance of fuel efficiency for the environment, the government of Canada has taken measures to ensure increased fuel efficiency within the airline industry.[54]

b. Internet

In a way, the internet has revolutionized the airline industry. It has changed passengers' behaviours in a way that increases the load factor and reduced the cost of paying travel agents, an input for airlines.

Dana & Orlov (2014) find a positive correlation between the rate of change of metropolitan-area internet penetration and the rate of change of airlines' load factors. The ability for the customer to use the internet to investigate and purchase airline tickets reduces market frictions and allows airlines to meet demand with less capacity and higher load factors (Dana & Orlov, 2014). The internet provides the customer with information about alternate departure times, carriers, airports, and itineraries (number and location of stops). This makes it more likely that customers will take advantage of price incentives to travel on flights with excess capacity which increases the load factor. It also benefits the airlines by lending another mechanism to ensure planes are as full as possible, and unprofitable trips made by largely empty planes do not occur.

The internet also replaces travel agents because it is easy for travellers to book their own trips. Travel arrangement and reservation services are an intermediate input of air transportation (Cansim Table 381-0022). Duke, Torres & Kern (2006), find that travel agent commissions have declined in recent years. Passengers can purchase their own tickets on the airline's website rather than going through a travel agent. This shifts the labour from the travel agent, who is remunerated, to the consumer, who is not. This results in a reduction of inputs for the airline industry. In this way, the reduction in the cost of travel agent commission increases productivity. Similarly, computerized self check-in kiosks at airports and the ability to check in online reduce the number of customer service staff an airline must hire to assist travellers at the airport which raises labour productivity.

v. Organizational Changes

a. Cost Reductions Measures

Certain cost reduction measures have been mentioned in section ii on Air Canada's bankruptcy. Additional cost reductions are worth noting. For example, free meals and pillows on

[54] For example, in 2012 Canada submitted *Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation* to the International Civil Aviation Organization which set a target for Canadian air carriers to improve their fuel efficiency at an average rate of 2% per year from a 2005 base level until 2020.

certain flights have been eliminated to reduce costs (Belobaba, Hernandez, Jenkins, Powell & Swelbar, 2011). This results in a reduction of inputs which increases total factor productivity.

Airlines now charge for meals. If this income is considered in the output of the air transportation subsector, this results in an increased productivity.[55] As prepared meals are the fifth largest intermediate input, this is substantial.

Measures to reduce turn-around times also improve aircraft productivity (Belobaba, Hernandez, Jenkins, Powell & Swelbar, 2011). The turn-around time is the time it takes for passengers to load/unload the aircraft as well as for ground servicing.

C. Policy

Part A described the state of the air transportation subsector and part B described factors that have contributed to the growth in productivity. The goal of this section is to put forward policy recommendations that will promote productivity growth.

i. Policies that Foster Increased Demand

An increased demand leads to an increase in capacity utilization. As explained above, capacity utilization is important for air transportation productivity since a higher load factor means a lower cost per unit. This section focuses on policies that foster an increased demand.

Tourism is important for increasing the load factor because tourists' travel dates tend to be more flexible than those of business travellers, making tourists more sensitive to pricing mechanisms used to fill planes. Prices factor in tourists' choices and increasing the attractiveness of air travel in Canada could increase the load factor and productivity, and would profit the Canadian economy as a whole. With this in mind, certain steps can be taken to increase demand.

Fuel taxes increase the price of air travel paid for by passengers. In Canada, a federal fuel tax is only applied to domestic flights. This is standard international practice and maintains international competitiveness. However, some provincial governments levy fuel taxes on international flights. Major Canadian airports compete with other international airports that are not subject to such taxes. This makes the Canadian air industry less competitive and reduces usage. For example, international flights from the Toronto airport are charged a fuel tax while those from Buffalo are not. Eliminating these taxes could increase tourism and therefore capacity utilization and create economies of scale. In Ontario, Gill, Raynor & Neil (2013) estimate that removing the provincial tax on international flights may lead to almost 30,000 additional tourists per year. Taxes on domestic flights also have an effect on the air transportation industry. Higher prices to travel within Canada decrease the incentive to travel for Canadians. This affects international competitiveness as well because "a stronger domestic market can help provide a solid base for airports and air carriers to compete in international markets" (Gill, Raynor & Neil,

[55] This would only change airline revenues to the extent that the cost of meals was not previously captured in the price of a ticket when they were free.

2013). It is interesting to note that fuel taxes are higher in Canada than in the United States (Gill, Raynor & Neil, 2013). In the United States, taxes are also reinvested into airports which can lead to further productivity improvements while in Canada the taxes go into general revenue accounts. Policymakers should reconsider fuel tax practices when trying to revitalize the Canadian air transportation subsector and increase its capacity utilization.

As discussed in section B, the liberalization of international air transportation links can increase competitiveness of the Canadian air industry and increase travel on Canadian airlines. This can be done by continuing to negotiate open skies type agreements. It is also worth mentioning that streamlining the Canadian visa process could also be an advantage for the Canadian air transportation industry and would encourage tourism to Canada as well as transit through Canada during international travel.

ii. Further Deregulation

As noted in section B, certain policies are currently in place which are not favourable to productivity growth. This section will discuss policies that could be relaxed to increase productivity growth. However, these regulations are in place for a reason and our recommendations for productivity growth in the air transportation subsector need to be balanced with interests outside of the air transportation subsector.

First, as discussed in section B, cabotage, which is the right for a foreign airline to operate flights within a country, is prohibited in Canada. Only airlines owned in majority by Canadians can fly from Canada to Canada. Relaxing this policy could increase competition in the Canadian air transportation subsector and increase productivity.

Also discussed in Section B is the night time constraints of Canadian airports such as Toronto Perason. Relaxing these would allow planes to fly 24 hours which would increase their productivity. Perhaps nightly arrivals should be restricted to the least noisy types of airplanes during these hours.

Finally, policies such as those preventing Porter from acquiring jets could be relaxed to increase productivity. In particular, the decision not to allow the extension of the runway at the Toronto Island airport should be reconsidered

iii. Fuel Efficiency

Increased fuel efficiency leads to total factor productivity growth because it allows producing more with fewer inputs. Section B has already shown that the air transportation subsector has benefitted from increases in fuel efficiency. Policy should encourage increases in fuel efficiency as a way to increase productivity. Fuel efficiency also has a positive impact on the environment which is a growing concern in recent times. The federal government already encourages fuel efficiency within the air transportation subsector and has signed agreements with airlines to increase fuel efficiency (Transport Canada, 2014). The latest, signed in 2012, is Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation. This plan sets ambitious goals to reduce greenhouse gas emissions from both domestic and international flights. It supersedes a 2005 voluntary agreement. Continued encouragement of fuel efficiency will be a source of productivity growth in the future. Tax incentives such as accelerated capital cost allowances may promote purchases of fuel efficient planes.

iv. Low Cost Carriers

Low cost carriers are airlines that offer lower costs and fewer comforts. The airlines have a lower cost per unit and higher productivity than traditional airlines. They typically work with a single aircraft type and offer a service with no frills, charging extra for food, baggage, priority boarding, seat allocation etc. Workers employed by low cost carriers are not unionized and have lower wages than those working for traditional airlines.

In the United States, low cost carriers have driven change in the airline industry, with lower cost structures and higher productivity levels (Belobaba, Hernandez, Jenkins, Powell & Swelbar, 2011). The low cost carriers increase competition and force the traditional airlines to reduce costs and improve productivity. Low cost carriers are not as present on the Canadian air transportation market as in the United States.

More low cost carriers on the Canadian market could increase competition. Policies that allow entries of new carriers into the air transportation subsector allow low cost carriers to enter the market and reduce costs while improving productivity. Policymakers wishing to improve productivity should seek to increase the number of low cost carriers to increase competition in the Canada airline industry and increase productivity.

Section 5: The Rail Transportation Subsector

Canada's rail industry is world-class (Cairns, 2015). This subsector is essential in the transportation of goods across the country. High productivity in the industry ensures lower costs for firms and consumers and is vital to international competitiveness. The goal of this section is to understand productivity in the Canadian rail transportation subsector. Part A will describe the outputs, inputs, and productivity in the rail transportation subsector. This will be done using primarily Statistics Canada data, compared to Transport Canada data when possible. Part B will explain the drivers of productivity growth and part C will put forward policy recommendations to promote productivity growth in the rail transportation subsector.

Rail transportation (482) is a North American Industry Classification System (NAICS) three digit subsector of transportation and warehousing (48-49). It comprises establishments primarily engaged in operating railways.[56] Rail transportation can be divided into two types, freight and passenger rail. Freight rail refers to the transportation of goods while passenger real refers to that of people. The main Canadian railways are Canadian National, Canadian Pacific and VIA rail.

Freight rail revenues are considerably greater than passenger revenues. In fact, passenger revenues are only 2.25 per cent of total railway revenues (see table 6-5 in the CSLS transportation database). This means that when discussing rail transportation in this section we are referring mostly to freight.

A. Economic and Productivity Performance

i. Output

a. Gross Output

Nominal gross output, which is the total value of sales, was $11,071 million in 2011 in the rail transportation subsector (Table 6-1 in the CSLS transportation database).[57] The nominal gross output grew an average of 3.15 per cent per year between 2000 and 2011. This growth was slower than in the transportation and warehousing sector as a whole and than in all industries, where nominal gross output grew an average of 4.67 and 4.06 per cent per year respectively.

Transport Canada calculated a real gross output index. This index has grown an average of 1.56 per cent per year between 2000 and 2013. This is a slower growth than the growth of nominal gross output in the Statistics Canada data. Unfortunately Statistics Canada does not provide a time series of real gross output, so estimates from the two organizations are not directly comparable.

[56] In December 2014, 283 establishments were included in the rail transportation subsector in Canada, most located in Ontario (30 per cent) and Quebec (26 per cent) (Industry Canada, based on Statistics Canada Canadian Business Patterns Database).

[57] The CSLS has put together a complete database for the four modes of transportation examined in this report. The database will be posted with this report.

Table 43: Nominal GDP, Implicit Prices, and Real GDP, Rail Transportation, 1997-2014

	Nominal GDP (Millions of Current Dollars)			Implicit Price Deflator			Real GDP (Millions of Chained 2007 Dollars)		
	All Industries	Transportation and Warehousing	Rail Transportation	All Industries	Transportation and Warehousing	Rail Transportation	All Industries	Transportation and Warehousing	Rail Transportation
1997	837,260	37,116	…	78.23	79.70	…	1,070,192	46,569	4,503
1998	867,786	38,969	…	78.08	82.04	…	1,111,384	47,498	4,358
1999	932,530	41,265	4,131	79.49	81.85	88.37	1,173,088	50,415	4,675
2000	1,025,033	43,318	4,845	82.88	81.84	87.86	1,236,822	52,929	5,515
2001	1,058,086	45,941	4,867	84.36	84.63	87.86	1,254,236	54,286	5,540
2002	1,095,600	47,758	5,080	85.11	88.15	89.94	1,287,248	54,179	5,648
2003	1,157,137	48,401	4,972	88.03	88.99	86.92	1,314,512	54,391	5,721
2004	1,231,468	50,687	5,568	90.87	89.80	88.85	1,355,222	56,443	6,267
2005	1,312,696	55,968	6,177	94.04	93.65	92.76	1,395,920	59,765	6,659
2006	1,388,359	59,719	6,510	96.75	97.12	98.83	1,434,935	61,489	6,587
2007	1,466,692	61,140	6,430	100.00	97.89[1]	100.00	1,466,691	62,458	6,430
2008	1,551,684	62,150	6,303	104.7	99.82	107.34	1,482,081	62,261	5,872
2009	1,473,183	59,576	5,768	102.43	99.88	112.57	1,438,301	59,649	5,124
2010	1,564,105	63,101	6,441	105.03	102.03	113.32	1,489,226	61,847	5,684
2011	1,667,007	67,020	6,530	108.64	104.84	113.74	1,534,440	63,929	5,741
2012	**…**	…	…	…	…	…	1,565,595	64,839	5,948
2013	**…**	…	…	…	…	…	1,598,734	65,667	6,171
2014	**…**	…	…	…	…	…	1,637,656	68,596	6,364
				Compound Average Annual Growth (Per Cent)					
2000-2011	4.52	4.05	2.75	2.49	2.28	2.38	1.98	1.73	0.37
2000-2013	…	…	…	…	…	…	1.99	1.67	0.87
2000-2014	…	…	…	…	…	…	2.03	1.87	1.03

Source: Statistics Canada Cansim Tables 379-0023 and 379-0029 (nominal GDP all industries and rail transportation), 383-0032 (nominal GDP transportation and warehousing), and 379-0031 (real GDP) Based on Input-Output Accounts. Implicit price deflator calculated by CSLS. Growth rates from 379-0023 (1997-2008) used to link the GDP from 379-0029(2007-2011) to create a longer time series (the growth rate between two years is applied to a value to obtain an estimate of the value for the previous year).

1. It is unclear why this value is not 100. The 2007 value for nominal GDP should be the same as the real GDP because the real GDP is in 2007 dollars. These values are from Statistics Canada.

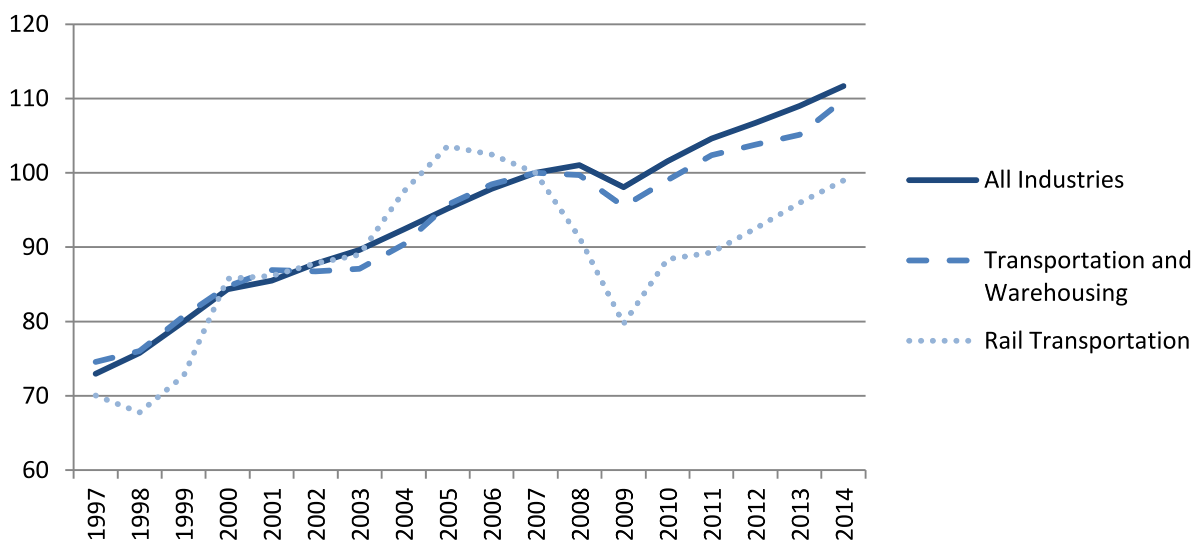
In 2011, 41.0 per cent of gross output was intermediate inputs in the rail transportation subsector. This share of intermediate inputs grew 2.59 percentage points since 2000, when the share of intermediate inputs was 38.4 per cent. Since 1999, the share of intermediate inputs was highest in 1999 (44.5 per cent of gross output) and lowest in 2005 (35.5 per cent of gross output).The largest intermediate input in rail transportation is diesel fuel. This accounted for 11.9 per cent of gross output in nominal terms in 2011 (Statistics Canada Cansim table 381-0022).[58] Intermediate inputs accounted for more of the gross output in the transportation and warehousing sector as a whole, where they accounted for 53 per cent of gross output in 2011, and in all industries, where they accounted for 47 per cent in 2011.

b. Nominal GDP

In nominal terms, GDP in the rail subsector was $6.5 billion in 2011, accounting for just 0.39 per cent of the total economy. This was down in relative terms from 0.44 per cent in 1999. Growth in the sector was 2.75 per cent per year between 2000 and 2011, well below the 4.52 per cent which prevailed in the general economy or even the 4.05 per cent growth in the broader transportation and warehousing sector for the same period.

c. Real GDP

Chart 26: Real GDP, All Industries, Transportation and Warehousing Sector, and Rail Transportation Subsector, 2000=100, 1997-2014



Source: Calculated by CSLS with data from Statistics Canada Cansim Table 379-0031. Based on Input-Output Accounts.

---

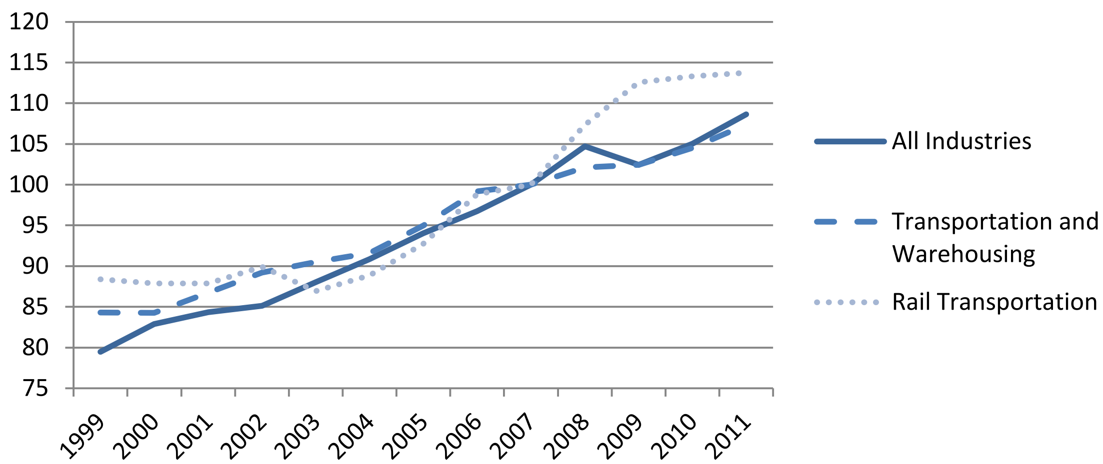
[58] The other major intermediate inputs in the rail transportation subsector are repair construction services (9.33 per cent of gross output), rail transportation support (5.00 per cent of gross output), maintenance and repair, commercial and industrial machinery and equipment renting and leasing services (2.57 per cent of gross output), and parts for railroad rolling stocks (1.50 per cent of gross output).

Chart 26 shows how real GDP growth in the sector compared to that of the Canadian economy and the transportation and warehousing subsector. Real GDP in the rail transportation subsector was $6.4 billion chained 2007 dollars in 2014. Real GDP grew an average of 1.03 per cent per year between 2000 and 2014. Real GDP in the rail transportation subsector fell significantly more than in the general economy during the global financial crisis and still has not recovered to its 2006 value as of 2014.

d. Prices

The ratio between nominal and real GDP provides an implicit price deflator which can be used to assess how prices move in the sector through time. The implicit price deflator grew at a rate of 2.38 per cent per year from 2000 to 2011 in the rail transportation subsector, slower than the rate of 2.49 per cent prevailing in the total economy and slower than the transportation and warehousing subsector (2.23 per cent). Price growth has been unusually strong in the sector since 2007 though, particularly during the global financial crisis. Prices in rail transportation rose by 12.6 per cent between 2007 and 2009 while they only rose by about 2.4 per cent in the transportation and warehousing sector and the overall economy. The rise in prices in the rail transportation subsector between 2007 and 2009 is surprising as output was falling during this period.

Chart 27: Implicit Price Deflator, All Industries, Transportation and Warehousing Sector, and Rail Transportation Subsector, 2007=100, 1999-2011



Source: Calculated by CSLS with data from Statistics Canada Cansim Tables 379-0023 and 379-0029 (nominal GDP for all industries and rail transportation), 383-0032 (nominal GDP for transportation and warehousing), and 379-0031 (real GDP). Based on Input-Output Accounts.

Transport Canada provides an output price index. The output price index has grown an average of 2.63 per cent per year between 2000 and 2013. The output price index has a similar growth to that of the implicit price deflator calculated by CSLS (2.42 per cent per year and 2.38 per cent year between 2000 and 2011 for the Transport Canada output price index and Statistics Canada implicit price deflator respectively).

ii. Inputs

a. Employment

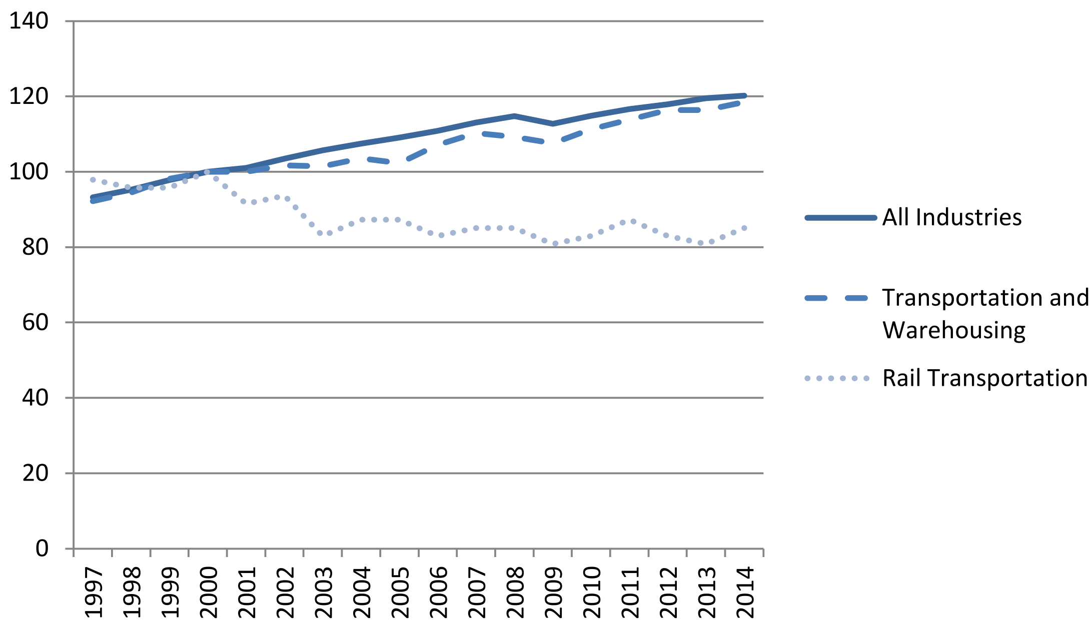
Until recently, employment in the sector had been on a long downward trend. In 1997, there were about 46,000 positions in the rail transportation subsector (Table 44). By 2008, this figure had fallen to a low of 40,000. Employment in the sector remains at about 40,000 as of 2014 based upon the most recent figures from Statistics Canada in CPA (see Box 1 for a comparison of employment data from the LFS or SEPH). This employment growth of -0.82 per cent between 2000 and 2014 has been very weak compared to that of 1.01 per cent in the total economy and 0.93 in the transportation and warehousing sector.

Table 44: Jobs and Hours Worked, All Industries, Transportation and Warehousing Sector, and Rail Transportation Subsector, Thousands, 1997-2014.

	Jobs			Hours Worked		
	All Industries	**Transportation and Warehousing**	**Rail Transportation**	**All Industries**	**Transportation and Warehousing**	**Rail Transportation**
1997	14,038	647	46	25,060,353	1,279,068	91,030
1998	14,353	663	45	25,570,682	1,325,665	89,231
1999	14,730	689	45	26,237,389	1,381,263	91,243
2000	15,067	702	47	26,801,128	1,394,972	92,250
2001	15,216	702	43	26,955,303	1,390,612	82,903
2002	15,589	714	44	27,337,720	1,409,576	87,790
2003	15,923	712	39	27,704,314	1,402,757	79,190
2004	16,190	727	41	28,487,799	1,459,753	84,564
2005	16,431	718	41	28,703,810	1,424,551	86,069
2006	16,702	752	39	29,137,021	1,495,267	77,835
2007	17,038	774	40	29,668,182	1,513,348	79,362
2008	17,285	767	40	29,986,515	1,493,833	79,780
2009	16,986	755	38	28,893,597	1,432,868	72,803
2010	17,298	781	39	29,459,132	1,497,236	77,380
2011	17,572	799	41	29,866,008	1,521,242	77,744
2012	17,764	817	39	30,421,795	1,552,733	78,421
2013	18,003	817	38	30,735,028	1,535,770	77,240
2014	18,109	832	40	30,846,788	1,587,949	82,190
	Compound Average Annual Growth (Per Cent)					
1997-2007	1.96	1.81	-1.47	1.70	1.70	-1.36
2007-2014	0.87	1.04	0.03	0.56	0.69	0.50
2000-2014	1.32	1.22	-1.04	1.01	0.93	-0.82

Source: Statistics Canada Cansim Table 383-0031. Based on Canadian Productivity Accounts.

Chart 28: Jobs, All Industries, Transportation and Warehousing Sector, and Rail Transportation Subsector, 2000=100, 1997-2014



Source: Calculated by CSLS with data from Statistics Canada Cansim Table 383-0031. Based on Canadian Productivity Accounts.

Hours worked, which further controls for overtime and the division between full-time and part-time work tells a similar story. However, it is interesting to note that average hours of 39.2 per week in rail transportation in 2014 were much higher than in the total economy (32.6) or in transportation and warehousing (36.6) (Table 6-1 in CSLS Transportation Database). This may be due to a lower share of part-time workers in this subsector. Furthermore, average hours per week have risen since 2000 in this subsector, by an average of 0.22 per cent per year, while they have been trending downward at the two broader levels, decreasing by about 0.3 per cent per year.

Transport Canada provides a quantity index of labour input. According to this, labour as an input has decreased an average of 1.90 per year between 2000 and 2013 in rail transportation. This is a larger decrease than that of the Statistics Canada data for workers and hours worked.

Total compensation per hour worked in 2014 was $43.34 in the rail transportation subsector, which is more than in the transportation and warehousing sector as a whole ($31.24) and than in all industries ($34.01) (Table 45). The total compensation per hour worked grew an average of 3.71 per cent per year between 2000 and 2014 in the rail transportation subsector, which is a faster growth than in the transportation and warehousing sector as a whole (2.70 per cent) and than in all industries (3.19 per cent).

Table 45: Total Compensation per Hour Worked, Dollars, All Industries, Transportation and Warehousing, Truck Transportation, 1997-2014

	All Industries	Transportation and Warehousing	Rail Transportation
1997	19.56	19.86	26.76
1998	20.22	20.38	28.78
1999	20.68	20.55	26.74
2000	21.90	21.51	26.02
2001	22.59	22.33	28.57
2002	23.12	22.46	28.94
2003	23.85	23.46	32.21
2004	24.50	24.01	32.98
2005	25.64	25.32	34.24
2006	26.94	25.98	38.12
2007	27.99	26.12	38.66
2008	28.94	26.69	38.16
2009	29.79	27.44	40.72
2010	30.13	27.29	40.21
2011	31.23	28.36	43.87
2012	31.99	29.00	44.48
2013	32.96	30.74	44.14
2014	34.01	31.24	43.34
	Compound Average Annual Growth (Per Cent)		
2000-2014	3.19	2.70	3.71

Statistics Canada Cansim Table 383-0031. Based on Canadian Productivity Accounts.

b. Investment

Real gross investment in rail transportation has grown at a compound annual rate of 1.33 per cent between 2000 and 2013 from $1.6 billion to $1.9 billion (Table 46). This growth in investment has been relatively weak compared to the total economy which grew at 3.85 per cent and the transportation and warehousing sector where investment grew at 3.90 per cent. However, real investment net of depreciation is more important for the accumulation of capital which drives output and productivity growth. There are three fairly distinct periods. Between 1997 and 2001, investment exceeded depreciation by an average of $115 million. Investment was lower between 2002 and 2009, when depreciation always exceeded investment, so that annual net investment was -$142 million on average. Since 2010, investment has been much stronger, with net investment averaging $205 million per year.

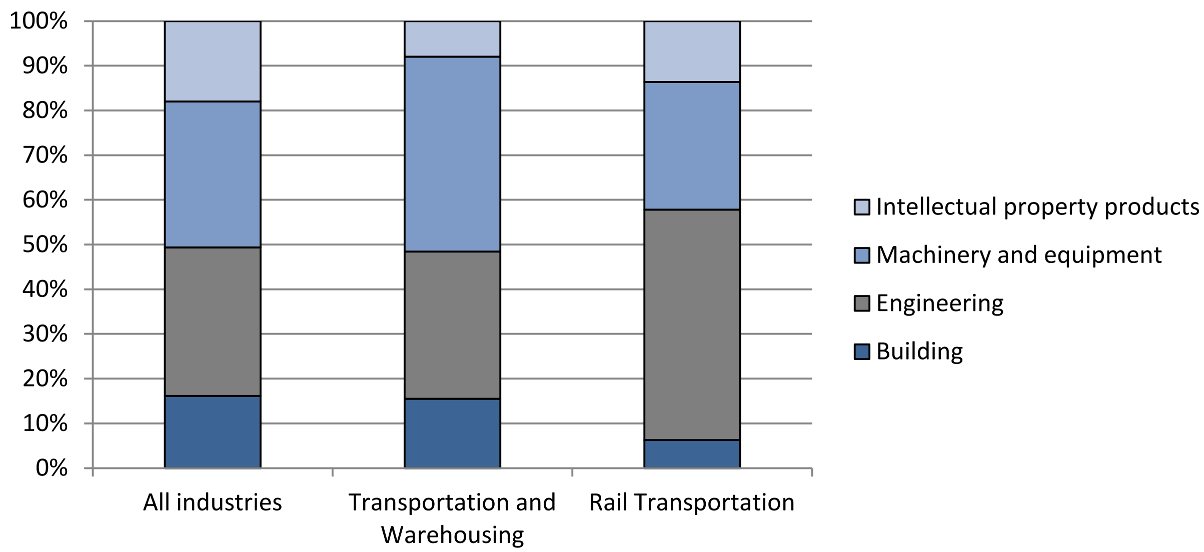
Investment in rail transportation is relatively more concentrated in engineering (track) and less in buildings when compared to other sectors. Just over half of the investment in the sector is in engineering, most of which will be related to maintenance and repair of existing track rather than construction of new track.

Table 46: Depreciation, Real and Net Total Fixed Non-Residential Investment, All Industries, Transportation and Warehousing Sector, and Rail Transportation Subsector, Millions of Chained 2007 Dollars, 1997-2013

	Real Investment			Depreciation			Real Net Investment		
	All Industries	Transportation and Warehousing	Rail Transportation	All Industries	Transportation and Warehousing	Rail Transportation	All Industries	Transportation and Warehousing	Rail Transportation
1997	149,863	9,664	1,414	125,677	7,803	1,348	24,185	1,861	66
1998	158,463	13,788	1,828	133,183	8,669	1,458	25,281	5,119	370
1999	167,359	15,086	1,542	140,857	9,793	1,515	26,502	5,294	27
2000	175,814	12,286	1,578	148,611	10,408	1,526	27,203	1,878	52
2001	180,948	12,244	1,603	155,583	10,735	1,541	25,365	1,508	62
2002	176,598	11,985	1,234	160,913	11,078	1,524	15,685	907	-290
2003	188,065	9,789	1,388	165,579	11,180	1,518	22,486	-1,391	-130
2004	205,484	9,790	1,348	171,848	11,051	1,524	33,637	-1,261	-176
2005	229,154	12,499	1,526	181,345	11,264	1,534	47,810	1,235	-8
2006	248,386	14,249	1,519	193,042	11,815	1,546	55,344	2,434	-27
2007	255,890	16,283	1,428	204,405	12,528	1,541	51,485	3,755	-113
2008	267,824	19,924	1,299	214,535	13,406	1,529	53,289	6,518	-230
2009	232,217	17,057	1,359	218,881	14,023	1,523	13,336	3,035	-164
2010	262,785	15,128	1,717	221,663	14,236	1,561	41,123	893	157
2011	276,557	16,434	1,879	228,634	14,450	1,609	47,923	1,984	270
2012	286,560	18,204	1,863	236,207	14,873	1,650	50,353	3,331	213
2013	287,126	20,215	1,874	243,084	15,469	1,693	44,042	4,747	181
Compound Average Annual Growth (Per Cent)									
2000-2013	3.85	3.90	1.33	3.86	3.10	0.80	3.78	7.39	10.01

Source: Statistics Canada Cansim Table 031-0002. Based on Stock and Consumption of Fixed Non-Residential Capital.

Chart 29: Real Total Fixed Non-Residential Investment, All Industries, Transportation and Warehousing, and Rail Transportation Subsector, Breakdown by Asset as a Share of Total Investment, 2013



Source: Calculated by CSLS with data from Statistics Canada Cansim Table 031-0002. Based on Stock and Consumption of Fixed Non-Residential Capital.

Over time, absolute investments in machinery and equipment (primarily rolling stock – that is railroad cars and locomotives) generally trended downwards between 1997 and 2008 (from $563 million chained 2007 dollars in 1997 to $139.2 in 2008), but increased significantly from 2009 to 2013 (from $235.4 chained 2007 dollars in 2009 to $552.4 in 2013). Excluding 1997, investment in engineering has been reasonably consistent, fluctuating around $1 billion annually. Investments in buildings were notably much higher during the two high net real investment periods noted above. Intellectual property investments have become increasingly important over time.

c. Capital

The capital stock represents the cumulative impact of real net investment over an extended period of time and is an input in production. Rail transportation is a very capital intensive industry. The net capital stock in rail transportation has been very stable between 1997 and 2013, hovering between $20.75 billion and $22.00 billion in any given year. On average, the net capital stock has declined by 0.11 per cent in the industry between 2000 and 2013, while it has been growing by 2.4 per cent in the total economy and 1.8 per cent in transportation and warehousing. Chart 30 illustrates that there has not been much movement in the net capital stock in this subsector.

Table 47: Real Total Fixed Non-Residential Geometric End of Year Gross Stock and Geometric End of Year Net Stock, Millions of Chained 2007 Dollars, All Industries, Transportation and Warehousing Sector, and Rail Transportation Subsector, 1997-2013

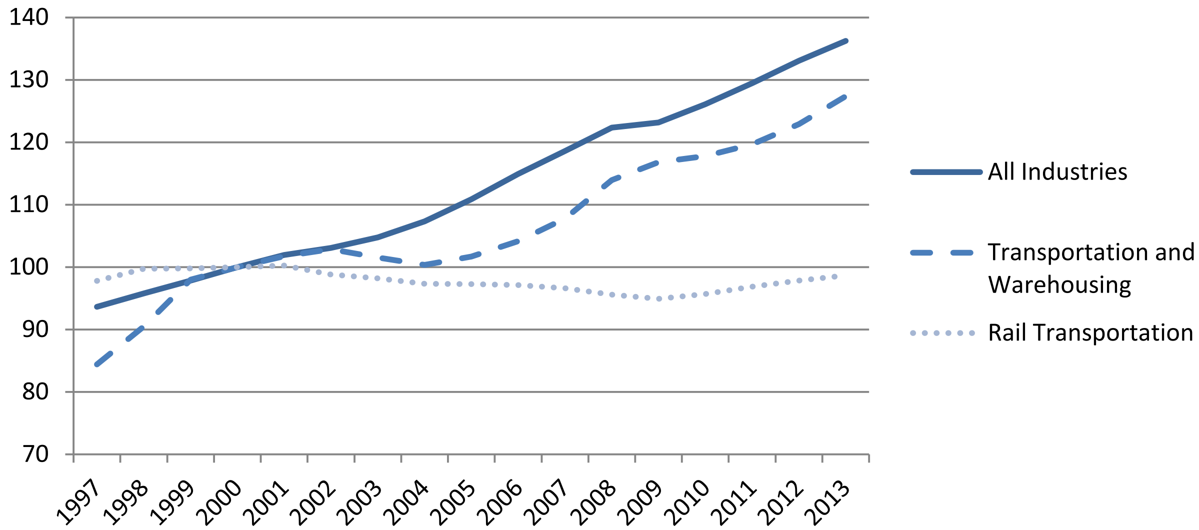
	End of Year Gross Stock			Geometric End of Year Net Stock		
	All Industries	Transportation and Warehousing	Rail Transportation	All Industries	Transportation and Warehousing	Rail Transportation
1997	2,840,265	215,377	58,187	1,317,326	88,523	21,413
1998	2,910,565	224,598	58,573	1,347,976	94,880	21,840
1999	2,978,531	236,613	58,549	1,376,679	102,760	21,853
2000	3,050,963	242,524	58,493	1,407,019	104,861	21,902
2001	3,120,137	247,762	58,386	1,434,355	106,691	21,959
2002	3,176,095	251,971	57,842	1,450,191	107,876	21,640
2003	3,233,818	252,982	57,431	1,474,036	106,453	21,507
2004	3,299,222	253,356	56,951	1,509,779	105,193	21,317
2005	3,381,391	256,330	56,653	1,559,783	106,636	21,304
2006	3,477,036	260,756	56,345	1,616,688	109,188	21,271
2007	3,572,845	266,769	55,927	1,668,675	113,016	21,156
2008	3,671,527	275,718	55,339	1,721,451	119,466	20,936
2009	3,724,916	281,418	54,808	1,733,028	122,504	20,783
2010	3,804,615	284,787	54,615	1,773,755	123,475	20,952
2011	3,889,710	288,998	54,545	1,821,693	125,514	21,217
2012	3,977,473	294,585	54,438	1,872,074	128,852	21,427
2013	4,058,877	301,718	54,312	1,916,594	133,534	21,602
	Compound Average Annual Growth					
2000-2013	2.22	1.69	-0.57	2.41	1.88	-0.11

Source: Statistics Canada Cansim Table 031-0002. Based on Stock and Consumption of Fixed Non-Residential Capital.
Note: The gross capital stock is the total value of all capital in use, regardless of its age. Conversely, the net capital stock is depreciated by the age of the capital stock.

Transport Canada also calculates estimates of the quantity of capital as an input. According to the Transport Canada data, capital quantity has increased 1.53 per cent per year between 2000 and 2013. This increase in capital contrasts with the Statistics Canada data, which shows a slight decrease in capital for the rail transportation subsector. One notable difference between the Transport Canada and Statistics Canada datasets is that the former only incorporates mainline carriers (CN, CP, and Via Rail) whereas the latter incorporates all rail line operators in Canada.

Engineering is even more dominant in terms of the capital stock than it is for investment. It accounted for 77 per cent of the capital stock in 2013 (Table 6-4 in CSLS Transportation Database). The large network of track represents most of the capital in the industry. Machinery and equipment, the second largest component of the capital stock, accounted for 11 per cent of total capital stock in 2013. This represents mostly rolling stock.

Chart 30: Real Total Fixed Non-Residential Geometric End of Year Net Stock, Rail Transportation Subsector, 2000=100, 1997-2013



Source: Calculated by CSLS with data from Statistics Canada Cansim Table 031-0002. Based on Stock and Consumption of Fixed Non-Residential Capital.

Between 2000 and 2013, the total capital stock in rail shrank at an annual rate of 0.1 per cent. Machinery and equipment declined at a rate of 1.2 per cent and buildings declined at a rate of 1.9 per cent. Engineering was relatively stable, growing at a rate of 0.2 per cent. Intellectual property products, which represent a relatively small component of the capital stock, have rapidly increased at a rate of 9.1 per cent per year.

Exchange rates play an important role in the capital investment behaviour of firms in much of the transportation sector (see, for example, Landon and Smith, 2006). However, large firms may be less affected by currency fluctuations than their smaller competitors as they are more capable of carrying large foreign currency reserves to smooth over any volatility in prices caused by the exchange rate. Given that the rail transportation subsector is dominated by two extremely large firms, CN and CP, it is likely the case that capital investment in rail is affected by exchange rates much less than a subsector such as trucking.

iii. Productivity

a. Labour Productivity

The real labour productivity level, as measured by real GDP (in chained 2007 dollars) per hour worked, is very high in the rail transportation subsector. In 2013, it was $77.4 per hour compared to $53.1 in the total economy and just $43.2 in the transportation and warehousing sector (Table 48). Over the 2000 to 2014 period, labour productivity has grown an average of

1.86 per cent per year in the rail transportation subsector, which is more than in the transportation and warehousing sector of which it is part, which grew an average of 0.93 per cent per year for the period and than in all industries, where labour productivity grew 1.01 per cent per year.

Labour productivity growth in the rail transportation subsector between 1997 and 2013 can be thought of in terms of two periods. Between 1997 and 2006, when employment was declining and output was rising, labour productivity grew rapidly from just under $50 per hour in 1997 to nearly $85 per hour in 2006. Since 2006, productivity growth in the sector has stalled. Labour productivity fell from 2006 to 2009. While it has been increased between 2009 and 2014, labour productivity in the subsector remains below its 2006 level.

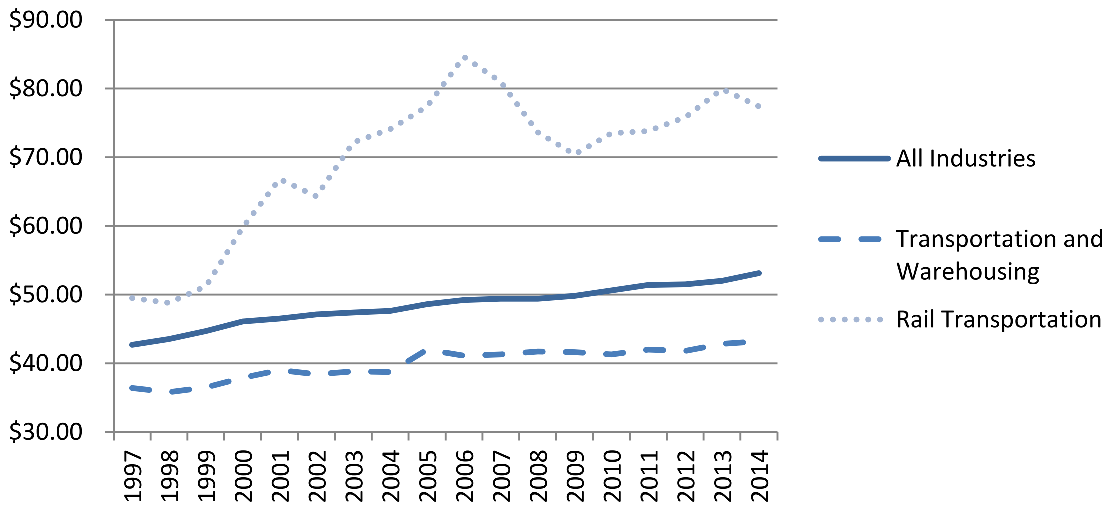
Table 48: Labour Productivity, Chained 2007 Dollars, All Industries, Transportation and Warehousing, and Rail Transportation Subsector, 1997-2014

	Real GDP per Hour Worked			Real GDP per Job		
	All Industries	Transportation and Warehousing	Rail Transportation	All Industries	Transportation and Warehousing	Rail Transportation
1997	$42.7	$36.4	$49.5	$76,235	$72,025	$96,880
1998	43.5	35.8	48.8	77,430	71,597	96,823
1999	44.7	36.5	51.2	79,638	73,218	103,064
2000	46.1	37.9	59.8	82,087	75,408	118,462
2001	46.5	39.0	66.8	82,428	77,339	130,154
2002	47.1	38.4	64.3	82,573	75,879	128,671
2003	47.4	38.8	72.2	82,552	76,363	146,824
2004	47.6	38.7	74.1	83,706	77,606	153,791
2005	48.6	42.0	77.4	84,958	83,192	162,673
2006	49.2	41.1	84.6	85,913	81,799	169,419
2007	49.4	41.3	81.0	86,082	80,744	160,349
2008	49.4	41.7	73.6	85,743	81,227	147,816
2009	49.8	41.6	70.4	84,677	79,037	134,931
2010	50.6	41.3	73.5	86,092	79,234	146,798
2011	51.4	42.0	73.8	87,322	79,967	139,752
2012	51.5	41.8	75.8	88,133	79,379	152,181
2013	52.0	42.8	79.9	88,806	80,401	163,276
2014	53.1	43.2	77.4	90,432	82,482	158,348
	Compound Average Annual Growth (Per Cent)					
2000-2010	0.92	0.85	2.08	0.48	0.50	2.17
2000-2014	1.01	0.93	1.86	0.69	0.64	2.09

Source: Calculated by CSLS with data from Cansim Tables 379-0031 and 383-0031. Based on Input-Output Accounts and Canadian Productivity Accounts.

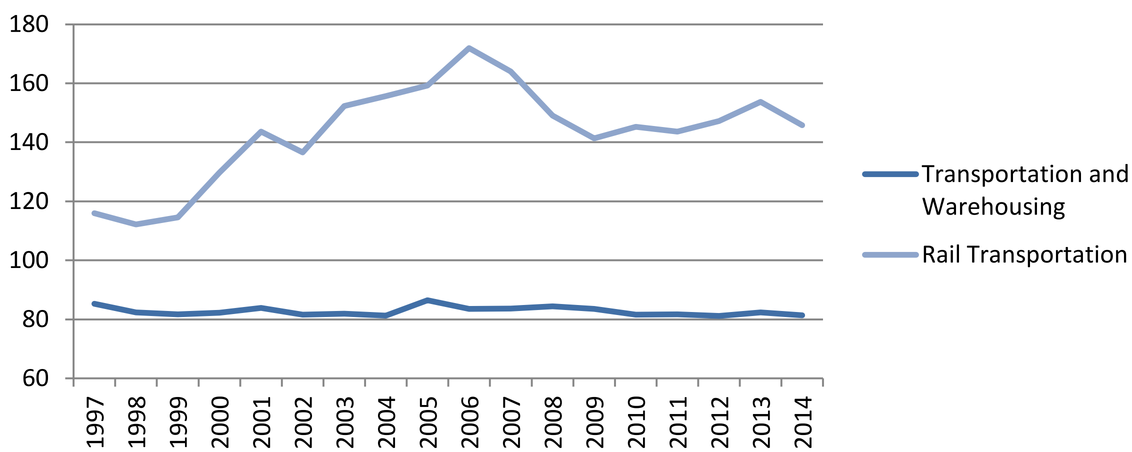
In 2000, real GDP per hour worked in the rail transportation subsector was 130 per cent relative to all industries and in 2014 it was 146 per cent (Chart 32). The ratio of real GDP per hour worked in the rail transportation subsector relative to all industries grew by 16 percentage points between 2000 and 2014 while in transportation and warehousing sector as a whole it decreased 0.9 percentage points.

Chart 31: Labour Productivity Defined as Real GDP per Hour Worked, All Industries, Transportation and Warehousing, and Rail Transportation, Chained 2007 Dollars, 1997-2014



Source: Calculated by CSLS with data from Cansim Tables 379-0031 and 383-0031. Based on Input-Output Accounts and Canadian Productivity Accounts.

Chart 32: Labour Productivity Relative to All Industries, Transportation and Warehousing, Rail Transportation, Per Cent, 1997-2014



Source: Calculated by CSLS with data from Cansim Tables 379-0031 and 383-0031. Based on Input-Output Accounts and Canadian Productivity Accounts.

Labour productivity can also be defined as GDP per worker, although using workers as a labour input is less appropriate than hours worked because average hours worked per week vary over time and across industries. Real GDP (in chained 2007 dollars) per worker was $158,348 in 2014 in rail transportation, much higher than in the transportation and warehousing sector as a whole and than in all industries. Real GDP per worker grew an average of 2.09 per cent per year between 2000 and 2014, a faster growth than in both transportation and warehousing and all industries.

Transport Canada also calculates estimates of labour productivity. According to Transport Canada, labour productivity grew an average of 3.53 per cent per year between 2000 and 2013, which is a much faster growth than the growth in labour productivity calculated from Statistics Canada data based on either workers or hours worked. This is in part due to the fact that Transport Canada estimated a stronger decrease in labour input than Statistics Canada (see part ii.a employment).

Table 49: Labour Productivity (per Hours Worked) and Capital Productivity in the United States, Business Sector and Line-Haul Railroads*, 2007=100, 1997-2014

	Labour Productivity		Capital Productivity
	Business Sector	Line-Haul Railroads	Line-Haul Railroads
1997	75.42	72.00	88.16
1998	77.74	73.52	85.64
1999	80.45	75.96	88.29
2000	83.19	82.28	90.98
2001	85.51	87.71	91.14
2002	89.17	96.83	92.98
2003	92.60	101.63	95.37
2004	95.56	103.80	99.27
2005	97.57	100.03	100.70
2006	98.53	105.82	107.22
2007	100.00	100.00	100.00
2008	100.80	104.45	103.19
2009	104.11	100.35	84.02
2010	107.55	108.49	92.95
2011	107.61	105.49	94.19
2012	108.40	106.65	93.19
2013	108.87	109.90	93.27
2014	109.52	108.60	n.a.
	Compound Average Annual Growth (Per Cent)		
2000-2010	2.60	2.80	0.16
2000-2013	2.09	2.25	0.19
2000-2014	1.98	2.00	n.a.

Source: United States Bureau of Labor Statistics http://www.bls.gov/data/
*Only data for line-haul railroads is available (NAICS 482111)

Data for the rail transportation subsector is often suppressed at the provincial level, therefore provincial level labour productivity data is not worthwhile to present here. It is available in the CSLS transportation database table 6-6-iii.

The United States Bureau of Labor Statistics produces indexes of labour productivity for rail transportation (Table 49). In the United States, labour productivity of line-haul railroads grew 2.00 per cent per year between 2000 and 2014, slightly faster than in the business sector where it grew 1.98 per cent per year. Both the rail transportation subsector and the business sector as a whole experienced faster growth in the United States than in Canada.

b. Capital Productivity

Table 50: Real Capital Stock Productivity, Value Added Produced by $1000 of Real Capital Stock, Chained 2007 Dollars, All Industries, Transportation and Warehousing, and Rail Transportation Subsector, 1997-2013

	All Industries	Transportation and Warehousing	Rail Transportation
1997	812	526	210
1998	824	501	200
1999	852	491	214
2000	879	505	252
2001	874	509	252
2002	888	502	261
2003	892	511	266
2004	898	537	294
2005	895	560	313
2006	888	563	310
2007	879	553	304
2008	861	521	280
2009	830	487	247
2010	840	501	271
2011	842	509	271
2012	836	503	278
2013	834	492	286
Compound Average Annual Growth (Per Cent)			
2000-2013	-0.40	-0.20	0.98

Source: Calculated by CSLS with data from Statistics Canada Cansim Tables 379-0031, 031-0003, and 031-0002. Based on Input-Output Accounts and Stock and Consumption of Fixed Non-Residential Capital.

The general pattern for capital productivity over the period is very similar to that observed in labour productivity. It rose from $210 of output per thousand dollars of capital input in 1997 to 310 in 2006 (

Table 50). Capital productivity steeply declined to 247 during the 2009 recession but has recovered somewhat to 286. Over the 2000 to 2013 period, capital productivity in the subsector grew at a rate of 0.98 per cent annually, which is quite a bit better than the growth rate for all industries nationally of -0.40 per cent. Capital productivity is lower in the rail transportation subsector than in the transportation and warehousing sector as a whole and than in the total economy. This is because the rail transportation subsector is more capital intensive than most subsectors, and much of the essential capital stock goes unused for hours at a time (e.g. rails).

Transport Canada also calculates estimates of capital productivity. According to Transport Canada data, capital productivity has increased an average of 0.04 per cent per year between 2000 and 2013, which is a slower increase than calculated by CSLs with Statistics Canada data. This is in part due to the fact that Transport Canada estimated a stronger increase in capital stock than Statistics Canada (see section ii.c capital).

For comparison, in the United States, capital productivity grew slower that in Canada, by an average of 0.19 per cent per year between 2000 and 2013 (Table 50).

c. Multifactor Productivity

Statistics Canada data on multifactor productivity is not available at the disaggregated level for the rail transportation subsector.[59] However, Transport Canada calculates estimates of total factor productivity. According to Transport Canada, total factor productivity in rail transportation grew an average of 1.26 per cent per year between 2000 and 2013.

B. Explaining Productivity Trends

Part A described in detail the outputs and inputs of the rail transportation subsector as well as its productivity, and compared these to the transportation and warehousing sector as a whole as well as to the average for all industries. As reported in part A, the rail transportation subsector experienced above average labour productivity growth as well as capital productivity growth since 2000. The goal of the present section is to explain the drivers of this productivity growth in the rail transportation subsector.[60]

i. Policy

a. Deregulation[61]

In 1987, the National Transportation Agency deregulated the railway industry in Canada, increasing competition. Pricing restraints were removed and confidential contracts between shippers and carriers became allowed. In 1996, the National Transportation Act was revised with the Canadian Transportation Act which more fully deregulated the industry mainly by allowing railways to abandon unprofitable lines. To abandon a line, railways must first offer it to other potential short line operators, then to various levels of government. If no one takes the line, then it can be abandoned. Table 51 shows a decrease of 1.54 per cent per year in the total line owned

---

[59] It is only available for an aggregate of air, rail, water and scenic and sightseeing transportation and support activities for transportation.

[60] Note that, unlike for truck transportation and urban transit systems, it will not be possible to report on labour productivity growth decomposition as Statistics Canada does not provide these data for the rail transportation subsector.

[61] See Gratwick (2001) for more information on policy.

between 1997 and 2013. This is likely due to abandonment of unprofitable lines. The abandonment of unprofitable lines contributes to improving productivity in the rail transportation subsector since unprofitable lines do not need to be operated.

The OECD produces an index of the degree of regulation in the rail industry between 1975 and 2013 based on entry barriers, the degree of public ownership, market structure, and vertical integration between rail operators and infrastructure providers. The index ranges from a maximum of 6.00 (high regulation) to a low of 0.00 (low regulation). Canada had lowest value of the index out of 34 countries in 1975, but it was quite high in absolute terms at 4.88.[62] It remained at this level until 1996 when it fell to a new low of 2.25. The index has remained at this level as of 2013. Internationally, the index suggests that Canada has relatively loose regulations, as it has had the second lowest level of the index since 1996.[63]

Table 51: Length of Track Owned at End of Year, Annual, Kilometres, Canada, 1997-2013

	Total track operated	Total line owned	Total line operated under lease, contract, trackage rights or jointly owned
1997	76,063	64,395	11,667
1998	74,530	63,071	11,459
1999	74,052	62,373	11,679
2000	74,412	62,672	11,741
2001	73,821	62,004	11,816
2002	73,186	61,715	11,470
2003	71,920	60,431	11,488
2004	72,048	60,655	11,393
2005	72,367	57,884	14,483
2006	71,812	57,349	14,463
2007	71,716	57,646	14,069
2008	70,230	56,989	13,240
2009	67,537	54,488	13,049
2010	66,312	53,410	12,902
2011	64,218	51,648	12,570
2012	63,104	50,740	12,364
2013	62,341	50,269	12,072
	Compound Average Annual Growth (Per Cent)		
1997-2013	-1.24	-1.54	0.21

Source: Statistics Canada Cansim Table 404-0010, based on the Railway Transport Survey.

According to Iacobacci & Schulman (2009), the deregulation of the rail transportation subsector and the privatization of the Canadian National Railway (described below in section b) are the main drivers of the strong productivity growth in the rail transportation subsector. Oum,

[62] See Appendix Table 5 for more detailed information.
[63] For further details on the OECDs product market regulation index in this sector, see Appendix C or Koske et al. (2014).

Waters & Yu (1999) report that almost all studies on productivity and efficiency measurement in rail transport conclude that increased competition via regulatory liberalisation and deregulation has improved efficiency.

b. Privatization of the Canadian National Railway

Table 52: Operating Ratios (Total Rail Operating Expenses/Total Rail Operating Revenues), Canadian National and Canadian Pacific, 1986-2009

	Canadian National	Canadian Pacific
1986	92	85
1987	89	82
1988	87	85
1989	91	91
1990	98	90
1991	95	98
1992	120	111
1993	96	91
1994	89	87
1995	122	119
1996	93	92
1997	80	86
1998	93	86
1999	76	98
2000	73	84
2001	74	85
2002	75	83
2003	71	90
2004	71	86
2005	67	83
2006	66	82
2007	68	83
2008	69	86
2009	67	102

Source: Calculated by CSLS with data from Statistics Canada Cansim Table 404-0004, based on the Railway Transport Survey.

In 1995, the Canadian National Railway (CN) was privatized, prior to which it had been a Crown corporation. This led to wide changes in management and largescale layoffs. According to Boardman, Laurin & Moore, (2009), the privatization of CN generated welfare gains of at least $4 billion (in 1992 dollars) and possibly up to $15 billion. Laurin & Bozec (2001) report that from 1981 to 1991 (prior to privatization), CN was less efficient than its private sector competitor, Canadian Pacific (CP), but that its performance surpassed that of CP following privatization. In fact, Table 52 shows that from 1986 to 1996, CN has a higher operating ratio (defined as the ratio of operating expenses to revenue) than CP, but from 1997 and on, CN has a smaller operating ratio than CP. This suggests that privatization may have led to productivity gains in the rail transportation subsector.

ii. Capital

a. Large Network of Tracks

In 2013, 50,269 kilometres of tracks were operated in Canada (Table 51). Canada has the fifth largest railway network in the world (Railway Association of Canada, no date).

The large network of tracks encourages the use of trains to transport freight or for passenger travel. In fact, the volume of goods handled by rail in Canada is the fourth largest in the world (Railway Association of Canada, no date). The extensive network of track may contribute to the train transportation subsector's above-average labour productivity level. However, productivity suffers if some of the track does not transport much cargo but must still be maintained.

iii. Technical Progress

a. Fuel Efficiency

Fuel is the most important intermediate input in rail transportation. Increases in fuel efficiency mean that the same output can be achieved while spending less on intermediate inputs. Fuel efficiency has been increasing since 1990 in the rail transportation subsector, as shown in Table 53.

Table 53: Total Diesel Fuel Consumption per $100 Operating Revenues in Current Dollars, Litres, Canadian National, Canadian Pacific and VIA Rail, 1997-2009

	Fuel Consumption
1997	28.0
1998	27.6
1999	25.3
2000	24.2
2001	24.1
2002	24.0
2003	24.3
2004	23.8
2005	21.6
2006	20.3
2007	20.6
2008	19.1
2009	19.1

Source: Calculated by CSLS with data from Statistics Canada Cansim Tables 404-0012 and 404-0004, based on the Railway Transport Survey.

Several fuel reducing practices have led to the increase in fuel efficiency. Most importantly, the locomotive fleet is being renewed with locomotives that are compliant with United Stated Environment Protection Agency standards to reduce fuel consumption. Various technical innovations which will be discussed below have also increased fuel efficiency. Initiatives related to operations have also been put in place to further reduce the fuel consumption of rail transportation. The railways have on-going training programs focusing on the importance of fuel conservation practices for the crews. Training reviews are conducted and incentives have been introduced to reduce the variance in fuel use between drivers. Government programs are developed to share the cost of the deployment and evaluation of fuel conservation and emissions reduction schemes by railways. These programs contribute to increasing fuel efficiency and therefore the productivity of railroads.

Given the importance of fuel as an intermediate input of rail transportation, the improvements in fuel efficiency have had a positive impact on the total factor productivity of rail transportation. These are especially important as the cost of fuel has been increasing in Canada over the years, with diesel fuel costs growing from $9.5 per $100 of operating revenues in 2000 to $12.1 in 2014 (Table 54).

Table 54: Total Cost of Diesel fuel per $100 of Operating Revenues, Current Dollars, Canadian National, Canadian Pacific and VIA Rail, Current Dollars, 1997-2009

	Fuel Cost
1997	9.2
1998	7.8
1999	7.1
2000	9.5
2001	9.7
2002	8.7
2003	9.1
2004	9.5
2005	11.6
2006	12.4
2007	14.1
2008	18.2
2009	12.1

Source: Calculated by CSLS with data from Statistics Canada Cansim Tables 404-0012 and 404-0004, based on the Railway Transport Survey.

b. Renewal of Locomotive Fleet

Investment embodies technological progress in new goods. As locomotives are retired, better engines with greater fuel efficiency replace the older ones. These more efficient locomotives increase the productivity of the rail transportation subsector. In the United States, the Environment Protection Agency releases standards regarding fuel efficiency. Transport Canada (2010) reports that in Canada 236 locomotives had been replaced as of 2008 to meet the standard which was introduced in 2005. On top of having better fuel efficiency, these new locomotives have higher-power and higher-adhesion capabilities. This means that it takes fewer of the newer locomotives to pull the same weight as before. These newer locomotives with higher horsepower and better fuel efficiency contribute to the strong total factor productivity growth of the train transportation subsector.

Railways are also adding a “Low Idle” feature to their locomotives, which allows the engines to idle at a lower speed. According to Transport Canada (2010), this can result in a reduction of fuel consumption of as much as 10 litres per hour, and up to 1 per cent of the annual fuel consumption. Devices are also being installed on locomotives to switch them on and off while idling, thereby preventing radiator coolant from freezing and charging batteries while also reducing the total idle time. These features further improve the locomotive fleet and the productivity of the train industry.

According to Cairns (2015), train operations have also been improved with the placement of locomotives in the middle of trains to reduce excessive lateral forces, and of end of train devices that are replacing cabooses. According to Bitzan & Keeler (2003), the elimination of cabooses and associated crew reduced costs by 5-8% on the typical Class 1 railroad in 1997. These new features increase the productivity of train transportation.

c. Dynamic Braking and Train Pacing

Train pacing and braking strategies have been put in place in the rail transportation subsector. Dynamic braking equipment has been introduced in most locomotives in Canada. Dynamic braking, as opposed to air brakes, allows engineers to reduce the severity with which they apply brakes on the locomotive. Using dynamic breaking allows trains to coast to a stop rather than using heavy breaking which uses engine power. According to Cairns (2015), the use of dynamic breaking has increased the productivity of rail transportation. It has also contributed to the increase in fuel efficiency. Transport Canada (2010) reports that in Canada train braking strategies are audited to ensure compliance with dynamic braking objectives.

d. Infrastructure Improvements

Improvements to rail line infrastructure are contributing to increases in rail transportation productivity. Cairns (2015) attributes growth in rail total factor productivity to continuous welded rail, improved elastic track fastening systems, and advanced track inspection cars. Continuous welded rail, used on most modern railways, is a form of track where rails are welded together. This results in fewer joints, which gives a strong and smooth ride, and requires less maintenance. Rail fastening systems are what fastens rail to railroad ties. Advanced track inspection cars perform rail and tie inspections while in motion. This enables the identification and repair of problems before failure occurs. In addition to the productivity gains from these technologies, rail safety has been improved as well by diagnosing and pre-empting such track failures.

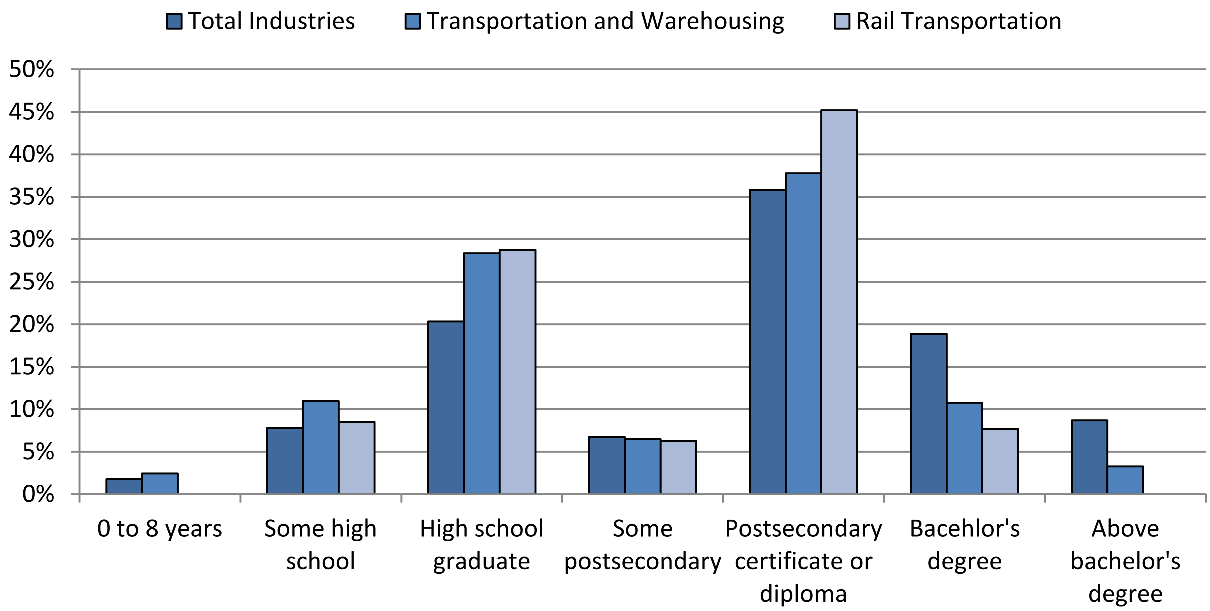
Railways are also investing in improvements that reduce friction on rails and increase fuel efficiency. These are improvements on sharp curves, grades, uneven roadbeds, track flexing and jointed rail. The laser glazing of nails is also currently under study and shows promising results for increasing fuel efficiency. Rail lubrication, which further reduces friction, has been shown in tests to increase fuel efficiency (Transport Canada, 2010). For this reason, railways have put in place system-wide trackside flange lubricators and locomotive-mounted wheel flange lubricators.

Additionally, investments are being made for double tracking and siding extensions in heavily trafficked single lane tracks. Double tracking, which involves running a track in each direction rather than a single track on which trains travel in both directions, eliminates meets and idling which increases operation efficiency and fuel consumption.

iv. Human Capital

The educational level of those employed in rail transportation impacts the productivity level of this subsector. The goal of this section is to provide the educational attainment of workers in the rail transportation subsector. Chart 33 gives a breakdown of workers by their highest level of educational attainment in 2014.

Chart 33: Employment by Highest Level of Educational Attainment, Per Cent of Total, All Industries, Transportation and Warehousing, Rail Transportation, 2014

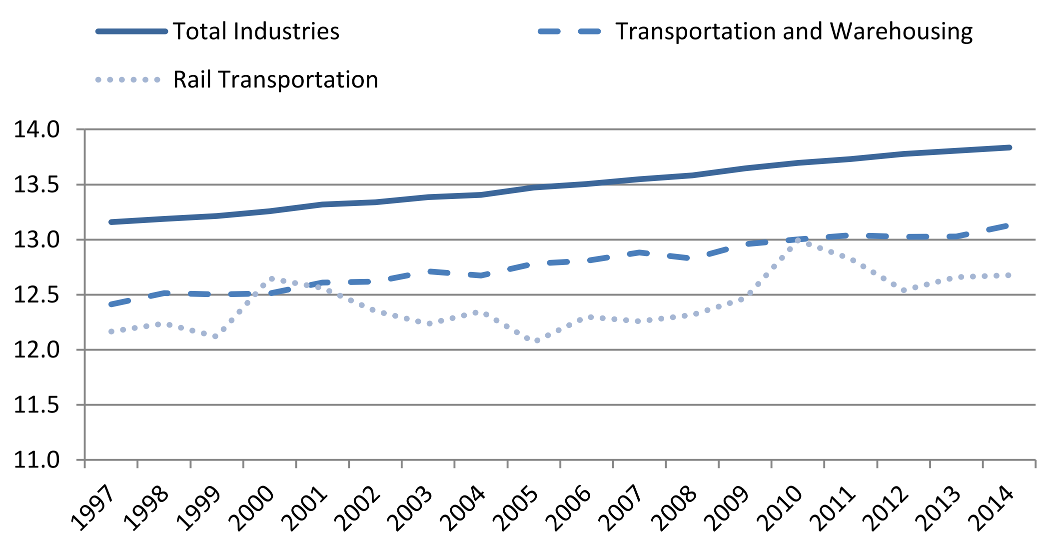


Source: Calculated by CSLS with data from the Labour Force Survey
Note: Data that show 0% are suppressed because they are below the confidentiality threshold.

Most workers (45 per cent) in rail transportation have a postsecondary certificate or diploma as their highest level of educational attainment. It is interesting to note that only 8 per cent of workers do not have a high school degree or above, which is less than in transportation and warehousing. This is promising for the productivity of the rail transportation subsector because workers with no high-school diploma raise a concern regarding basic literacy and numeracy skills, which can affect their productivity. Note that Chart 34 shows that no workers in the rail transportation subsector have education above a bachelor's degree, but this is likely due to data suppression by Statistics Canada for confidentiality.

In 2014, the average worker in rail transportation had 12.7 years of schooling, which is less than the average of 13.1 years in the transportation and warehousing sector as a whole and than the average of 13.8 years in all industries (Chart 34).[64] Between 2000 and 2014, the average years of schooling grew by 0.03 years in the train transportation subsector, and thus the growth of educational attainment in this subsector has been minimal. In the transportation and warehousing sector as a whole, educational attainment grew by 0.62 years for the same period, and in all industries the growth is 0.58 years.

Chart 34: Average Years of School per Worker, All Industries, Transportation and Warehousing, Rail Transportation, 1997-2014



Source: Calculated by CSLS with data from the Labour Force Survey

v. Investment

Investments in future transportation capacity are favorable to the rail transportation subsector. These are particularly important when specific corridors may be inadequate to meet future demand (Cairns, 2015). For example, the Asia-Pacific Gateway and Corridor Initiative is a set of investment and policy measures which focus on trade with the Asia-Pacific region, launched in 2006. The goal is to strengthen Canada's competitive position in international

[64] Average years of schooling were calculated by attributing values for years of schooling in each category and computing the average of all cases. The following values were used: 0 to 8 years -8 years, some high school-10 years, high school graduate-12 years, some postsecondary-13 years, postsecondary certificate or diploma-14 years, bachelor's degree-16 years, and above bachelor degree-18 years.

commerce (Cairns, 2015). Part of this is the Roberts Bank Rail Corridor Program. This is a package of road and rail improvements funded through a collaboration of public and private sector partners. Through this program, $307 million was used to improve the safety and efficiency of the road and rail network (Government of Canada, 2014). This type of investment contributes to the success of the rail industry in Canada and improves productivity.

vi. Organizational Factors

a. Operating Ratio

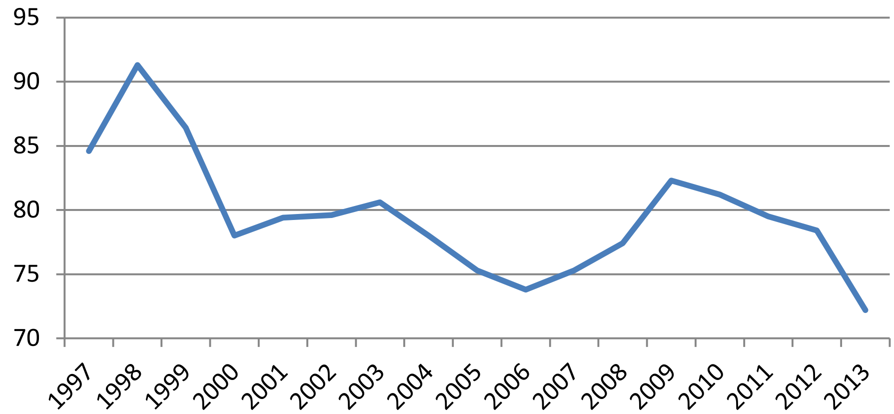
The operating ratio is the ratio of operating expenses over revenue. In the rail transportation subsector, the operating ratio has diminished from 84.6 per cent in 1997 to 72.2 per cent in 2013 (Table 55). The operating ratio has decreased 12.4 percentage points between 2000 and 2013. The decrease in the operating ratio is due to both lower costs and increased efficiency. The notable increase in fuel efficiency of the rail transportation subsector explains, at least in part, the fall of the operating ratio, although this was somewhat offset by rising fuel prices.

Table 55: Total Rail Operating Expenses, Revenues, and Operating Ratio, 1997-2013

	Total Rail Operating Expenses (Thousands of Current Dollars)	Total Rail Operating Revenues (Thousands of Current Dollars)	Operating Ratio (Per Cent)
1997	6,056,472	7,162,305	84.6
1998	6,203,184	6,796,212	91.3
1999	5,941,526	6,873,713	86.4
2000	5,622,515	7,212,494	78.0
2001	5,769,958	7,265,945	79.4
2002	5,824,323	7,320,557	79.6
2003	5,984,538	7,427,123	80.6
2004	6,211,181	7,958,786	78.0
2005	6,853,837	9,102,626	75.3
2006	7,192,139	9,742,482	73.8
2007	7,435,996	9,875,686	75.3
2008	8,032,610	10,373,112	77.4
2009	7,293,064	8,860,124	82.3
2010	8,062,873	9,931,792	81.2
2011	8,481,074	10,663,662	79.5
2012	9,132,550	11,645,130	78.4
2013	8,864,625	12,271,480	72.2
		Compound Average Annual Growth (Per Cent)	
2000-2013	3.56	4.17	-0.58

Source: Statistics Canada, Cansim Table 404-0004, based on the Railway Transport Survey

Chart 35: Operating Ratio, Rail Transportation, 1997-2013



Source: Statistics Canada, Cansim Table 404-0004, based on the Railway Transport Survey

b. Co-Production

Co-production is a process where railways cooperate to share infrastructure. This optimizes their utilization. For example, when two railways have parallel routes each being used in two directions, they will instead share and run trains in one direction on one route and the other direction on the other route through a negotiated agreement. This is called directional running. Another example of co-production is when railways allow reciprocal access to two different bottleneck locations or reciprocal access over line-haul segments on a corridor. Reciprocal access over line-haul segments on a corridor allows for redundant segments to be discontinued when there is more than one route because the railways will negotiate joint use of segments of line over a given corridor.

According to Cairns (2015) these types of agreements result in increased line capacity, improved equipment utilization, increased efficiency of operations, elimination of redundant infrastructure or facilities, and provision for alternative operations at times of accidents or weather incidents. These types of agreement improve efficiency and productivity in the train transportation subsector.

Note that these are commercial agreements, not regulations. They usually do not allow the right to pick up or make deliveries along the way.

c. Intermodal Containers

Intermodal containers are not specific to rail transportation but to intermodal transportation. An intermodal container is a large box made to carry freight. These are easily stackable and made to be transferrable between transportation modes. An example of intermodal transportation chain follows:

- a loaded container is transported by truck from the shipping facility to a train terminal;

- the container is loaded on a train and sent to a train terminal by a dock;
- the container is loaded onto a ship and shipped overseas.

Intermodal containers reduce handling speeds during the transportation process and reduce costs, thus increasing productivity (Barnhart & Laporte, 2006). As in trucking, intermodal containers also insure railways against hauling empty cars, as transporters are more likely to be able fill an intermodal container car on a return trip due to its versatility than a use-specific car (e.g. grain or bitumen car).

C. Policies to Promote Productivity Growth

i. Deregulation

Part A has described deregulations that took place in the train transportation subsector. The deregulation undoubtedly was a factor in the growing productivity of this subsector. Policymakers should continue to promote deregulation in this industry.

Several measures currently in place still regulate the train transportation subsector. The industry could be further deregulated by letting go of these regulations, which could further promote productivity growth in the subsector. Cairns (2015) provides detailed policy recommendations to deregulate train transportation on which we draw in this section.

For one, Cairns (2015) states that extended interswitching regulations should be allowed to lapse in 2016. Interswitching happens when a shipper only has access to a single carrier, but is within a prescribed distance of others. The goal is to ensure that these shippers with access to only one carrier have fair and reasonable access to the railway system at a regulated rate. One railway carrier performs the pickup of cars from a shipper and hands off these cars to another carrier that performs the line haul. For example, a carrier A can negotiate with a firm to transport freight to a final destination. However, carrier A does not have direct access to the shipper, but carrier B does. Carrier B will then have to pick up the shipment and hand it off to carrier A who will do the line haul until the final destination. The interswitching must happen within a prescribed distance of the pickup location, usually of 30 kilometers but 160 km in the prairies (Cairns, 2015). The Railway Interswitching Regulations set the rates to be charged for interswitching services, and railway companies are responsible for reimbursing each other (Canadian Transportation Agency, 2015). The goal is to create competition where otherwise there would have been none. According to Cairns (2015), *extended* interswitching regulation introduced in the 2014 *Fair Rail for Grain Farmers Act* “undermines pricing freedom, distorts competition in favour of U.S. railroads, and will deter future investment”.

Cairns (2015) also states that attempts to micro-manage future grain shipments should be resisted. During the winter of 2013/2014, a “perfect storm” led a significant backlog in the transportation of western grain. The fall crop in 2013 was larger than average and some producers held back their grain expecting higher prices in the future. However, the winter of

2013/2014 was especially harsh and railways were forced to reduce the frequency, size and speed of their trains. This reduction affected all shippers, but especially the grain farmers who had held their grain. In 2014, the federal government responded to the urgings from western agriculture interests and created the Fair Rail for Grain Farmers Act. This act gives the Minister of Transport the ability to mandate grain volumes that must be transported. However, as Cairns (2015) explains, government regulations on commercial decisions are known to have a negative impact on productivity, and favouring Western grain means disadvantaging other Western freight (coal for example[65]). Cairns (2015) also states that this will harm future investments.

Instead of the Fair Rail for Grain Farmers Act, Cairns (2015) suggests that the maximum revenue entitlement for western grain should be eliminated. This would lead to a more commercial grain transportation system. The maximum revenue entitlement creates a ceiling for the total revenues that can be earned by railways from transporting grain.[66] According to Prentice & Parsons (2015), "the revenue cap has now reached a point of diminishing returns for farmers [...]. The cap is hurting the efficiency, growth and productivity of the system, by limiting the investments and innovation, technology and capacity required to competitively move Canadian grains and other products to world export markets." Policymakers should eliminate the maximum revenue entitlement rather than micro-managing grain transportation.

Note however that co-production (described in section B) is based on commercial agreements, not regulations. Commercial agreements between railways are positive for the productivity of the rail transportation subsector.

ii. Encouraging Fuel Efficiency and Technical Advancement

Section B has shown that fuel efficiency has clearly had an impact on the positive growth of productivity in the rail transportation subsector. Given that this also has a positive impact for the environment, fuel efficiency in the industry should clearly be encouraged.

Government programs are already in place to encourage increases in fuel efficiency. For example, the clean rail academic grant program provides federal funds to academic research programs developing technologies and practices which aim to reduce air emissions from the rail sector. Programs such as this one will help maintain the positive growth of rail productivity.

iii. Investment

Investments in the railway industry promote productivity. When the infrastructure in place is not sufficient to respond to the predicted future demand, investments will be beneficial

[65] Crude oil is another product which is notably affected by favour given to Western grains. While the transport of crude has undergone significant growth in recent years, it still only makes up around 2 percent of total rail traffic (Cairns, 2015).

[66] More information regarding the formula used to calculate the respective maximum revenue entitlement of CN and CP can be found at: https://www.otc-cta.gc.ca/eng/qa-maximum-revenue-entitlement-transportation-western-grain . In 2014-2015, CN was assessed a maximum revenue entitlement of $738 million and CP was assessed one of $722 million, as per Decision No. 400-R-2015 from the Canadian Transportation Agency.

not only to increase the productivity of the rail transportation subsector, but also for the industries dependent on it, and for the Canadian economy in the international market.

In section B, we described the Asia-Pacific Gateway Corridor. This model featured investments from a range of stakeholders, such as governments, municipalities, ports and railways. According to Cairns (2015), this model of investment should be used to enhance access to and from international trade corridors when there appears to be a specific need for greater transportation investment.

Private investment in locomotives and rolling stock could be encouraged by offering accelerated capital cost allowances on machinery and equipment in the sector.

iv. Safety

It is impossible to make policy recommendations in the railway industry without discussing safety concerns. As productivity is increased and costs are lowered, safety can be negatively affected. Safety concerns need to be addressed regardless of the positive or negative impact on productivity. Table 56 shows a decrease in railway accidents between 2005 and 2014, although the number of accidents increased after 2012.

Table 56: Accidents, Rail Transportation Subsector, 2005-2014

	Accidents
2005	1476
2006	1371
2007	1334
2008	1199
2009	1055
2010	1089
2011	1044
2012	1041
2013	1087
2014	1225

Source: Transportation Safety Board of Canada, Statistical-Summary – Railway Occurrences 2014, Table 1.
http://www.tsb.gc.ca/eng/stats/rail/2014/sser-ssro-2014.asp
Note: Accidents are defined b the Transportation Safety Board of Canada as
a. a person is killed or sustains a serious injury as a result of
(I) getting on or off or being on board the rolling stock, or
(ii) coming into contact with any part of the rolling stock or its contents;
b. the rolling or its contents
(i) are involved in a collision or derailment,
(II) sustain damage that affects the safe operation of the rolling stock,
(iii) cause or sustain a fire or explosion, or
(iv) cause damage to the railway that poses a threat to the safe passage of rolling stock or to the safety of any person, property or the environment;

Accidents at public railway crossings are an example of a safety concern. A crash at a level crossing in Ottawa in 2014 between an OC Transpo bus and a VIA Rail train increased concern over the safety of level crossings. Overpasses may be a solution but these come at a high cost for municipalities and railways. This can affect productivity negatively in the short term because of the large capital investment that does not generate any output, but overpasses can increase productivity in the long run as safety is increased and accidents are avoided. Overpasses can also increase productivity because they facilitate the flow of railways traffic as opposed to level crossings. In particular, railways are subject to regulations regarding blocking traffic at level crossings which may reduce productivity around some crossings. It is important to keep in mind that overpasses benefit ground transportation as well.

The transportation of dangerous goods has been in the spotlight following the derailment in Lac Megantic in 2013, when a train carrying oil derailed downtown and exploded, killing 47 people. Regulatory changes in the transportation of dangerous goods are being made in Canada. Cairns (2015) recommends that these should be harmonized with those underway in the United States, to avoid a disruption in the North American rail industry. He also recommends that changes to railway liability in the event of a catastrophic accident should be made. These are currently under consideration. Cairns (2015) gives the example of a fund to cover liabilities beyond a cap.

Section 6: Urban Transit Systems

Urban transit is an important mode of transportation within cities. This industry is comprised of establishments that operate in the mass transportation of passengers. It includes light rail, subways, and buses. In addition to providing passenger travel, this industry serves social goals of transporting populations with physical disabilities or providing affordable transportation to low-income individuals. Urban transit also reduces congestion and helps protect the environment. In order to better understand urban transit productivity, section A provides a description of inputs, outputs, and productivity of urban transit systems. These are based on Statistics Canada data and will be compared to Transport Canada data when possible. Section B then explains the drivers of productivity and section C offers policy recommendations to promote productivity.

Box 2: Data Availability and Data Gaps in Urban Transit Systems

	485+487- Transit and Ground Passenger Transportation and Scenic and Sightseeing Transportation	**485- Transit and Ground Passenger Transportation**	**4851-Urban Transit Systems**
Nominal Gross Output	-	1997-2010	-
Nominal GDP	2007-2011	1997-2010	2007-2011
Real GDP	2002-2014	-	1997-2014
Implicit Prices	2007-2011	-	2007-2011
Employment/Hours	1997-2013	-	1997-2013
Investment	-	1997-2013	-
Capital Stock	-	1997-2013	-
MFP	-	1997-2010	-

Note: 1997 is the first year for which data are presented in this report, prior data may be available.

Box 3: NAICS Codes Involving Urban Transit

Urban transit systems, a four digit NAICS industry (4851), are part of the transit and ground passenger transportation subsector represented by the NAICS code 485. This industry covers establishments that transport passengers. Excluded are establishments that are primarily engaged in passenger transportation associated with scenic or sightseeing activities; these fall under NAICS code 487, scenic and sightseeing transportation. The transit and ground passenger transportation subsector is the aggregate of six groups, which are: 4851-urban transit systems, 4852-interurban and rural bus transportation, 4853-taxi and limousine service, 4854-school and employee bus transportation, 4855-charter bus industry, and 4859-other transit and ground passenger transportation. Although some CANSIM tables have data for the NAICS code 4851 as well as for an aggregation of 485 and 487, some only have data for 485. In the following section, it will be specified in each table whether the data are for 4851, 485, or an aggregate of 485 and 487. To give an idea of the size of each group, Table 57 gives a breakdown of the number of establishments and employment for each in December 2013. Urban Transit Systems account for 34.99 per cent of employment in the transit and ground passenger transportation subsector, making this the largest industry in this subsector.

Table 57: Establishments per Group, Employment, and Output, in the Transit and Ground Passenger Transportation and Scenic and Sightseeing Transportation Sectors

	Establishments (December 2013)	Per Cent of Total	Employment (2011) (Workers) ***	Per Cent of Total	Nominal GDP (2011) (Millions)
485- Transit and Ground Passenger Transportation	23,929	100.00	144,710	100.0	$7,863 (2010 value)
4851- Urban Transit Systems	186	0.78	50,640	34.99	$5,308
4852- Interurban and Rural Bus Transportation	159	0.66	3,110	2.15	...
4853- Taxi and Limousine Service*	20,641	86.26	40,695	28.12	$911
4854- School and Employee Bus Transportation	1,745	7.29	40,710	28.13	...
4855- Charter Bus Industry	360	1.50	4,650	3.21	...
4859- Other Transit and Ground Passenger Transportation**	838	3.50	4,905	3.39	...
487- Scenic and Sightseeing Transportation	865	n.a.	2,715	n.a.	...

Source: Establishments- Industry Canada, from Statistics Canada, Canadian Business Patterns Database, Output- Statistics Canada Cansim Table 379-0029, based on Input-Output accounts, Employment- Statistics Canada 2011 NHS

*This industry will not be explored in detail as this section focuses on urban transit systems. However, it would be an interesting topic to address, especially with the implication of Uber for taxi productivity.

**This industry comprises establishments, not classified to any other industry, primarily engaged in providing shuttle services to airports and similar facilities, special needs transportation services and other transit and ground passenger transport. Shuttle services included in this industry are those that use vans and/or buses as a means of transport. They usually travel on fixed routes and service particular hotels or carriers. Special needs transportation establishments use conventional or specially converted vehicles to provide passenger transportation to the infirm, elderly or handicapped. Examples of these activities include: airport limousine service, scheduled carpool operation, shuttle services (except employee bus), special needs passenger transportation service (definitions from Statistics Canada).

***The employment numbers in this table are from the NHS. The employment for urban transit systems is lower than in Table 62, where the data are from the CPA. It is not clear why the numbers are not consistent. Also note that the nominal GDP is 5.8 times bigger in urban

A. Economic and Productivity Performance

i. Output

a. Gross Output

There are no data available for the nominal total gross output, which is the total value of sales, in urban transit systems. In the transit and ground passenger transportation subsector (NAICS 485), the nominal total gross output was $13,030 million in 2010 (Table 4-1 in CSLS Transportation Database[67]).[68] The nominal gross output grew an average of 6.13 per cent per year from 2000, when the gross output was $7,187 million. The growth was faster in the transit and ground passenger transportation subsector (NAICS 485) than in the transportation and warehousing sector as a whole, where the compound average annual growth was 4.48 per cent per year from 2000 to 2010. It was also faster than in all industries, where the compound average annual growth was 3.81 for the same period.

Transport Canada has data available for the real gross output in urban transit, which is unavailable from Statistics Canada. According to Transport Canada, real gross output increased an average of 2.66 per cent per year between 2000 and 2013.

Intermediate inputs account for less of the gross output in the transit and ground passenger transportation subsector (NAICS 485) than in the transportation and warehousing sector as a whole (39.7 per cent and 52.7 per cent respectively in 2010). The growth of nominal intermediate inputs in the transit and ground passenger transportation subsector (NAICS 485) was 7.92 per cent per year between 2000 and 2010, which is more rapid than the growth of the gross output which was 6.13 per cent. The largest intermediate input in this subsector is fuel, therefore the gross output is dependent on the price of fuel. In 2011, diesel fuel as an intermediate input accounted for 11.9 per cent of gross output (Statistics Canada Cansim Table 381-0022).[69]

b. Nominal GDP

In 2011, the nominal GDP in urban transit systems (NAICS 4851) was $5,308 million. This represents an increase of 4.96 per cent per year from 2007. This growth in urban transit systems (NAICS 4851) was faster than in transit and ground passenger transportation in general (NAICS 485), where growth was 3.56 per cent per year for the same period. In the transportation and warehousing sector, growth was even slower, at 1.06 per cent per year. Urban transit systems

---

[67] The CSLS has put together a complete database on the four modes of transportation examined in this report. The database will be posted with this report.

[68] The last year for which gross output data is available is 2010 for the transit and ground passenger transportation subsector.

[69] Other main inputs, in order, are repair construction services (9.0 per cent of gross output), electricity (5.5 per cent of gross output), motor vehicle repair and maintenance services (4.7 per cent of gross output), and employment services (4.4 per cent of gross output).

Table 58: Nominal GDP, Millions of Current Dollars, All Industries, Transportation and Warehousing Sector, Transit and Ground Passenger Transportation Subsector, Scenic and Sightseeing Transportation Subsector, and Urban Transit Systems, 1997-2011

	All Industries	48 and 49- Transportation and Warehousing	485 and 487- Transit and Ground Passenger Transportation, and Scenic and Sightseeing Transportation	485- Transit and Ground Passenger Transportation	4851- Urban Transit Systems
1997	837,260	37,116	…	4,708	…
1998	867,786	38,969	…	4,532	…
1999	932,530	41,265	…	4,610	…
2000	1,025,033	43,318	…	4,775	…
2001	1,058,086	45,941	…	4,820	…
2002	1,095,600	47,758	…	5,251	…
2003	1,157,137	48,401	…	5,542	…
2004	1,231,468	50,687	…	5,891	…
2005	1,312,696	55,968	…	6,251	…
2006	1,388,359	59,719	…	6,754	…
2007	1,466,692	61,140	7,151	7,079	4,248
2008	1,551,684	62,150	7,842	7,760	4,713
2009	1,473,183	59,576	7,417	7,337	4,615
2010	1,564,105	63,101	7,945	7,862	4,912
2011	1,667,007	67,020	8,303	…	5,308
			Compound Average Annual Growth (Per Cent)		
2007-2010	2.17	1.06	3.57	3.56	4.96
2000-2010	4.32	3.83	…	5.11	…
2000-2011	4.52	4.05	…	…	…

Source: Statistics Canada Cansim Tables 379-0023 and 379-0029 [379-0023 was aggregated to obtain growth rates for all industries which were used to link the GDP from 379-0029 to create a longer time series] (all industries), 383-0032 (transportation and warehousing, and transit and ground passenger transportation), and 379-0029 (Transit and Ground Passenger Transportation and Scenic and Sightseeing Transportation, and urban transit). Based on Input-Output Accounts.

Note: For comparison, in transit and ground passenger transportation (NAICS 485), nominal gross output had a compound annual growth of 6.13 per cent per year from 2000 to 2010, and intermediate inputs had an average compound annual growth of 7.92 per cent per year for the same period. This means that the cost of intermediate inputs grew faster than value added.

(NAICS 4851) accounted for 62.5 per cent of the value added in transit and ground passenger transportation (NAICS 485) in 2010 (Table 58).[70,71]

[70] In the same year, taxi and limousine service (NAICS 4853) accounted for 12.1 per cent of the value added in transit and ground passenger transportation (NAICS 485) and other transit and ground passenger transportation and scenic and sightseeing transportation (NAICS 4852, 4854, 4855, 4859, 487) accounted for 26.4 of transit and ground passenger transportation (NAICS 485).

[71] Notice that the value added of transit and ground passenger transportation and scenic and sightseeing transportation (NAICS 485 and 487) is very similar to that of transit and ground passenger transportation (NAICS

c. Real GDP

Table 59: Real GDP, Millions of Chained 2007 Dollars, All Industries, Transportation and Warehousing Sector, Transit and Ground Passenger Transportation Subsector, Scenic and Sightseeing Transportation Subsector, Urban Transit Systems, 1997-2014

	All Industries	48 and 49-Transportation and Warehousing	485 and 487-Transit and Ground Passenger Transportation, and Scenic and Sightseeing Transportation	4851-Urban Transit Systems	Urban Transit Systems as a Share of Transit and Ground Passenger Transportation, and Scenic and Sightseeing Transportation*	Urban Transit Systems as a Share of Transportation and Warehousing	Urban Transit Systems as a Share of All Industries
1997	1,070,192	46,569	...	3,192	...	6.85	0.30
1998	1,111,384	47,498	...	3,146	...	6.62	0.28
1999	1,173,088	50,415	...	3,404	...	6.75	0.29
2000	1,236,822	52,929	...	3,655	...	6.91	0.30
2001	1,254,236	54,286	...	3,497	...	6.44	0.28
2002	1,287,248	54,179	6,440	3,794	58.91	7.00	0.29
2003	1,314,512	54,391	6,299	3,687	58.53	6.78	0.28
2004	1,355,222	56,443	6,526	3,873	59.35	6.86	0.29
2005	1,395,920	59,765	6,777	3,962	58.46	6.63	0.28
2006	1,434,935	61,489	6,775	3,967	58.55	6.45	0.28
2007	1,466,691	62,458	7,151	4,248	59.40	6.80	0.29
2008	1,482,081	62,261	7,592	4,435	58.42	7.12	0.30
2009	1,438,301	59,649	6,993	4,255	60.85	7.13	0.30
2010	1,489,226	61,847	7,269	4,361	59.99	7.05	0.29
2011	1,534,440	63,929	7,376	4,537	61.51	7.10	0.30
2012	1,565,595	64,839	7,525	4,624	61.45	7.13	0.30
2013	1,598,734	65,667	7,748	4,775	61.63	7.27	0.30
2014	1,637,656	68,596	7,918	4,876	61.58	7.11	0.30
			Compound Average Annual Growth (Per Cent)				
2000-2013	1.99	1.67	...	2.08	...	0.40	0.08
2000-2014	2.03	1.87	...	2.08	...	0.21	0.05
2002-2014	2.03	1.99	1.74	2.11	0.37	0.12	0.08

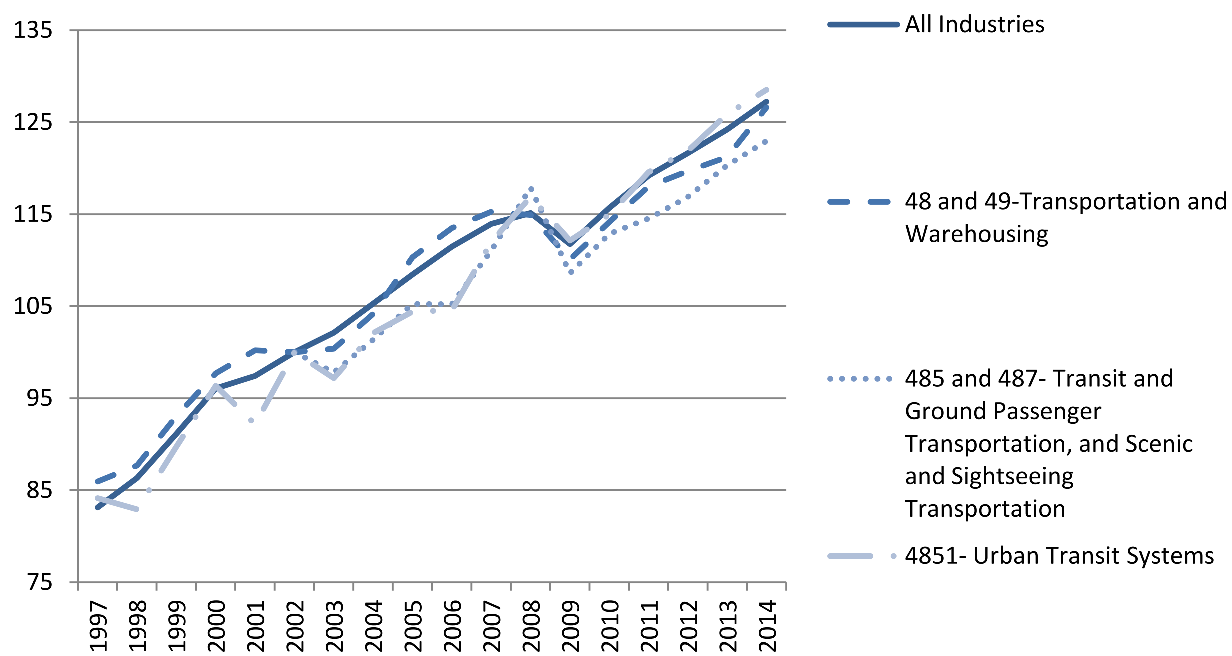
Source: Statistics Canada Cansim Table 379-0031. Based on Input-Output Accounts.
*Notice that urban transit makes up a larger share of GDP in transit and ground passenger and scenic and sightseeing transportation, than of employment.

Real GDP, which gives a better idea of a change in the level of economic activity than nominal GDP, was $4,876 million of chained 2007 dollars in 2014 for urban transit systems (NAICS 4851) (Table 59). Real GDP increased 2.08 per cent per year between 2000 and 2014. This growth was faster than in the transportation and warehousing sector as a whole, where real

485) alone. This means that the contribution of scenic and sightseeing transportation is minimal. This will be important later for tables where this is the only data available.

GDP grew 1.87 per cent per year for the same period and than in the total economy where it was 2.03 per cent per year (Chart 36).

Chart 36: Real GDP, All Industries, Transportation and Warehousing Sector, Transit and Ground Passenger Transportation Subsector, Scenic and Sightseeing Transportation Subsector, and Urban Transit Systems, 2002=100, 1997-2014

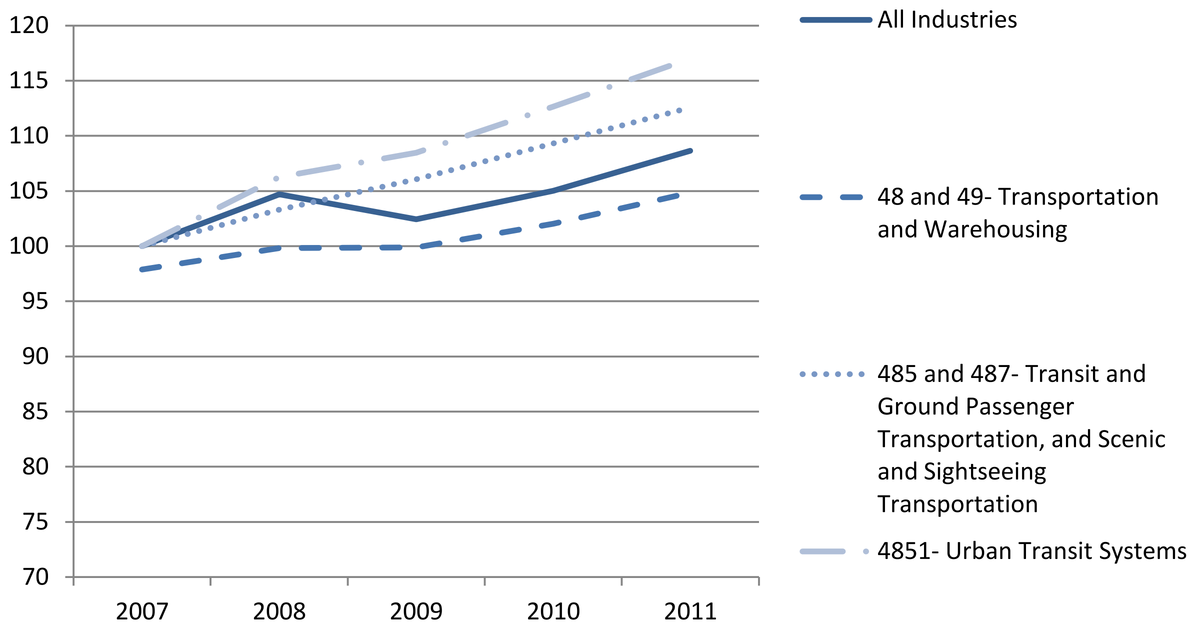


Source: Calculated by CSLS with data from Statistics Canada Cansim Table 379-0031. Based on Input-Output Accounts.

d. Prices

The implicit price deflator is calculated by dividing nominal GDP by real GDP. The implicit price deflator grew 4.00 per cent per year between 2007 and 2011 in urban transit systems (NAICS 4851) (Chart 37 and Table 60). This growth is faster than in transit and ground passenger transportation and scenic and sightseeing transportation (NAICS 485 and 487), where the implicit price deflator grew 3.00 per cent per year. It is also faster than in the transportation and warehousing sector as a whole, and than in all industries, where implicit prices grew 1.73 and 2.09 respectively during the same period.

Chart 37: Implicit Price Deflator, All Industries, Transportation and Warehousing Sector, Transit and Ground Transportation Subsector, Scenic and Sightseeing Transportation Subsector, and Urban Transit Systems, 2007-2011



Source: Calculated by CSLS with Statistics Canada data (see Table 58 and Table 59). Based on Input-Output Accounts.
Note: In 2007 all sectors should be at 100. This is because in 2007 nominal and real GDP should be equal as real GDP is in 2007 dollars. It is unclear why transportation and warehousing is not 100. The implicit price deflator is calculated by CSLS based on Statistics Canada Cansim tables 383-0032 and 379-0031. See Table 60 for details.

The implicit price deflator is a price index. In urban transit systems (NAICS 4851), the rapid growth of the implicit price deflator was caused by a raise in fares for urban transit. The rising fares may be an attempt to recover the costs associated with declining productivity (detailed in section 6.iii below).

Transport Canada calculates an output price index. According to this index, output prices have grown an average of 2.90 per cent per year between 2000 and 2013 in urban transit. For the period of 2007 to 2011, Transport Canada shows a growth of the output price index of 3.04 per cent per year, which is slightly lower than the 4.00 per cent growth of the implicit price deflator calculated by CSLS with Statistics Canada data. The difference may be due to the Transport Canada price index being based on gross output while the implicit price deflator is based on GDP.[72]

[72] Statistics Canada does not provide a time series for real gross output.

Table 60: Implicit Price Deflator, All Industries, Transportation and Warehousing Sector, Transit and Ground Passenger Transportation Subsector, Scenic and Sightseeing Transportation Subsector, Urban Transit Systems, 1997-2011

	All Industries	48 and 49- Transportation and Warehousing	485 and 487- Transit and Ground Passenger Transportation, and Scenic and Sightseeing Transportation	4851- Urban Transit Systems
1997	78.23	79.70	...	...
1998	78.08	82.04	...	...
1999	79.49	81.85	...	...
2000	82.88	81.84	...	...
2001	84.36	84.63	...	...
2002	85.11	88.15	...	...
2003	88.03	88.99	...	...
2004	90.87	89.80	...	...
2005	94.04	93.65	...	...
2006	96.75	97.12	...	...
2007	100.00	97.89*	100.00	100.00
2008	104.70	99.82	103.29	106.27
2009	102.43	99.88	106.06	108.46
2010	105.03	102.03	109.30	112.63
2011	108.64	104.84	112.57	116.99
		Compound Average Annual Growth (Per Cent)		
2007-2011	2.09	1.73	3.00	4.00
2000-2011	2.49	2.28	...	...

Source: Calculated by CSLS with Statistics Canada data (see Table 58 and Table 59). Based on Input-Output Accounts.
*This value should be 100, as the real and nominal GDP for 2007 should be equal. It is unclear why it is not. These values are based on Statistics Canada Cansim Tables 383-0032 and 379-0031.

e. Ridership

Table 61: Ridership of National and Major Canadian Cities, Millions, 1999-2014

		OC Transpo (Ottawa)	Translink (Vancouver)	TTC (Toronto)	STM (Montreal)
1999	**…**	75	…	393	342
2000	**…**	81	…	411	348
2001	**…**	85	…	420	355
2002	**…**	87	…	416	363
2003	**…**	88	…	405	363
2004	**…**	89	…	418	358
2005	**…**	90	…	2005	359
2006	**…**	92	…	445	363
2007	**…**	96	…	460	368
2008	1,826	94	…	467	383
2009	1,829	83	313	471	383
2010	1,912	99	347	477	389
2011	1,972	104	353	500	405
2012	2,026	101	362	514	413
2013	**…**	98	354	525	417
2014	**…**	97	…	535	…
			Compound Average Annual Growth		
2008-2012	2.63	1.83	…	2.43	1.90
2000-2014	…	1.33	…	1.90	…
2010-2013	**…**	-0.51	0.67	3.25	2.34
2004-2014	**…**	0.90	…	2.50	…
2008-2013	**…**	0.81	…	2.37	1.72

Source: Canadian Urban Transit Association Transit Stats 2008-2012, Statistics Canada Cansim Table 031-0002, OC Transpo statistics, Translink 2013 Report, Toronto Transit Commission Annual Reports 2007-2014, Société de Transport de Montréal Activity Reports 2013-2000

Ridership, a measure of output, is the number of rides provided. Limited data are available at the national level. The Canadian Urban Transit Association provides transit statistics for the period of 2008 to 2012, which include ridership.

Table 61 provides ridership data at the national level as well as for major Canadian cities. In Canada, ridership has been increasing. Over the period of 2008 to 2012, ridership has increased by 2.63 per cent per year in Canada. In major Canadian cities (Ottawa, Toronto, Vancouver, and Montreal), ridership increased slightly less. For the same period, ridership increased by an average of 1.83 per cent per year in Ottawa, 2.00 per cent per year in Toronto, and 1.90 per cent per year in Montreal.

ii. Inputs

a. Employment

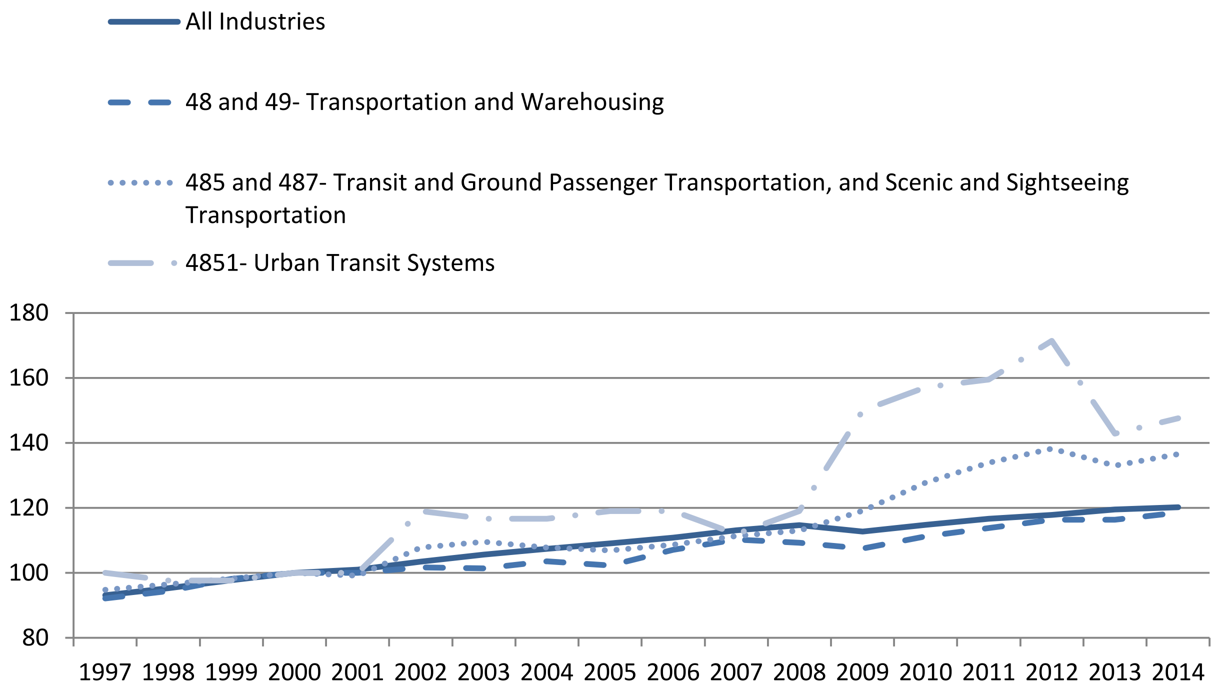
Table 62: Persons employed, Thousands, All Industries, Transportation and Warehousing Sector, Transit and Ground Transportation Subsector, Scenic and Sightseeing Transportation Subsector, Urban Transit Systems, 1997-2014

	All Industries	48 and 49- Transportation and Warehousing	485 and 487- Transit and Ground Passenger Transportation, and Scenic and Sightseeing Transportation	4851- Urban Transit Systems
1997	14,038	647	109	42
1998	14,353	663	111	41
1999	14,730	689	113	41
2000	15,067	702	115	42
2001	15,216	702	114	42
2002	15,589	714	124	50
2003	15,923	712	126	49
2004	16,190	727	124	49
2005	16,431	718	123	50
2006	16,702	752	125	50
2007	17,038	774	128	47
2008	17,285	767	130	50
2009	16,986	755	137	63
2010	17,298	781	147	66
2011	17,572	799	154	67
2012	17,764	817	159	72
2013	18,003	817	153	60
2014	18,109	832	157	62
Compound Average Annual Growth (Per Cent)				
2000-2014	1.32	1.22	2.3	2.9

Source: Statistics Canada Cansim Table 383-0031. Based on Canadian Productivity Accounts (mainly LFS and SEPH).
Note that these numbers, based on the CPA (LFS and SEPH), are higher than those in Table 57, which are based on the 2011 NHS.

In 2014, there were 62 thousand persons employed in urban transit systems (NAICS 4851) (Table 62). Between 2000 and 2014, the growth in employment was more rapid in urban transit systems (NAICS 4851) than in transit and ground passenger transportation and scenic and sightseeing transportation (NAICS 485 and 487), transportation and warehousing, and all industries (Chart 38). The growth in employment was 2.9 per cent per year in urban transit systems (NAICS 4851). In transit and ground and scenic and sightseeing transportation (NAICS 485 and 487), the growth was 2.3 per cent per year for the same period. In transportation and warehousing, the growth in employment was even less, at 1.22 per cent per year for the period. These employment numbers are based on number of jobs.[73]

Chart 38: Persons employed, 2000=100, All Industries, Transportation and Warehousing Sector, Transit and Ground Passenger Transportation Subsector, Scenic and Sightseeing Transportation Subsector, Urban Transit Systems, 1997-2014



Calculated by CSLS with data from Statistics Canada Cansim Table 383-031.Based on Canadian Productivity Accounts (mainly LFS and SEPH).

From 2000 to 2014, hours worked in urban transit systems (NAICS 4851) grew in line with employment, although slightly slower, at a rate of 2.6 per cent per year (Table 4-1 in CSLS Transportation Database).[74] In the transit and ground passenger and scenic and sightseeing transportation subsectors (NAICS 485 and 487), hours worked grew slower, at 1.8 per cent per year. In the transportation and warehousing sector as a whole, hours worked grew even less, at an average of 1.01 per cent per year for the same period.

Transport Canada calculated a labour input quantity index. The labour input quantity index grew 2.46 per cent per year between 2000 and 2013, which is slightly slower than the growth in employment and hours worked provided by Statistics Canada.

---

[73] Note that the number of jobs is not the same as the number of workers. A single worker may hold multiple jobs.
[74] There are two explanations for the slower growth of hours worked compared to employment (3.81 vs. 3.97per cent). 1. An increase in the share of part time workers and 2) a decrease in the hours worked by full time and/or part time workers. This should be reflected in the average weekly hours worked. In urban transit systems (NAICS 4851), average weekly hours worked of all employed persons decreased 0.15 per cent per year, where as in transportation and warehousing, as well as in all industries, the decrease was 0.30 and 0.31 per cent per year (see database tables 4N, 2N, 1N). Note that the difference in growth rates between hours worked and employment is much smaller in urban transit systems (NAICS 4851) than in other industries.

In 2014, workers in urban transit systems (NAICS 4851) worked 33.67 hours per week on average, slightly more than in transit and ground and scenic and sightseeing transportation subsectors (NAICS 485 and 487), where workers worked 32.64 hours per week on average (Table 4-1 in CSLS Transportation Database).

Table 63: Total Compensation per Hour Worked, Dollars, All Industries, Transportation and Warehousing, Transit, Ground Passenger and Scenic and Sightseeing Transportation, Urban Transit Systems, 1997-2014

	All Industries	48 and 49- Transportation and Warehousing	485 and 487- Transit and Ground Passenger Transportation, and Scenic and Sightseeing Transportation	4851- Urban Transit Systems
1997	19.56	19.86	17.15	27.78
1998	20.22	20.38	16.26	26.61
1999	20.68	20.55	16.9	28.28
2000	21.90	21.51	18.22	31.03
2001	22.59	22.33	19.11	32.05
2002	23.12	22.46	18.89	30.16
2003	23.85	23.46	19.93	33.62
2004	24.50	24.01	20.32	33.20
2005	25.64	25.32	22.00	35.19
2006	26.94	25.98	22.72	37.91
2007	27.99	26.12	22.64	37.35
2008	28.94	26.69	22.75	35.96
2009	29.79	27.44	23.87	34.87
2010	30.13	27.29	23.79	34.11
2011	31.23	28.36	24.14	34.95
2012	31.99	29.00	24.86	35.61
2013	32.96	30.74	26.56	41.35
2014	34.01	31.24	28.36	46.65
	Compound Average Annual Growth (Per Cent)			
2000-2014	3.19	2.70	3.21	2.96

Source: Statistics Canada Cansim Table 383-031. Based on Canadian Productivity Accounts.

Total compensation per hour worked in 2014 was $46.65 in urban transit systems (NAICS 4851), which is more than in the transportation and warehousing sector as a whole ($31.24) and than in all industries ($34.01) (Table 63). It is also much higher than in transit and ground passenger transportation and scenic and sightseeing transportation (NAICS 485 and 487), where total compensation per hour worked was only $28.36 in 2014. The total compensation per hour worked grew an average of 2.96 per cent per year in urban transit systems, which is a faster growth than in the transportation and warehousing sector as a whole (2.70 per cent) but slower than in all industries (3.19 per cent).

b. Investment

There are no data available for investment in urban transit systems. In 2013 in the transit and ground passenger transportation subsector (NAICS 485), real total fixed non-residential investments reached $5,278 million chained 2007 dollars (Table 64). However, real net total fixed non-residential investment was $2,225 million chained 2007 dollars, indicating a depreciation of $3,052 million chained 2007 dollars. Real net investment grew strongly in the transit and ground passenger transportation subsector (NAICS 485), at an average of 13.84 per cent per year between 2000 and 2013. This compares to an average of 7.39 per cent per year in the transportation and warehousing sector as a whole, and to only 3.78 per cent per year in all industries. Real investment in the transit and ground passenger transportation subsector (NAICS 485) grew 9.33 per cent per year and depreciation in the same subsector grew 7.16 per cent per year. Recent infrastructure investments in urban transit have been aimed at alleviating congestion and creating light rail lines in large cities. The rapid growth rate of investment in recent years is due to large infrastructure investments, such as the construction of the Confederation Line in Ottawa and the Evergreen Line in Metro Vancouver (Prime Minister of Canada, 2015).[75]

In 2013, machinery and equipment accounted for 43.5 per cent of investment in the transit and ground passenger transportation subsector (NAICS 485) (Chart 39).[76] This share is the same as in the transportation and warehousing sector as a whole. The second largest investment was in engineering, which received 28.3 per cent of all investment. This is followed by building, at 24.7 per cent and finally by intellectual property products which only received 3.1 per cent of total investment.

[75] The Confederation Line in Ottawa is a $600 million investment for the construction of a 12.5 kilometre electric rail system that will cross the core of the city. The Evergreen Line in Metro Vancouver is a $416.7 million line which will be linked to the existing Millennium Line with connections to other transit lines and the regional bus network. Other large federal investments since 2006 include $697 million for the Toronto-York Subway Extension project in Toronto, $265 million for the construction of a new light rail rapid transit system between the Ontario cities of Waterloo and Kitchener as well as a rapid bus transit from Kitchener to Cambridge, and $400 million for the construction of the Edmonton Valley Line Southeast Light Rail Transit in Edmonton.

[76] In urban transit, most of the machinery and equipment consists of buses and subway cars.

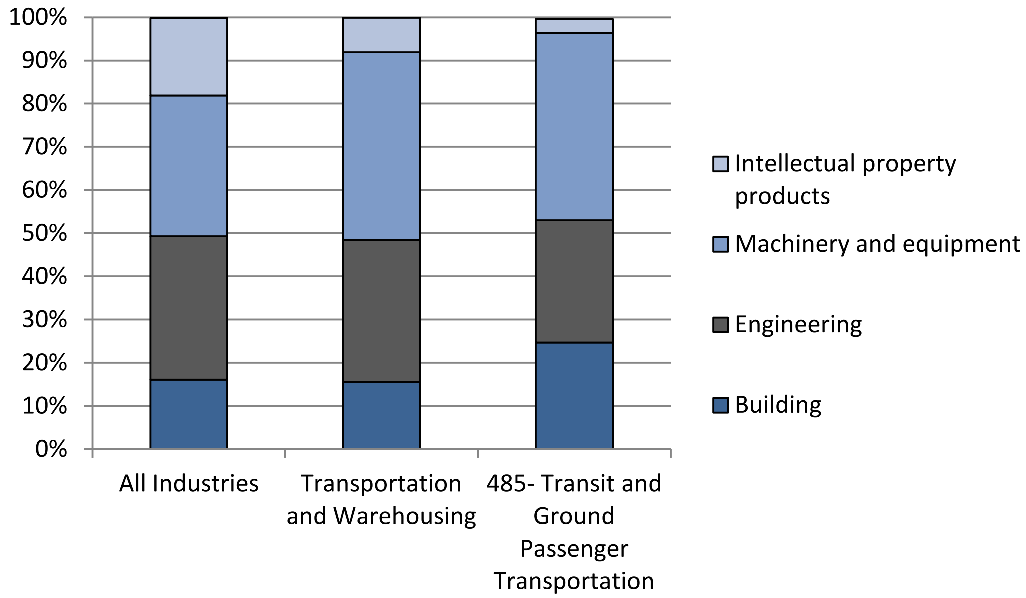
Table 64: Depreciation, Real and Net Total Fixed Non-Residential Investment, Millions of Chained 2007 Dollars, All Industries, Transportation and Warehousing, and Transit and Ground Passenger Transportation, 1997-2013

	Real Gross Investment			Depreciation			Real Net Investment		
	All Industries	48 and 49- Transportation and Warehousing	485- Transit and Ground Passenger Transportation	All Industries	48 and 49- Transportation and Warehousing	485- Transit and Ground Passenger Transportation	All Industries	48 and 49- Transportation and Warehousing	485- Transit and Ground Passenger Transportation
1997	149,863	9,664	1,097	125,677	7,803	1,013	24,185	1,861	84
1998	158,463	13,788	1,779	133,183	8,669	1,076	25,281	5,119	702
1999	167,359	15,086	1,973	140,857	9,793	1,176	26,502	5,294	797
2000	175,814	12,286	1,655	148,611	10,408	1,243	27,203	1,878	413
2001	180,948	12,244	1,513	155,583	10,735	1,292	25,365	1,508	221
2002	176,598	11,985	1,428	160,913	11,078	1,333	15,685	907	95
2003	188,065	9,789	1,544	165,579	11,180	1,371	22,486	-1,391	172
2004	205,484	9,790	1,629	171,848	11,051	1,426	33,637	-1,261	204
2005	229,154	12,499	2,027	181,345	11,264	1,505	47,810	1,235	522
2006	248,386	14,249	2,445	193,042	11,815	1,621	55,344	2,434	824
2007	255,890	16,283	2,828	204,405	12,528	1,762	51,485	3,755	1,066
2008	267,824	19,924	3,798	214,535	13,406	1,963	53,289	6,518	1,835
2009	232,217	17,057	3,685	218,881	14,023	2,189	13,336	3,035	1,495
2010	262,785	15,128	4,777	221,663	14,236	2,435	41,123	893	2,341
2011	276,557	16,434	4,331	228,634	14,450	2,650	47,923	1,984	1,681
2012	286,560	18,204	4,833	236,207	14,873	2,832	50,353	3,331	2,001
2013	287,126	20,215	5,278	243,084	15,469	3,052	44,042	4,747	2,225
	Compound Average Annual Growth (Per Cent)								
2000-2013	3.85	3.90	9.33	3.86	3.10	7.16	3.78	7.39	13.84

Source: Statistics Canada Cansim Table 031-0002. Based on Stock and Consumption of Fixed Non-Residential Capital.

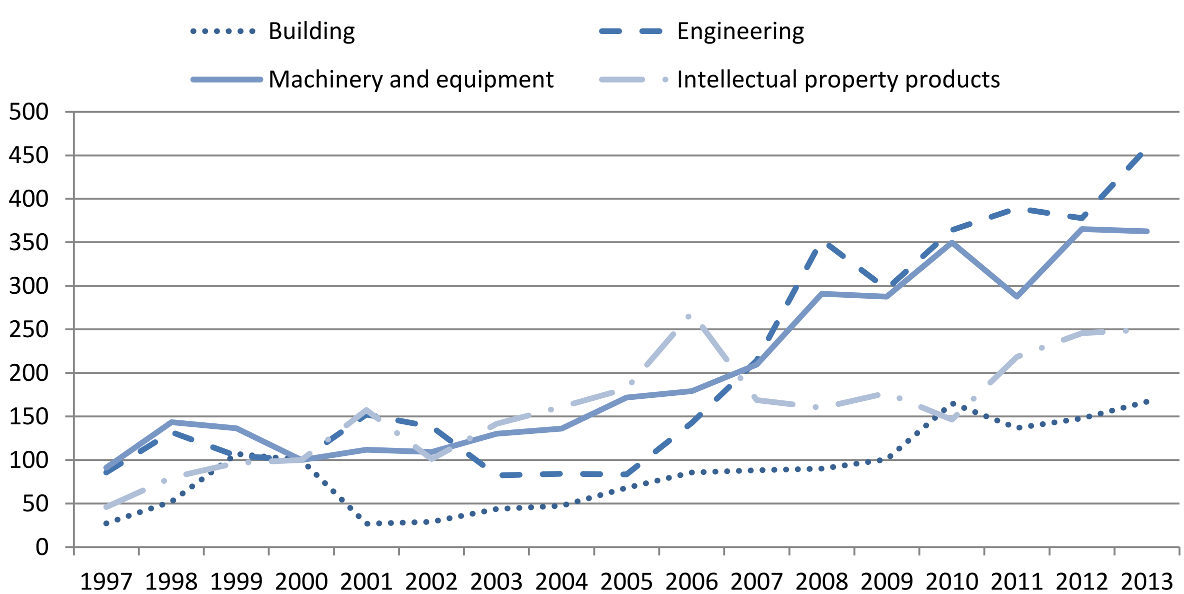
Note: These data are not available for urban transit systems (NAICS 4851) but only for transit and ground passenger transportation (NAICS 485). However, investment in urban transit makes up most of the investment in this subsector.

Chart 39: Real and Total Fixed Non-Residential Investment, Breakdown by Asset as a Share of Total Investment, 2013



Source: Calculated by CSLS with data from Statistics Canada Cansim Table 031-0002.

Chart 40: Real Total Fixed Non-Residential Investment in the Transit and Ground Passenger Transportation Subsector (NAICS 485), Breakdown by Asset, Millions of Chained 2007 Dollars, 2000=100, 1997-2013



Source: Calculated by CSLS with data from Statistics Canada Cansim Table 031-0002. Based on Stock and Consumption of Fixed Non-Residential Capital.

c. Capital

There are no data on capital stock for urban transit systems. Real total fixed non-residential geometric end of year net stock grew strongly in the transit and ground passenger transportation subsector (NAICS 485), at an average of 5.94 per cent per year between 2000 and 2013 (Table 65). This growth was stronger than in the transportation and warehousing sector as a whole, where the capital stock grew at an average of 1.88 per cent per year, and than in all industries as a whole, where the capital stock grew by an average of 2.41 per cent per year (Chart 41). Notice that the capital stock in transit and ground passenger transportation was generally growing in line with that of all industries until 2007 when the capital stock in the sector began to grow rapidly.

Table 65: Real Total Fixed Non-Residential Geometric End of Year Net Stock, Millions of Chained 2007 Dollars, All Industries, Transportation and Warehousing, and Transit and Ground Passenger Transportation,1997-2013

	All Industries	48 and 49-Transportation and Warehousing	485- Transit and Ground Passenger Transportation
1997	1,317,326	88,523	11,033
1998	1,347,976	94,880	11,825
1999	1,376,679	102,760	12,732
2000	1,407,019	104,861	13,202
2001	1,434,355	106,691	13,450
2002	1,450,191	107,876	13,553
2003	1,474,036	106,453	13,739
2004	1,509,779	105,193	13,947
2005	1,559,783	106,636	14,481
2006	1,616,688	109,188	15,310
2007	1,668,675	113,016	16,378
2008	1,721,451	119,466	18,200
2009	1,733,028	122,504	19,693
2010	1,773,755	123,475	22,031
2011	1,821,693	125,514	23,717
2012	1,872,074	128,852	25,729
2013	1,916,594	133,534	27,962
	Compound Average Annual Growth (Per Cent)		
2000-2013	2.41	1.88	5.94

Source: Statistics Canada Cansim Table 031-0002. Based on Stock and Consumption of Fixed Non-Residential Capital.

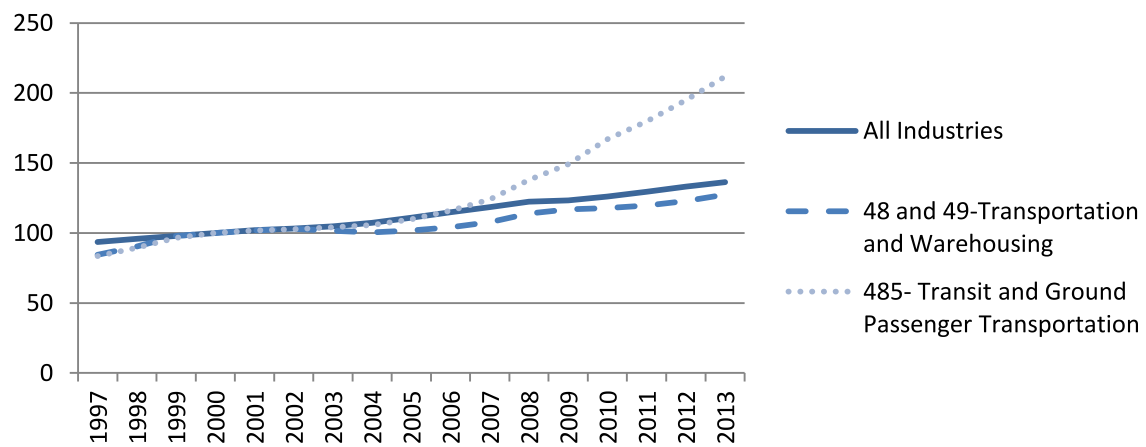
Transport Canada also calculates a capital input quantity index for public transit. This index has grown rapidly between 2000 and 2013, at an average rate of 12.27 per cent per year. The most likely explanation for the much higher growth rate of capital based on the Transport Canada data is that the Statistics Canada data combines urban transit with ground passenger transportation. If capital growth was weak in the ground passenger and transportation subsector, then this would significantly reduce the growth rate for the composite industry. Transport Canada officials have clarified that the very strong capital growth in the Transport Canada data was driven by several major recent investments and the composition of those investments. In particular, there has been a major decrease in the price index for investment in computers in recent years which has led to a very large increase in the estimated quantity of investment in computers in the sector.

Transit and ground passenger transportation (NAICS 485) is a dynamic subsector, growing faster than others. Big Canadian cities have growing capital infrastructure for urban transit, mostly for light rail as discussed above under investment. This growth in infrastructure is captured by the high growth rate of capital stock.

In 2013, the largest assets in terms of capital stock in the transit and ground passenger transportation subsector (NAICS 485) were building and engineering which accounted for 35.3 and 35.0 per cent of total capital stock respectively (Table 4-4 in CSLS Transportation Database). Machinery and equipment followed, accounting for 28.1 per cent of capital stock. Finally, intellectual property products were marginal, representing only 1.5 per cent of total capital stock.

Although it represents the smallest asset in transit and ground passenger transportation (NAICS 485), intellectual property products have had the strongest growth between 2000 and 2013, at an average of 8.57 per cent per year. This compares to a growth of all assets of 5.94 per cent per year for the period. Intellectual property products can be of three types: research and development, software, and mineral exploration and evaluation. In the case of urban transit, mineral exploration and evaluation is absent, leaving research and development and software.

Chart 41: Real Total Fixed Non-Residential Geometric End of Year Net Stock, 2000=100, All Industries, Transportation and Warehousing, and Transit and Ground Passenger Transportation, 1997-2013



Source: Calculated by CSLS with data from Statistics Canada Cansim Table 031-0002. Based on Stock and Consumption of Fixed Non-Residential Capital.

iii. Productivity

a. Labour Productivity

Table 66: Labour Productivity, Chained 2007 Dollars, All Industries, Transportation and Warehousing, Transit and Ground Passenger Transportation and Scenic and Sightseeing Transportation, and Urban Transit Systems, 1997-2014

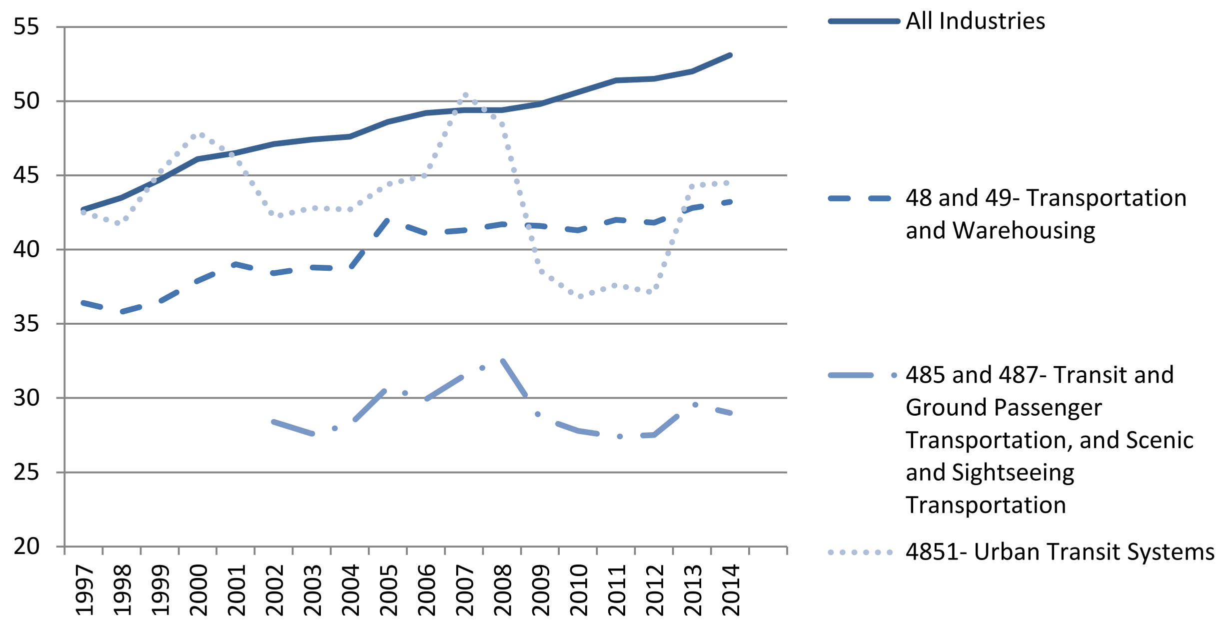
	Real GDP per Hour Worked				Real GDP per Job			
	All Industries	48 and 49-Transportation and Warehousing	485 and 4878-Transit and Ground Passenger Transportation, and Scenic and Sightseeing Transportation	4851-Urban Transit Systems	All Industries	48 and 49-Transportation and Warehousing	485 and 4878-Transit and Ground Passenger Transportation, and Scenic and Sightseeing Transportation	4851-Urban Transit Systems
1997	42.7	36.4	...	42.5	76,235	72,025	...	76,510
1998	43.5	35.8	...	41.7	77,430	71,597	...	76,704
1999	44.7	36.5	...	45.2	79,638	73,218	...	83,739
2000	46.1	37.9	...	47.9	82,087	75,408	...	87,024
2001	46.5	39.0	...	46.2	82,428	77,339	...	84,103
2002	47.1	38.4	28.4	42.2	82,573	75,879	52,099	76,200
2003	47.4	38.8	27.6	42.8	82,552	76,363	50,044	74,689
2004	47.6	38.7	28.2	42.7	83,706	77,606	52,485	78,480
2005	48.6	42.0	30.7	44.4	84,958	83,192	55,178	79,582
2006	49.2	41.1	29.9	45.0	85,913	81,799	54,176	78,992
2007	49.4	41.3	31.5	50.5	86,082	80,744	55,819	90,556
2008	49.4	41.7	32.6	48.5	85,743	81,227	58,510	88,355
2009	49.8	41.6	28.7	38.6	84,677	79,037	51,064	68,015
2010	50.6	41.3	27.8	36.8	86,092	79,234	49,434	66,423
2011	51.4	42.0	27.4	37.6	87,322	79,967	47,843	67,752
2012	51.5	41.8	27.5	37.1	88,133	79,379	47,294	64,397
2013	52.0	42.8	29.6	44.3	88,806	80,401	50,558	78,984
2014	53.1	43.2	29.0	44.5	90,432	82,482	50,278	78,154
	Compound Average Annual Growth (Per Cent)							
2000-2014	1.01	0.94	n.a.	-0.52	0.69	0.64	n.a.	-0.76
2002-2014	1.00	0.99	0.17	0.44	0.76	0.70	-0.30	0.21
2007-2011	1.00	0.42	-3.43	-7.11	0.36	-0.24	-3.78	-7.00

Source: Calculated by CSLS with data from Cansim Tables 379-0031 and 383-0031. Based on Input-Output Accounts and Canadian Productivity Accounts.

Labour productivity, defined as real GDP per hour worked, has been declining in urban transit systems (NAICS 4851) since 2000 (Chart 42). It went from $47.9 chained 2007 dollars per hour in 2000, to $44.5 per hour in 2014 (Table 66). Labour productivity fell by an average of

0.52 per cent per year between 2000 and 2014. The decline in labour productivity is explained by the greater growth of hours worked (2.6 per cent) than real GDP (2.1 per cent).

Chart 42: Labour Productivity Defined as Real GDP per Hour Worked, Chained 2007 Dollars, All Industries, Transportation and Warehousing, Urban Transit Systems, 1997-2014



Source: Calculated by CSLS with data from Cansim Tables 379-0031 and 383-0031. Based on Input-Output Accounts and Canadian Productivity Accounts.

Labour productivity in urban transit systems (NAICS 4851) is much higher than in the transit and ground passenger transportation and scenic and sightseeing transportation (NAICS 485 and 487) subsector as a whole, where real GDP per hour worked was $29.0 chained 2007 dollars in 2013. Unlike the urban transit systems, in the transportation and warehousing sector as a whole, as well as in all industries, real GDP per hour worked has been growing, by an average of 0.94 and 1.01 per cent per year respectively for the same period.

In 2000, real GDP per hours worked in urban transit systems (NAICS 4851) was 106.1 per cent relative to in all industries, but in 2014 it was 86.42 per cent relative to all industries (Table 67). Labour productivity relative to all industries decreased an average of 21.45 per cent per year between 2000 and 2014 in urban transit systems (NAICS 4851). This ratio also diminished in transit and ground passenger transportation and scenic and sightseeing transportation (NAICS 485 and 487), and in transportation and warehousing.

Labour productivity can also be defined as GDP per worker, which has a trend similar to that of GDP per hour. Real GDP per worker has declined even more than real GDP per hour worked in urban transit systems (NAICS 4851). It has gone from $87,024 chained 2007 dollars in 2000, to $78,154 in 2014, an average decline of 0.76 per cent per year. We will address reasons for this development in part B of this section. In the transportation and warehousing sector as a whole, as well as in all industries, growth of GDP per worker has also been slower than growth of GDP per hour worked, although still positive.

Table 67: Labour Productivity Relative to All Industries, Transportation and Warehousing, Transit and Ground Passenger Transportation and Scenic and Sightseeing Transportation, and Urban Transit Systems, Per Cent, 1997-2014

	Real GDP per Hour			Real GDP Per Job		
	48 and 49- Transportation and Warehousing	485 and 4878- Transit and Ground Passenger Transportation, and Scenic and Sightseeing Transportation	4851- Urban Transit Systems	48 and 49- Transportation and Warehousing	485 and 4878- Transit and Ground Passenger Transportation, and Scenic and Sightseeing Transportation	4851- Urban Transit Systems
1997	85.25	n.a.	99.53	94.48	n.a.	100.36
2000	82.21	n.a.	103.90	91.86	n.a.	106.01
2014	81.36	54.61	83.80	91.21	55.60	86.42
	Compound Average Annual Growth (Per Cent)					
2000-2014	-0.07	n.a.	-1.52	-0.05	n.a.	-1.45
2002-2014	-0.02	-0.82	-0.56	-0.06	-1.05	-0.55

Source: Calculated by CSLS with data from Cansim Tables 379-0031 and 383-0031. Based on Input-Output Accounts and Canadian Productivity Accounts.

Table 68: Labour Productivity (Real GDP per Job), Chained 2007 Dollars, Transit, Ground Passenger and Scenic and Sightseeing Transportation (NAICS 485 + 4878), Canadian Provinces, 2007-2014

	Newfoundland and Labrador	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia
2007	35,378	26,111	29,435	31,471	49,565	50,958	51,231	47,009	54,933	85,844
2008	42,600	27,647	35,130	41,775	53,698	51,309	54,146	50,254	61,944	91,779
2009	36,615	22,051	26,643	34,767	48,251	43,432	48,264	41,701	51,325	86,695
2010	34,742	17,143	24,561	34,857	46,103	41,728	45,396	40,093	52,076	83,345
2011	35,760	19,000	25,968	35,758	46,630	38,464	47,285	44,011	50,667	89,078
2012	35,187	18,222	24,228	35,316	45,368	37,413	46,656	45,367	52,829	85,730
2013	32,273	16,327	23,398	36,835	46,698	43,223	47,400	41,701	45,764	90,156
2014	33,688	…	23,429	…	45,464	45,082	…	39,669	37,739	…
	Compound Average Annual Growth (Per Cent)									
2007-2014	-0.70	…	-3.21	…	-1.23	-1.74	…	-2.40	-5.22	…

Source: Calculated by CSLS with data from Cansim Tables 379-0030 and 383-0031. Based on Input-Output Accounts and Canadian Productivity Accounts.
Note: Data prior to 2007 is not available or suppressed for confidentiality reasons by Statistics Canada.

Unfortunately, labour productivity data at the provincial level for urban transit systems (NAICS 4851) is suppressed for confidentiality by Statistics Canada.Therefore, a provincial comparison is not possible. Table 68 shows a provincial comparison for the transit, ground passenger and scenic and sightseeing transportation subsector (NAICS 485 and 4878). Newfoundland had the lowest rate of loss of productivity, only an average of 0.70 per cent per year between 2007 and 2014, while Alberta had the highest rate of loss in productivity, an average loss of 5.22 per cent per year between 2007 and 2014.

Table 69: Nominal GDP per Hour Worked, All Industries, Transportation and Warehousing Sector, Transit and Ground Passenger Transportation and Scenic and Sightseeing Transportation Subsectors, and Urban Transit Systems

	Absolute (Current Dollars)				Relative to All Industries (Per Cent)		
	All Industries	48 and 49-Transportation and Warehousing	485 and 4878-Transit and Ground Passenger Transportation, and Scenic and Sightseeing Transportation	4851-Urban Transit Systems	48 and 49-Transportation and Warehousing	485 and 4878-Transit and Ground Passenger Transportation, and Scenic and Sightseeing Transportation	4851-Urban Transit Systems
1997	33.41	29.02	...	...	86.86	...	...
1998	33.94	29.40	...	...	86.62	...	...
1999	35.54	29.87	...	...	84.05	...	...
2000	38.25	31.05	...	...	81.19	...	...
2001	39.25	33.04	...	...	84.16	...	...
2002	40.08	33.88	...	...	84.54	...	...
2003	41.77	34.50	...	...	82.61	...	...
2004	43.23	34.72	...	...	80.33	...	...
2005	45.73	39.29	...	...	85.91	...	...
2006	47.65	39.94	...	...	83.82	...	...
2007	49.32	40.15	30.38	45.52	81.42	61.60	92.30
2008	51.52	41.28	32.44	46.60	80.12	62.96	90.44
2009	50.73	41.17	30.34	42.17	81.17	59.81	83.14
2010	52.88	41.83	30.33	41.17	79.10	57.35	77.86
2011	55.53	43.62	30.92	43.25	78.56	55.69	77.89
	Compound Average Annual Growth (Per Cent)						
2000-2011	3.45	3.14	...	...	-0.30	...	...
2007-2011	3.01	2.09	0.44	-1.27	-0.89	-2.49	-4.16

Source: Calculated by CSLS with data from Cansim Tables 39-0023, 379-0029, 383-0032, and 383-0031. Based on Input-Output Accounts and Canadian Productivity Accounts.

Nominal GDP per hour worked (Table 69) decreased less than real GDP per hour worked. This is because an increase in prices compensated for the decrease in real productivity.

Transport Canada also calculates a labour productivity index. In contrast to the decrease shown above, Transport Canada finds a slight increase in labour productivity of 0.19 per cent per year between 2000 and 2013. This difference is partly due to the fact that Transport Canada estimates slower growth in employment than the Statistics Canada data (see section ii.a employment) and partly due to the fact that Transport Canada estimates a higher growth rate of output.

b. Capital Productivity

Table 70: Real Capital Stock Productivity, Value Added Produced by $1,000 of Real Capital Stock, Chained 2007 Dollars, All Industries, Transportation and Warehousing, Transit and Ground Passenger Transportation, 1997-2013

	Absolute			Relative to All Industries (Per Cent)	
	All Industries	48 and 49- Transportation and Warehousing	485- Transit and Ground Passenger Transportation	48 and 49- Transportation and Warehousing	485- Transit and Ground Passenger Transportation
1997	$812	$526	($)…	64.75	…
1998	824	501	…	60.72	…
1999	852	491	..	57.58	..
2000	879	505	…	57.42	…
2001	874	509	…	58.19	…
2002	888	502	475	56.58	53.53
2003	892	511	458	57.29	51.41
2004	898	537	468	59.78	52.13
2005	895	560	468	62.62	52.29
2006	888	563	443	63.45	49.86
2007	879	553	437	62.88	49.67
2008	861	521	417	60.53	48.45
2009	830	487	355	58.67	42.79
2010	840	501	330	59.66	39.30
2011	842	509	311	60.47	36.92
2012	836	503	292	60.17	34.97
2013	834	492	277	58.95	33.22
Compound Average Annual Growth (Per Cent)					
2002-2013	-0.56	-0.19	-4.78	0.37	-4.25

Source: Calculated by CSLS with data from Statistics Canada Cansim Tables 379-0031, 031-0003, and 031-0002. Based on Input-Output Accounts and Stock and Consumption of Fixed Non-Residential Capital.

Capital productivity is defined here as the dollar amount produced by $1,000 of capital stock.[77] Because there are no data on capital stock available for urban transit systems, it is not

[77] We encounter difficulties when trying to calculate the capital productivity. This is because the value for real GDP is for both transit and ground passenger transportation and scenic and sightseeing transportation, whereas the capital stock data are only for transit and ground passenger transportation. However, we have seen with *section i) b) nominal GDP* that scenic and sightseeing transportation is very small compared to ground and passenger transportation. Therefore, this is not a significant issue.

possible to calculate capital productivity for urban transit systems. In 2013, $1,000 of capital stock in the transit and ground passenger transportation subsector (NAICS 485) produced only $277 of value–added on average (Table 70).

The transit and ground transportation subsector (NAICS 485) suffered a fall in real capital productivity between 2002 and 2013 of an average of 4.78 per cent per year, going from $475 in 2002, to $277 in 2013 (Table 70). This fall is linked to a higher growth of capital stock than output (6.81 per cent per year between 2002 and 2013 compared to 1.70 per cent per year respectively). Capital productivity took a smaller fall in the transportation and warehousing sector as a whole, as well as in all industries, of 0.19 and 0.56 per cent per year respectively. Section B will address causes of this decline.

The real capital stock grew faster (5.94 per cent) than workers (3.97 per cent) and hours worked (3.81 per cent). This means there was growth in the capital to labour ratio.

Transport Canada calculated a capital productivity index. Transport Canada shows a decrease of capital productivity of 8.56 per cent per year between 2000 and 2013. This is a faster decrease than that calculated by CSLS using Statistics Canada data. This is in part due to the fact than Transport Canada estimates a faster increase in the capital stock than Statistics Canada (see section ii.c capital).

c. Multifactor Productivity

Multifactor productivity based on value-added measures the efficiency with which capital and labour inputs are used to generate value-added. It reflects the joint effects of many factors such as technology, economies of scale, and managerial skill. There are no data available for multifactor productivity in urban transit systems. In the transit and ground passenger transportation subsector (NAICS 485), multifactor productivity has decreased by an average of 3.46 per cent per year between 2000 and 2010 (Table 71). This decrease is larger than in the transportation and warehousing sector as a whole, where multifactor productivity decreased by an average of 0.31 per year. In section B will we attempt to explain the fall in multifactor productivity.

Transport Canada calculates a total factor productivity index for urban transit specifically. Between 2000 and 2013, Transport Canada finds that total factor productivity has decreased an average of 2.88 per cent per year for urban transit.

B. Explaining Productivity Trends

In the previous section, the outputs and inputs of urban transit were observed in detail and compared to the transportation and warehousing sector as a whole, as well as all industries. Part A also described labour, capital and multifactor productivity. We found that labour productivity has decreased in urban transit systems (NAICS 4851) since 2000. Capital productivity and multifactor productivity have also decreased since 2000 in transit and ground passenger transportation (NAICS 485). However, section A was only descriptive and did not analyze the factors which influence productivity in urban transit systems. The goal of section B is to explain the factors that drive productivity in urban transit systems.

Table 71: Multifactor Productivity Based on Value-Added, Index, 2007=100, Transportation and Warehousing Sector, Transit and Ground Passenger Transportation Subsector, 1997-2013

	Business Sector	48 and 49- Transportation and Warehousing	485- Transit and Ground Passenger Transportation
1997	97.1	100.4	112.1
1998	97.8	94.9	105.9
1999	100.1	94.9	108.3
2000	102.0	97.3	112.5
2001	101.9	98.6	103.3
2002	103.0	98.1	103.7
2003	102.6	98.7	100.5
2004	102.0	99.2	103.6
2005	102.1	104.6	105.4
2006	101.3	102.6	98.4
2007	100.0	100.0	100.0
2008	98.0	97.0	98.6
2009	95.8	93.0	85.0
2010	97.5	94.3	79.1
2011	98.4	95.5	…
2012	97.7	…	…
2013	98.2	…	…
	Compound Average Annual Growth (Per Cent)		
2000-2010	-0.45	-0.31	-3.46
2000-2011	-0.32	-0.17	…
2000-2013	-0.29	…	…

Source: Cansim Table 383-0032 and 383-0021. Based on Canadian Productivity Accounts.

i. Labour Productivity Growth Decomposition

Labour productivity represents the amount of output produced per worker or per hour. In a growth accounting framework, gross-output based labour productivity growth can be explained by MFP, capital intensity, intermediate input intensity, and labour composition. The goal of growth accounting is to understand the effect of these four factors on labour productivity. Note that the following data are based on gross output, whereas most of the data presented in this report have been based on value-added. Gross output includes the value of the intermediate inputs, as opposed to value-added which does not.

The contribution of capital intensity to labour productivity represents the effects of capital investments on labour productivity growth. The contribution of capital intensity to growth in labour productivity averaged 1.41 per cent per year between 2000 and 2010 in the transit and ground passenger transportation subsector (NAICS 485) (Table 72). This growth is faster than in the transportation and warehousing sector as a whole where this contribution averaged 0.47 per cent per year for the same period (Table 73).

The contribution of intermediate inputs to labour productivity growth represents the effects of intermediate inputs on labour productivity. The contribution of intermediate inputs to growth in labour productivity was 0.74 per cent per year between 2000 and 2010 in the transit and ground passenger transportation subsector (NAICS 485). This growth is slower that in the transportation and warehousing sector as a whole where this contribution was 0.95 per cent per year for the same period.

Table 72: Labour Productivity Growth Decomposition Based on Gross Output, Index, 2007=100, 485-Transit and Ground Passenger Transportation, 1997-2010

		Contribution to Growth in Labour Productivity			
	Labour Productivity	Multifactor Productivity	Capital Intensity	Intermediate Input Intensity	Labour Composition
1997	86.7	107.6	88.3	94.5	96.6
1998	85.1	103.5	89.6	95.2	96.4
1999	86.3	104.6	91.8	92.7	97.0
2000	90.7	107.1	93.5	93.0	97.4
2001	89.1	101.8	93.5	95.4	98.1
2002	88.2	101.9	92.0	94.4	99.6
2003	85.4	100.0	91.6	94.7	98.5
2004	95.0	102.8	93.9	99.2	99.2
2005	100.4	103.5	97.2	99.5	100.1
2006	94.9	98.9	97.1	98.5	100.4
2007	100.0	100.0	100.0	100.0	100.0
2008	104.2	98.8	104.1	100.8	100.5
2009	99.3	90.2	107.0	101.9	100.9
2010	93.5	85.6	107.6	100.2	101.5
2011	…	…	…	…	…
		Compound Average Annual Growth (Per Cent)			
2000-2010	0.31	-2.22	1.41	0.74	0.41
		Per Cent Distribution			
2000-2010	100	-728	465	246	136

Source: Cansim Table 383-0032. Based on Canadian Productivity Accounts.

The contribution of labour composition to labour productivity growth represents the effects of skill upgrading as measured by increases in the experience and education composition of the workforce on labour productivity growth. The contribution of labour composition to growth in labour productivity in the transit and ground passenger transportation subsector

(NAICS 485) between 2000 and 2010 was 0.41 per cent per year. This contribution is greater than in the transportation and warehousing sector as a whole, where it was 0.17 per cent per year.

Note that in the following tables, the growth rate of multifactor productivity as well as the contributions of capital intensity, intermediate input intensity, and labour compensation add up to the growth of labour productivity, which is the idea behind growth accounting. The data presented in Tables 73 and 74 is given in terms of indices for each contributing factor to labour productivity. As such, it is immediately evident how the three components (capital intensity, intermediate input intensity, and labour composition) grow compared to one another.

Table 73: Labour Productivity Growth Decomposition Based on Gross Output, Index, 2007=100, 48 and 49-Transportation and Warehousing Sector, 1997-2011

		Contribution to Growth in Labour Productivity			
	Labour Productivity	Multifactor Productivity	Capital Intensity	Intermediate Input Intensity	Labour Composition
1997	87.0	100.0	94.3	93.7	98.3
1998	86.2	97.0	96.6	93.4	98.6
1999	86.6	96.7	98.0	92.7	98.6
2000	88.2	97.9	98.1	92.9	98.8
2001	89.7	98.6	98.6	93.2	99.1
2002	89.5	98.3	98.7	92.9	99.4
2003	90.2	98.6	98.6	93.3	99.3
2004	95.2	99.7	97.6	98.2	99.7
2005	100.6	102.3	99.0	99.4	99.9
2006	99.8	101.4	98.9	99.7	99.9
2007	100.0	100.0	100.0	100.0	100.0
2008	101.8	98.5	102.0	101.2	100.1
2009	102.5	96.4	104.0	101.9	100.3
2010	102.5	97.2	102.8	102.1	100.4
2011	103.4	97.8	102.7	102.4	100.6
		Compound Average Annual Growth (Per Cent)			
2000-2010	1.51	-0.08	0.47	0.95	0.17
		Per Cent Distribution			
2000-2010	100	-5	31	63	11

Source: Cansim Table 383-0032. Based on Canadian Productivity Accounts.

Table 74: Labour Productivity Growth Decomposition Based on Value-Added, Index, 2007=100, Business Sector, 1997-2013

		Contribution to Growth in Labour Productivity		
	Labour Productivity	Multifactor Productivity	Capital Intensity	Labour Composition
1997	84.0	97.1	89.2	97.0
1998	86.2	97.8	90.6	97.3
1999	89.3	100.1	91.6	97.4
2000	92.6	102.0	92.6	98.0
2001	94.1	101.9	93.7	98.5
2002	95.5	103.0	94.0	98.7
2003	96.0	102.6	94.5	99.0
2004	96.1	102.0	95.0	99.2
2005	98.5	102.1	96.9	99.6
2006	99.8	101.3	98.8	99.8
2007	100.0	100.0	100.0	100.0
2008	99.3	98.0	101.2	100.2
2009	99.2	95.8	103.1	100.5
2010	101.2	97.5	103.0	100.9
2011	102.8	98.4	103.4	101.0
2012	103.0	97.7	104.0	101.3
2013	104.3	98.2	104.8	101.4
		Compound Average Annual Growth		
2000-2010	0.90	-0.45	1.06	0.29
2000-2013	0.92	-0.29	0.95	0.26
		Per Cent Distribution		
2000-2010	100	-50	120	33
2000-2013	100	-32	104	29

Source: Statistics Canada Cansim Table 383-0021. Based on Canadian Productivity Accounts.
Note: The previous two tables for labour productivity in the transportation and warehousing sector and truck transportation subsector were based on gross output, but this one is based on value-added, therefore they are not comparable.

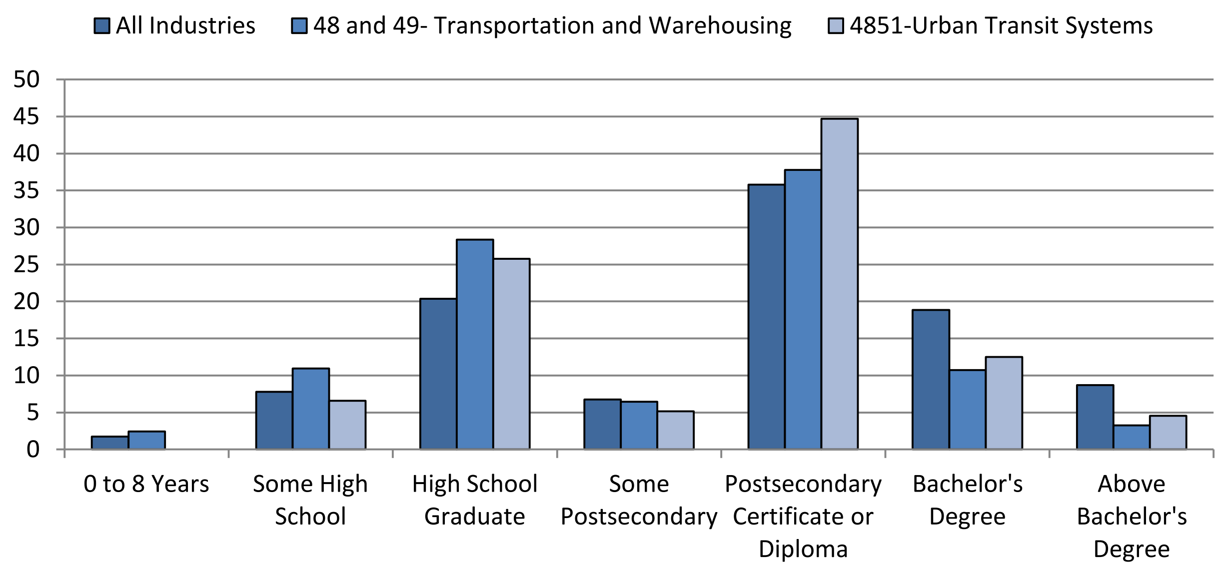
ii. Capital Intensity

Real capital stock has been increasing rapidly in the transit and ground passenger transportation subsector (NAICS 485), by an average of 5.94 per cent per year between 2000 and 2013. The growth in hours worked was not as strong. In urban transit systems (NAICS 4851), hours worked grew an average of 3.81 per cent per year, and in the transit and ground passenger transportation and scenic and sightseeing transportation subsectors (NAICS 485 and 4887), hours worked grew an average of 1.91 per cent per year for the same period. This means workers have more capital to work with. Such an increase in capital stock explains the decrease in capital productivity, since value-added did not grow at the same speed as the capital stock. The recent capital investments in infrastructure are costly. For example, the recent investments in light rail lines by many Canadian cities have been costly, but in the long run they will increase productivity and contribute to fulfilling social goals. These will be discussed further below.

iii. Human Capital

The education level of workers can be linked to productivity. This section shows the state of formal education by providing a breakdown of workers by their highest educational attainment level in 2014.

Chart 43: Employed by Highest Level of Educational Attainment, Per Cent of Total, All Industries, Transportation and Warehousing, Urban Transit Systems, 2014



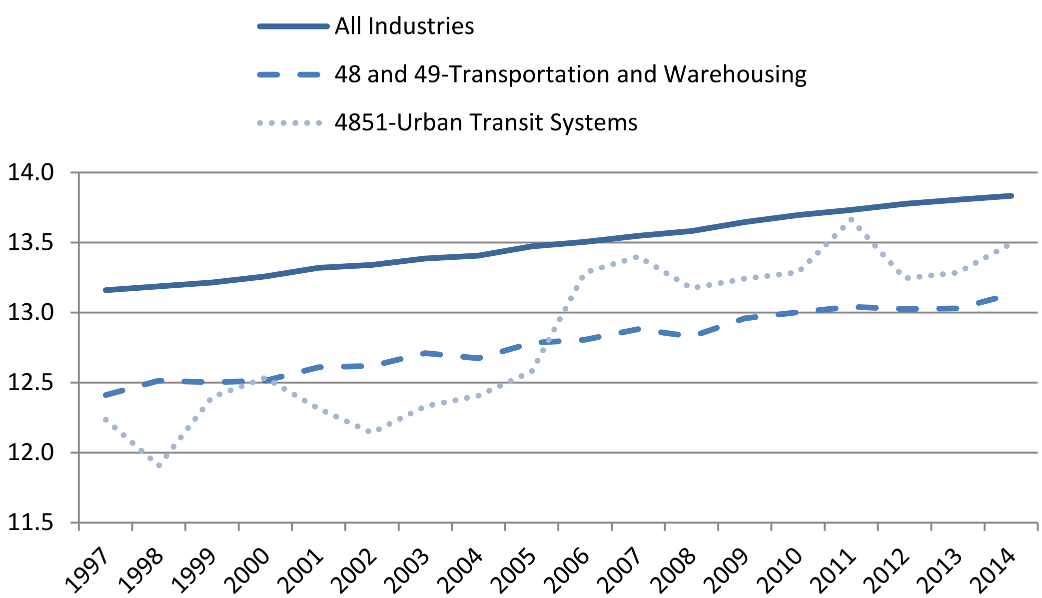
Source: Calculated by CSLS with data from the Labour Force Survey

In urban transit systems (NAICS 4851), for 44.7 per cent of workers a postsecondary certificate or diploma was the highest level of educational attainment and for 25.8 per cent of workers, a high school degree was their highest level of educational attainment (Chart 43). The proportion of workers who have not completed high school was smaller in urban transit systems than in both transportation and warehousing and all industries. Because workers with no high-school diploma raise a legitimate concern regarding basic literacy and numeracy skills, the educational attainment of workers in urban transit systems raises their productivity.

In 2014, the average worker in urban transit systems (NAICS 4851) had 13.5 years of schooling, which is 0.4 years more than in the transportation and warehousing sector as a whole where the average worker had 13.1 years of schooling (Chart 44).[78] It is, however, lower to all industries, where the average worker had 13.8 years of schooling. Between 1997 and 2014, the average years of schooling per worker in urban transit systems (NAICS 4851) grew 0.58 per cent per year, which is a faster growth that in the transportation and warehousing sector where the average years of schooling per worker grew 0.33 per cent per year for the same period.

[78] Average years of schooling were calculated by attributing values for years of schooling in each category and computing the average of all cases. The following values were used: 0 to 8 years -8 years, some high school-10 years, high school graduate-12 years, some postsecondary-13 years, postsecondary certificate or diploma-14 years, bachelor's degree-16 years, and above bachelor degree-18 years.

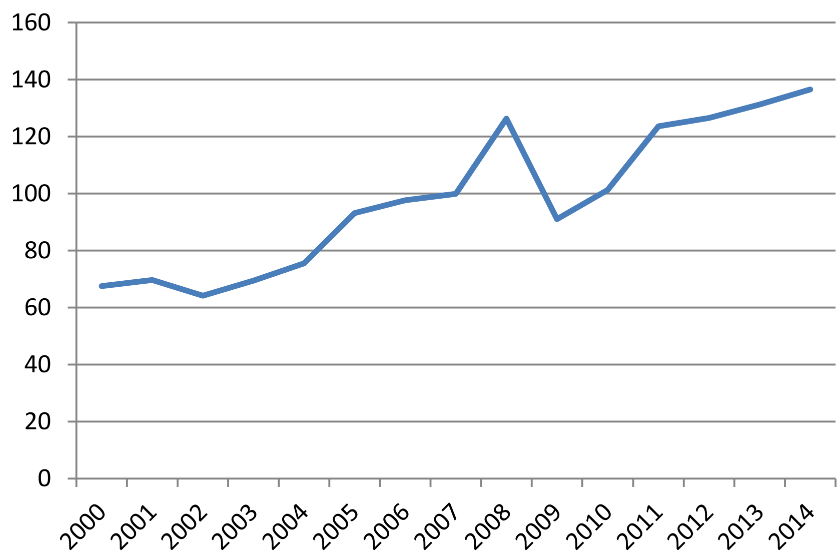
Chart 44: Average Years of School per Worker, All industries, 48 and 49- Transportation and Warehousing, 4851- Urban Transit Systems, 1997-2014



Source: Calculated by CSLS with data from the Labour Force Survey

iv. Fuel Prices

Chart 45: Average Retail Prices for Diesel Fuel at Self Service Filling Stations (Cents per Litre), Average of Select Urban Centers, Annual, Canada, 1997-2014



Source: Calculated by CSLS with data from Statistics Canada Cansim Table 326-0009. Based on Consumer Price Index sample survey.
Note: This is the average of prices in the following urban centers: St. John's, Newfoundland and Labrador; Charlottetown and Summerside, Prince Edward Island; Halifax, Nova Scotia; Saint John, New Brunswick; Québec, Quebec; Montréal, Quebec; Ottawa-Gatineau, Ontario part, Ontario/Quebec; Toronto, Ontario; Winnipeg, Manitoba; Regina, Saskatchewan; Saskatoon, Saskatchewan; Edmonton, Alberta; Calgary, Alberta; Vancouver, British Columbia; Victoria, British Columbia; Whitehorse, Yukon; Yellowknife, Northwest Territories

Operating expenses in urban transit rose 40% between 2001 and 2006 (CUTA, 2008). Although this trend reflects a growth in services offered (such as greater frequency of service or expanded routes) corresponding to a growth in ridership, the Canadian Urban Transit Association explains this reflects a rapid increase in the price of key inputs (CUTA, 2008). Diesel fuel is the largest input in urban transit systems and accounts for 11.9 per cent of gross output. Diesel fuel prices and fuel efficiency therefore affect the urban transit industry.

Diesel prices have doubled in Canada from an average of $0.67 per litre in 2000 to an average of $1.36 per liter in 2014. The following chart focuses on the evolution of the average retail prices for diesel (Chart 45).

In urban transit systems, not only has the price of fuel increased but fuel efficiency has decreased. Fuel consumption has increased faster than output. The diesel consumption per one thousand dollar of output has increased an average of 2.34 per cent per year between 2005 and 2013 (Table 75). It is not immediately clear why this has occurred, as transit authorities have been investing in more fuel efficient vehicles. One possibility is that increase could be due to innovations such as double-decker buses which are less aerodynamic than regular buses, although this seems unlikely. In principle, double-decker buses could achieve fuel efficiency superior to that of ordinary buses per passenger-kilometer because less weight needs to be moved per passenger, although this is not necessarily the case if there is significant excess capacity. As we shall see shortly, capacity utilization seems to have been falling in the industry.

Table 75: Evolution of Diesel Fuel Consumption per One Thousand Dollars of Output in Urban Transit Systems

	Diesel Consumption (Liters x 1,000)	Real GDP (Millions of Chained 2007 Dollars)	Diesel Consumption per $1000 of Output
2005	409,248	3,962	103
2006	425,235	3,967	107
2007	489,016	4,248	115
2008	509,832	4,435	115
2009	531,443	4,255	125
2010	540,549	4,361	124
2011	554,293	4,537	122
2012	540,155	4,624	117
2013	593,405	4,775	124
		Compound Annual Growth (Per Cent)	
2005-2013	4.75	2.36	2.34

Source: Statistics Canada Cansim Table 408-0008, based on the Annual Passenger Bus and Urban Transit Survey, and Cansim Table 379-0031, based on input-output accounts.

v. Technical Progress

a. Innovations

Bus dwell times, which is the time it takes for them to load and unload passengers, can be reduced by the use of electronic fare collection systems. These are collection systems where the user swipes a smart card rather than paying the fare in coins. These electronic fare collection systems lower dwell times because passengers do not need to know the exact cost of the fare and also because they permit simultaneous on board fare payment and multiple door boarding (Levinson et al., 2002). The decrease in bus dwell time increases the productivity of urban transit. Smart card data can also be used to monitor the performance of urban transit systems, by collecting information on dwell time, transit origin destination, ridership, passenger transit times and passenger kilometres driven (Wirasinghe et al., 2013). These data are useful for analysis and operation planning.

Articulated and double-decker buses increase labour productivity because they transport twice the passengers for the same amount of labour inputs. These also increase the mean speed of buses because bus dwell times[79] are reduced (Wirasinghe et al., 2013). Articulated buses are comprised of two rigid sections linked by an articulation. This allows an increase in the length of buses while still permitting buses to manoeuvre adequately. A double-decker bus has two storeys.

Reserved bus lanes also increase the productivity of urban transit by speeding up public transportation and allowing buses to avoid congestion.

b. Urban Rail Transit

Urban rail transit is key in reducing greenhouse gas and pollution emissions and congestion in large cities. In Canada, multiple forms of urban rail transit exist. These are subway, commuter rail, light rail and automated guideway transit. The benefits of rail transit are increased capacity, increased speed, increased reliability, positive environmental impact, increased passenger comfort and low operating costs (CUTA 2006).

Such systems are capital intensive and funding is necessary for their implementation, but in the long run they have a positive social impact and lower operational costs. As described in section A, many light rail systems are being built in Canada. The large capital investments lower capital productivity in the short run, but will increase labour productivity and social impacts in the long run.

---

[79] Improvements in accessibility which allow passengers in wheelchairs to board standard city buses may have slightly increased dwell times, although they have increased the transportation options available to those with disabilities and may have reduced requirements to operate specialized bus services specifically for this segment of the population.

vi. Fare Evasion

Fare evasion is the act of travelling on urban transit without having purchased a ticket. This can lead to an underestimate of output which would affect productivity measures. As an example to show the magnitude of fare evasion, TransLink (Metro Vancouver's transportation network) in an internal audit estimated that in 2006 they lost $7.1 million to fare evasion, which was 2.4% of their total fare revenue of $300 million (Price Waterhouse Coopers, 2007). According to the Globe and Mail, the Toronto Transit Commission lost $22 million to fare evasion in 2010 (Grant, 2011).

Unfortunately, an innovation described, articulated buses, raises the rate of fare evasion. Multiple doors on articulated buses make it easier for fare evaders to avoid paying fare while getting on the bus. This is because they can avoid the bus driver by using another door.

vii. Social Impacts

Urban transit has a social impact in the regions where it operates. For one, urban transit lowers greenhouse gas and pollution emissions because it lowers the amount of cars on the road. For the same reason, it diminishes congestion and accidents. Urban transit also improves access to employment for those who have no other transportation options. In this way, it increases equity.

These impacts have a value which is not captured by the output of urban transit. The Conference Board of Canada believes that the positive externalities of urban transit may have increased to offset the decline in productivity (Iacobacci & Schulman, 2009). For example, the social value of averted greenhouse gas and pollution emissions has increased over time. Public transit systems have also increased their delivery of services which have a low cost recovery but high social value, such as serving low density areas. The social impacts described in this section are the reason urban transit systems may still choose to operate despite having low productivity. An increase in the recognition of their importance may lead to decisions that lower the productivity of urban transit but have a higher social value.

Subsidies to the urban transit industry keep it running despite a low productivity. This is because of the social impact of urban transit. If the importance was put only on productivity, many of the services which have a positive social impact would be cut. The subsidies to urban transit are quite high. In fact, passenger fares accounted for only about 60 per cent of operating expenses in 2008 (CUTA, 2008). Most operating expenses are covered by municipalities, although limited operational funding comes from the provinces. In 2006, six per cent of transit operation costs nation-wide came from provincial funding, and none from the federal government. Urban transit systems incur not only operating expenses but also capital expenses. Provinces and the federal government have been increasing capital funding to the urban transit industry. In the last ten years, the federal government has committed to multiple funding programs for urban transit. For example, in 2005 the federal government created two programs dedicating $1.3 billion to transit capital needs until 2009 (CUTA, 2008). The inefficiency of providing urban transit services paid for by subsidies is a trade-off of its positive social impacts.

viii. Capacity Utilization

In urban transit, capacity utilization depends on ridership. As ridership increases for a given amount of capital, capacity utilization increases, As ridership decreases so does capacity utilization. Capacity utilization is closely linked to productivity in urban transit. The inputs to providing transportation services are relatively fixed. This means that when there are more passengers, the cost of a passenger mile decreases. In the urban transit industry, a diminishing ridership means buses operate while transporting fewer passengers, which decreases productivity.

In the previous section (Table 61) we saw that at the national level, ridership in urban transit has increased between 2008 and 2012 by an average of 2.63 per cent per year (Table 76). However, capital stock has increased faster during this period, by an average of 9.04 per cent per year. Because capital stock grew much faster than ridership, capacity utilization has decreased. It has decreased by an average of 5.88 per cent per year between 2008 and 2012.

Table 76: Capacity Utilization Defined as Ridership by Capital Stock, Urban Transit Systems, Canada, 2008-2012

	Ridership (Millions of Rides Provided)	Capital Stock (Millions of Chained 2007 Dollars)	Capacity Utilization
2008	1,826	18,200	10.0
2009	1,829	19,693	9.3
2010	1,912	22,031	8.7
2011	1,972	23,717	8.3
2012	2,026	25,729	7.9
		Compound Average Annual Growth	
2008-2012	2.63	9.04	-5.88

Source: Canadian Urban Transit Association Transit Stats 2008-2012, and Statistics Canada Cansim Table 031-0002
Note: Capital stock data is for 485-transit and ground passenger transportation

The decrease in capacity utilization, fueled by capital stock growing faster than ridership, negatively affects productivity. This could reflect a data problem in addition to a productivity matter. Specifically, the measure of capital stock advances well in advance of the use of the capital stock in question, given the long time horizons of subway or light rail projects.

C. Policies to Promote Productivity Growth

Section A described the state of urban transit in Canada by detailing various productivity measures as well as the factors upon which productivity depends. Section B detailed drivers of productivity growth in urban transit. Labour productivity, capital productivity and multifactor productivity have all declined in recent years. This is due to various factors, notably to the increased recognition of the importance of the positive social impacts of urban transit and a decline of ridership in major cities. The goal of the following section is to put forward policy recommendations that can increase the productivity of urban transit systems. The major themes of the policy recommendations presented in this report are increasing ridership, promoting integrated regional transportation planning agencies, and considering controlled competition in the industry.

i. Increasing Ridership

The most important way to increase productivity in urban transit is to increase ridership, particularly outside of rush hour. Increased ridership means that buses would carry a fuller load of passengers, increasing their capacity utilization. This lowers the cost per passenger and increases the output. Increasing ridership can be done in multiple ways: decreasing the cost of fares, increasing taxes on gas and parking, charging congestion charges and tolls, promoting an environment that supports urban transit, and offering Wi-Fi on urban transit.

As mentioned in section B, passenger fares make up 60 per cent of the operating expenses in urban transit, and the rest is paid by municipalities or provincial and federal subsidies. Canada's level of cost recovery exceeds that of the United States, Sweden, Italy, the Netherlands, and France (CUTA, 2008). However, this comes at a price. Canadian cities have some of the highest fares in North America (Kauri, 2014 and priceoftravel.com, 2010). High fares deter passengers from using public transit. Lower fares would make urban transit a more attractive option to potential users, and could make urban transit a more competitive option compared to car travel.

The use of fuel for car travel creates greenhouse gas emissions and pollutes the air. These negative externalities are not captured in the market selling price of fuel. This means that when individuals burn fuel to drive their car they are not directly paying the price for the pollution they create. Comparatively, passengers that use urban transit are lowering polluting emissions compared to the use of a car. A higher fuel tax which captures the externalities of burning fuel would force drivers to pay for the negative externalities they create and would raise the incentive to use public transit. Taxes could also be increased on parking to increase the incentive to use urban transit.

Congestion is another negative externality of car travel. Traffic congestion is a growing problem in Canada and affects the quality of life of Canadians and raises the production of greenhouse gas emissions and pollution (Council of Ministers Responsible for Transportation and Highway Safety, 2012). According to Canada's Ecofiscal Commission (2015), congestion pricing needs to be implemented in Canada to beat the congestion problem. A congestion tax captures the externality of congestion and increases the incentive to use public transit. A congestion tax is a fee to road users during rush hours. It can vary by time of day and day of the week, the highest being during peak demand and the lowest at unpopular hours. In the same way as a car fuel tax, a congestion tax would raise the incentive to use public transitive and make it more competitive compared to driving a car.

Similar to a congestion tax is charging tolls on roads. A toll is a fee claimed for passage on a road. The difference between a toll and a congestion tax is that a congestion tax is dependent on congestion and peak hours, where as a toll is constant. In the same way as a congestion tax, a toll internalizes the externalities of the use of a car and makes urban transit more attractive.

The recommendations to increase public transit ridership discussed this far are based on ending the under-pricing of car travel by addressing external costs, making urban transit a more appealing transportation option and thus increasing ridership. A decrease in the relative price of private transportation compared to public transit has made urban transit a progressively less enviable transportation option (see Table 77). Measures to increase the price of commuting by car are needed in order for ridership to increase in urban transit.

Table 77: Consumer Price Index, 2002=100, Private Transportation, and City Bus and Subway Transportation, Canada, 2000-2014

	Private Transportation	City Bus and Subway Transportation
2000	97.7	93.3
2001	97.5	96.8
2002	100.0	100.0
2003	105.4	104.2
2004	108.0	107.2
2005	112.4	111.0
2006	115.3	115.0
2007	117.3	118.1
2008	119.3	123.9
2009	112.1	126.4
2010	117.6	134.7
2011	125.4	137.8
2012	127.8	141.5
2013	128.5	145.3
2014	129.9	149.8
	Compound Average Annual Growth	
2000-2014	2.06	3.44

Source: Statistics Canada Cansim Table 362-0021.
Note: Private transportation refers to the purchase, leasing and rental of passenger vehicles.

Ridership can also be increased by attracting passengers with quality improvements and innovations such as providing passengers with Wi-Fi during their commute. Metro systems in cities such as Tokyo, Japan; Moscow, Russia; Paris, France; Bangalore, Mumbai and Gargaon, India offer free Wi-Fi (Joseph, 2014). A study in California on the California Capitol Corridor route where a free Wi-Fi serviced was launched has found that the number of trips on the California Capitol Corridor Route was 2.7% higher in 2012 than it would have been without free

Wi-Fi. An innovation such as this incentivises individuals to take public transit over driving a car.

A final way by which ridership can be increased is by creating a physical environment which promotes urban transit. This means, for one, that urban transit needs to be able to bypass congestion and provide a faster commute. The construction of light rail trains or lanes reserved for buses responds to this need. Another way by which ridership can be increased is the construction of bike paths and walking paths that link residential areas to major bus routes or the development of park-and-ride systems which allow those in the suburban areas to drive to transit stations and ride public transit to more densely populated areas. These options make it easier for individuals to get from their house to a bus route. Making a commute as simple as possible for the passengers is important to increase public transit ridership.

ii. Integrated Regional Transportation Planning Agencies

Iacobacci & Schulman (2009) note that organisational changes within the urban transit industry coincide with a slowdown of the productivity decline. The Conference Board of Canada refers to a slowdown of the productivity decline, because after 1990 the decline in productivity slowed down from an annual rate of 2.7 per cent to a rate of about 1 per cent per year until 2006, the latest year for which the Conference Board of Canada examined data.

Iacobacci & Schulman (2009) explain that the most significant organizational change is the establishment of integrated regional transportation planning agencies in the three largest cities in Canada. The goal of these is to provide long-term transportation planning and implementation. They control the planning, management, operations, and maintenance of transportation systems at the regional level. Organisational changes of this type increase productivity in the urban transit industry because they promote better management and long-term planning.

iii. Controlled Competition

In some places in Europe, the urban transit industry, facing a similar productivity problem as Canada, has turned to competitive tendering. Competitive tendering is the awarding of a route or network of routes to an operator following a competitive process. According to Iacobacci & Schulman (2009), the productivity of the London bus system grew by 3.7 per cent per year from 1984/1985 to 1999/2000, as a result of a conversion to competitive tendering.

The introduction of competitive tendering into the urban transit industry in Canada may result in better efficiency and increased productivity. This area is worth researching further.

Section 7: Summary and Conclusion

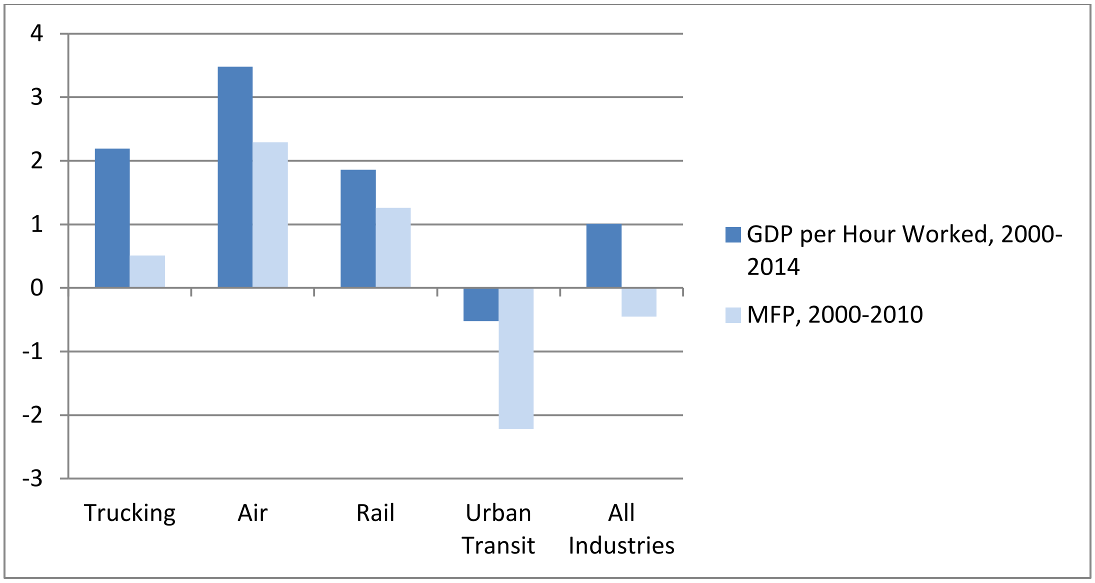
Productivity performance in the transportation sector has generally been strong. Labour productivity growth has been above the total economy average in the truck, air and rail transportation subsectors, but has been below average and even negative in urban transit systems (Table 78 and Chart 46). The increased productivity in trucking, air, and rail is due mainly to deregulation of the transportation sector which has allowed competitive forces to operate, technical progress, organizational factors, and capital accumulation. In urban transit systems, the fall in productivity is mostly due to capital investments and the growing importance of the social impacts of urban transit. Policy has an impact on productivity and this report has offered several policy solutions that could lead to productivity growth. These are specific to each subsector, but generally focus on further deregulation, increased fuel efficiency and increased capacity utilization.

Table 78: Compound Annual Growth Rates of Productivity and Related Variables in Major Transportation Subsectors, Canada

		Trucking	Air	Rail	Urban Transit*	Transportation**	All Industries
Output	Real GDP	2.81	3.42	1.03	2.11	2.14	2.03
Labour Input	Hours Worked	0.61	-0.06	-0.82	2.61	0.58	1.01
	Jobs,	0.95	0.17	-1.04	2.87	0.84	1.32
Labour Productivity	GDP per Hour Worked	2.19	3.48	1.86	-0.52	1.55	1.01
	GDP per Job	1.83	3.25	2.09	-0.76 [B]	1.29 [B]	0.69
Capital	Net Capital Stock	4.86	-0.19	-0.11	5.94 [B]	2.36 [B]	2.41
Capital Intensity***	Capital per Hour Worked	4.42	0.36	1.27	3.18	1.19	1.33
MFP****	MFP	0.51[B]	2.30[A]	1.26[A]	-2.22[B]	..	-0.45[C]

Note: Figures represent compound annual growth rates.
[A] MFP data for Air and Rail is based on Transport Canada's Productivity Database, 2000-2013.
[B] Statistics Canada MFP estimates based on gross output.
[C] This MFP estimate is based on value-added MFP in the business sector.
* The MFP and Capital estimates use data on the broader Transit and Ground Passenger Transportation subsector rather than urban transit, as estimates specific to Urban Transit were not available from Statistics Canada.
** Constructed as the aggregate of rail, trucking, air, urban transit, water transportation, and pipelines. Note that this does not include taxis, scenic and sightseeing transportation, other ground transportation, support services for transportation, postal services and couriers and messengers, and warehousing
*** Estimates are for the 2000-2013 period.
**** Estimates for trucking and urban transit are for the 2000-2010 period. Estimates for air and rail are for 2000-2013. Since time periods and sources differ, most of the MFP estimates are not perfectly comparable to the input and output data nor across sectors.
Source: CSLS Transportation Database using data from Statistics Canada.

Chart 46: Compound Annual Growth Rates, Labour Productivity and MFP, Canada



Note: MFP data for Air and Rail is based on Transport Canada's Productivity Database. Statistics Canada MFP estimates for Trucking and Urban Transit are based on gross output. The MFP estimate for urban transit uses data on the broader Transit and Ground Passenger Transportation subsector, as estimates specific to Urban Transit were not available from Statistics Canada.
Source: CSLS Transportation Database using data from Statistics Canada.

Several opportunities exist for further research on productivity in the transportation sector. This report focused on four of the major transportation subsectors, but similar analyses could also be performed in other transportation subsectors such as pipelines, water transport, and support activities for transportation. Further analysis of international and provincial differences in performance may also yield further insights as to how productivity can be improved. The general productivity trends should continue to be monitored in the future in order to ensure that the transportation continues to operate as productively as possible.

Given the broad nature of the analysis conducted here, in-depth quantitative assessments of the potential impact of specific policies were not conducted, but such research may be worthwhile.

One challenge in this assessment has been inconsistencies between the data constructed by Transport Canada and Statistics Canada. While the two data sources usually support similar stories, there are a few sizable discrepancies (see Appendix B for a comparison and brief discussion). Further research is needed to better understand why the two data sources diverge and to determine which one is preferable for assessing the performance of the transportation sector.

References

Air Canada (2014). *Air Canada: Annual Report 2014.*

Funding Universe. (no date). *Air Canada- Company History* http://www.fundinguniverse.com/company-histories/air-canada-history/

Air Canada: Fundamentally Reinvented? (2004). *https://www.aviationstrategy.aero/newsletter/Nov-2004/4/Air_Canada%3A_fundamentally_reinvented%3F*

Apostolides, A. D. (2009). *Estimation and Analysis of Multifactor Productivity in Truck Transportation, 1987-2003*. US Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics, Office of Advanced Studies.

Arjomandi, A., and Seufert, J.H. (2014), “An evaluation of the world’s major airlines’ technical and environmental performance”, *Economic Modelling*, 41, 133-144.

Barnhart, C., & Laporte, G. (Eds.). (2006). *Handbooks in Operations Research & Management Science: Transportation: Transportation* (Vol. 14). Elsevier.

Beck, A., Bente, H., and Schilling, M. (2013). *Railway Efficiency*. International Transport Forum. Discussion Paper 2013-12.

Belobaba, P., Hernandez, ., Jenkins, J., Powell, R., & Swelbar, W., (2011). *Productivity Trends in the US Passenger Airline Industry 1978-2010*, Transportation @MIT, US Transportation Productivity Study. http://engineeringfiles.mit.edu/downloads/transportation/MIT_Airline_Productivity_Study_2011_Final1.pdf.

Bergeron-Olivier, Annie. (2013). *Air Canada’s Privatization, 25 Years Later*. iPolitics. http://ipolitics.ca/2013/04/12/air-canadas-privatization-25-years-later/

Bitzan, J. D., & Keeler, T. E. (2003). Productivity growth and some of its determinants in the deregulated US railroad industry. *Southern Economic Journal*, 232-253.

Boardman, A. E., Laurin, C., Moore, M. A., & Vining, A. R. (2009). A cost-benefit analysis of the privatization of Canadian national railway. *Canadian Public Policy*, *35*(1), 59-83.

Brown, W. M. (2015). How much thicker is the Canada–US border? The cost of crossing the border by truck in the pre-and post-9/11 eras. *Research in Transportation Business & Management*, 16, 50-66.

Cairns M. (2015). *Staying on the Right Track: A Review of Canadian Freight Rail Policy.* Macdonald-Laurier Institute.

Calver (2015). "On the Relationship between Gross Output-based TFP Growth and Value Added-based TFP Growth: An Illustration Using Data from Australian Industries," *International Productivity Monitor*, Number 29, Fall, pp.68-82.

Canada's Ecofiscal Commission. (2015). *We Can't Get There From Here: Why Pricing Traffic Congestion is Critical to Beating it.* Report.

Canadian Transportation Agency. (2015). *Interswitching Rates.* https://www.otc-cta.gc.ca/eng/interswitchingrates

Canadian Urban Transit Association. (2008). *Investing in Transit: An Ongoing Challenge*. Issue Paper 26.

Canadian Urban Transit Association. (2006). *Rail Transit in Canada*. Issue Paper 19.

Centre for the Study of Living Standards (2012) **"**The Impact of Information and Communication Technology on the Productivity of the Canadian Transportation System: A Macroeconomic Approach for the Air and Rail Sectors," prepared for Transport Canada, CSLS Research Report 2012-07, June. http://www.csls.ca/reports/csls2012-07.pdf

Competition Bureau. (2014). *Competition Bureau Submission to the OECD Competition Committee Roundtable on Airline Competition*. http://www.competitionbureau.gc.ca/eic/site/cb-bc.nsf/eng/03746.html

Council of Ministers Responsible for Transportation and Highway Safety. (2012). *The High Cost of Congestion in Canadian Cities.* Urban Transportation Task Force.

Council of Ministers Responsible for Transportation and Highway Safety. (2013). *Canada's National Highway System Annual Report 2012.*

CPCS. (2014). *Evolution of Canadian Railway Economic Regulation and Industry Performance under Commercial Freedom.* Report.

Dana Jr, J.D., & Orlov, E. (2014). "Internet Penetration and Capacity Utilization in the US Airline Industry", *American Economic Journal: Microeconomics*, 6(4), 106-137.

Diewert, Erwin (2015). "A Note on Reconciling Gross Output TFP Growth with Value Added TFP Growth," *International Productivity Monitor*, Number 29, Fall, pp.60-67.

Dubé, V., & Pilon, D. (2006). *On the road again*. Statistics Canada.

Duke, J., Torres, V. & Kern, P. (2005). Multifactor Productivity Change in the Air Transportation Industry. *Monthly Labor Review*. 128 (3). p35-45.

Gill, Vijay, & Macdonald, Alicia (2013). *Understanding the Truck Driver Supply and Demand Gap and Its Implications for the Canadian Economy*. The Conference Board of Canada.

Gill, Vijay, Raynor, R., & Neil, R. (2013). *Growing Canada's Economy: A New National Air Transportation Policy*, The Conference Board of Canada. http://www.conferenceboard.ca/temp/4c9795c7-a1b6-4d3e-8dc2-f810644d2317/14-105_nationalairpolicy.pdf

Government of Canada. (2014). *Completion of the Roberts Bank Rail Corridor*. http://news.gc.ca/web/article-en.do?nid=854739

Grant, Kelly. (2010). *Jump in Fare Evasion Cost TTC $22 Million in 2010*. The Globe and Mail.

Gratwick J. (2001)., *The Evolution of Canadian Transportation Policy.* Report.

Gregory, Alexander (2012). *The Productivity of the Canadian Airline Industry: A Dynamic Carrier Level Approach.* M.A. Research Paper. University of Ottawa.

Hansman, R. J. (2005, January). The Impact of Information Technologies on Air Transportation. *Aerospace Sciences Conference*, AIAA (Vol. 1).

Hewitt, J., Stephens, J., Smith, K., & Menuez, N. (1999). Infrastructure and economic impacts of changes in truck weight regulations in Montana. *Transportation Research Record: Journal of the Transportation Research Board*, (1653), 42-51.

Hubbard, T. N. (2001). *Information, decisions, and productivity: on-board computers and capacity utilization in trucking* (No. w8525). National Bureau of Economic Research.

Iacobacci, Mario, & Schulman, Joseph (2009). *The Productivity Performance of Canada's Transportation Sector: Market Forces and Governance Matter.* The Conference Board of Canada

InterVISTAS Consulting 2013). *Canada's Fiscal Policy for Aviation: What are the true Costs?* http://culture.alberta.ca/tourism/programs-and-services/air-access/pdf/InterVISTAS-Report-on-CanadasAviationPolicy.pdf

Joseph, Coby. (2014) *How Providing Wi-Fi Can Increase Mass Transit Ridership*. TheCityFix. http://thecityfix.com/blog/wifi-increase-mass-transit-transport-ridership-bus-metro-coby-joseph/

Kauri, Vidya. (2014). *More Public Transit Riders, Paying Far More to Ride*. Macleans.

Koske, I., I.Wanner, R. Bitetti and O. Barbiero (2014). "The 2013 update of the OECD product market regulation indicators: policy insights for OECD and non-OECD countries", OECD Economics Department Working Papers.

Landon, Stuart, & Smith, Constance E. (2006). "Exchange rates and investment good prices: A cross-industry comparsion". *Journal of International Money and Finance*, 25, 237-256.

Laurin, C., & Bozec, Y. (2001). Privatization and productivity improvement: the case of Canadian National. *Transportation Research Part E: Logistics and Transportation Review*, *37*(5), 355-374.

Lemp, J. D., Kockelman, K. M., & Unnikrishnan, A. (2011). Analysis of large truck crash severity using heteroskedastic ordered probit models. *Accident Analysis & Prevention*, *43*(1), 370-380.Levinson, Herbert S., Samuel Zimmerman, Jennifer Clinger, and G. Scott Rutherford. Bus rapid transit: An overview. *Journal of Public Transportation* 5, no. 2: 1.

Liebert, V. & Niemeier, H. M. (2013). "A Survey of Empirical Research on the Productivity and Efficiency Measurement of Airports*". Journal of Transportation and Economics Policy (JTEP)*, 47(2), 257-189.

Logistics Solution Builders Inc. (2005). *Operating Costs of Trucks in Canada 2005.* Prepared for the Economic Analysis Directorate. Transport Canada. LSB 2005-08

Madore, O., & Shaw, D. J. (1993). *The Canadian Airline Industry: Its Structure, Performance and Prospects.* http://publications.gc.ca/Collection-R/LoPBdP/BP/bp329-e.htm

Marowits, Ross. (2013). *Air Canada must keep heavy-maintenance work in Canada, Quebec court rules.* The Globe and Mail. http://www.theglobeandmail.com/globe-investor/air-canada-must-keep-heavy-maintenance-work-in-canada-quebec-court-rules/article8184209/.

Meyer, J. R., & Gomez-Ibanez, J. A. (1980). Measurement and analysis of productivity in transportation industries. In *New Developments in Productivity Measurement* (pp. 293-332). University of Chicago Press.

Monteiro, J. (no date). Trucking Transportation in Canada Before and After Deregulation – Major Trends. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.433.5048&rep=rep1&type=pdf

OECD (2001) Measuring productivity – Measurement of aggregate and industry-level productivity growth (Paris: OECD).

Ontario Ministry of Transportation. (2009). *Frequently Asked Questions.* Long Combination Vehicle Program. http://www.mto.gov.on.ca/english/trucks/long-combination-vehicle-faq.shtml

Owram, K. (2015). *Ottawa Says "No" to Jets at Toronto Island Airport, Dealing Blow to Porter's CSeries Plan.* Financial Post. http://business.financialpost.com/news/transportation/transport-minister-marc-garneau-rules-out-jets-at-billy-bishop-toronto-city-airport

Oum, T. H., Waters, W. G., & Yu, C. (1999). A survey of productivity and efficiency measurement in rail transport. *Journal of Transport economics and Policy*, 9-42.

Powell II, R. a. (2012). *Productivity Performance of US Passenger Airlines since Deregulation.* Doctoral Dissertation, Massachusetts Institute of Technology.

https://scholar.google.com/scholar?oi=gsb40&q=Productivity%20Performance%20of%20US%20Passenger%20Airlines%20since%20Deregulation&lookup=0&hl=en

Prentice B., & Parsons G. (2015). *Freedom in Western Grain Movement: Why the Revenue Cap Needs to Go.*

Price Waterhouse Coopers. (2007). *TransLink Fare Evasion Internal Audit*.

Prime Minister of Canada . (2015). *Public Transit Fund*. http://pm.gc.ca/eng/news/2015/06/18/public-transit-fund

Public Transportation Prices in 80 Worldwide Cities. http://www.priceoftravel.com/595/public-transportation-prices-in-80-worldwide-cities/

Railway Association of Canada. (2014). *Canada's Railways 2-14 Rail Trends.* Report.

Railway Association of Canada. (No Date). *Rail Facts.* http://www.railcan.ca/education/facts

Redekop, David (2008). *Clipping the Wings of Canada's Aviation Industry.* Conference Board of Canada. http://www.conferenceboard.ca/economics/hot_eco_topics/default/08-10-06/clipping_the_wings_of_canada_s_aviation_industry.aspx

Robbie Whelan. (2015). *Mobile Apps Get Picked Up by Independent Truckers for Better Routes.* The Wall Street Journal.

Sarwant Singh. (2015). *The Disruption Uber Has Brought to the Taxi Business Is Coming To Trucking.* Forbes.

Sharpe, Andrew and Ricardo de Avillez (2011) "A detailed analysis of Nova Scotia's productivity performance, 1997-2010," CSLS Research Report 2012-05.

Sharpe, Andrew and Erik Johnson (2011), "The Innovation Performance of the Canadian Transportation Sector: Investment in Machinery and Equipment and Information Communication Technology," Unpublished CSLS Research Report.

Statistics Canada. (2006). *Study: Economic importance of transportation*. The Daily.

Toronto Pearson. (no date). *Noise Questions and Answers.* http://www.torontopearson.com/en/noisequestionsandanswers/#

Toronto Transit Commission. (2013). *Transit Services 2013 Performance Measurement and Benchmarking Report.* Report.

TransLink, (2014). *2013 Bus Service Performance Review*. Summary Report

Transport Canada. (2010). *Emissions Reduction Initiative.* http://www.tc.gc.ca/eng/programs/environment-ecofreight-about-voluntary-voluntaryagreementsrail-1855.htm

Transport Canada. (2011). *National Highway System. http://www.tc.gc.ca/eng/policy/acg-acgd-menu-highways-2149.htm*

Transport Canada. (2012). *Transprotation in Canada.* Report TP 14816.

Transport Canada. (2014). *Canadian Aviation Regulation Advisory Council (CARAC) Notice of Proposed Amendment (NPA): Flight Crew Fatigue Management. http://wwwapps.tc.gc.ca/Saf-Sec-Sur/2/NPA-APM/doc.aspx?id=10200*

Transport Canada (2015). *Transportation in Canada 2014: Overview Report. https://www.tc.gc.ca/media/documents/policy/2014_TC_Annual_Report_Overview-EN.pdf*

United States Department of Transportation. *Length of Haul*. http://www.rita.dot.gov/bts/programs/freight_transportation/html/length_of_haul.html

United States General Accounting Office. (1994). *Longer Combination Trucks Potential Infrastructure Impacts, Productivity Benefits, and Safety Concerns.* Report to Congressional Committees.

WestJet (2014). *Executing on Our Strategies: WestJet Annual Report 2014.*

Whelan, R. (2015). *Mobile Apps Get Picked Up by Independent Truckers for Better Routes.* The Wall Street Journal. http://www.wsj.com/articles/mobile-apps-get-picked-up-by-independent-truckers-for-better-routes-1431052055

Wirasinghe, S. C., L. Kattan, M. M. Rahman, J. Hubbell, R. Thilakaratne, and S. Anowar. (2013). Bus rapid transit–a review. *International Journal of Urban Sciences* 17, no. 1: 1-31.

Woodrooffe J., Ash L. & Champion J. (2000). *Rail Operations Efficiency Report.* Woodrooffe and Associates.

Appendix

A. NAICS Definitions of Transportation and Warehousing and its 3-Digit Subsectors

48-49 - Transportation and warehousing

This sector comprises establishments primarily engaged in transporting passengers and goods, warehousing and storing goods, and providing services to these establishments. The modes of transportation are road (trucking, transit and ground passenger), rail, water, air and pipeline. These are further subdivided according to the way in which businesses in each mode organize their establishments. National post office and courier establishments, which also transport goods, are included in this sector. Warehousing and storage establishments are subdivided according to the type of service and facility that is operated.

481 - Air transportation

This subsector comprises establishments primarily engaged in for-hire, common-carrier transportation of people and/or goods using aircraft, such as airplanes and helicopters.

482 - Rail transportation

This subsector comprises establishments primarily engaged in operating railways. Establishments primarily engaged in the operation of long-haul or mainline railways, short-haul railways and passenger railways are included.

484 - Truck transportation

This subsector comprises establishments primarily engaged in the truck transportation of goods. These establishments may carry general freight or specialized freight. Specialized freight comprises goods that, because of size, weight, shape or other inherent characteristics, require specialized equipment for transportation. Establishments may operate locally, that is within a metropolitan area and its hinterland, or over long distances, that is between metropolitan areas.

485 - Transit and ground passenger transportation

This subsector comprises establishments primarily engaged in a variety of passenger transportation activities, using equipment designed for those purposes. These activities are distinguished based on process factors, such as whether routes are scheduled, run over fixed routes, and charged on a per-seat or per-vehicle basis.

483 - Water transportation

This subsector comprises establishments primarily engaged in the water transportation of passengers and goods, using equipment designed for those purposes.

486 - Pipeline transportation

This subsector comprises establishments primarily engaged in the transport of goods by pipeline. The pipelines are designed to specifications for the transport of a particular good, such as crude oil, natural gas and refined petroleum products. Pipeline transportation includes integrated systems comprising various types of pipelines and ancillary facilities, such as pumping stations and incidental storage facilities.

487 - Scenic and sightseeing transportation

This subsector comprises establishments primarily engaged in providing recreational transportation, such as sightseeing or dinner cruises, steam train excursions, horse-drawn sightseeing rides, air-boat rides or hot-air balloon rides. These establishments often use vintage or specialized transportation equipment. The services provided are local in nature, usually involving same-day return. Establishments that provide charter fishing services are included.

488 - Support activities for transportation

This subsector comprises establishments primarily engaged in providing services to other transportation establishments. These services may be specific to a mode of transportation, or they may be multi-modal.

491 - Postal service

This subsector comprises establishments primarily engaged in operating the postal service. Establishments of the Post Office, other than those primarily engaged in providing courier services, are classified in this industry, as well as establishments that carry on one or more functions of the postal service on a contract basis, except the delivery of mail in bulk.

492 - Couriers and messengers

This subsector comprises establishments primarily engaged in providing courier delivery services; or messenger and delivery services of small parcels within a single urban area.

493 - Warehousing and storage

This subsector comprises establishments primarily engaged in operating general merchandise, refrigerated and other warehousing and storage facilities. Included in this subsector are third-party warehouses serving retail chains and wholesalers. Establishments in this subsector provide facilities to store goods for customers. They do not take title to the goods they handle. These establishments take responsibility for storing the goods and keeping them secure. They may also provide a range of services, often referred to as logistics services, related to the distribution of a customer's goods. Logistics services can include labelling, breaking bulk, inventory control and management, light assembly, order entry and fulfillment, packaging, pick and pack, price marking and ticketing and transportation arrangement. However, establishments in this subsector always provide storage services in addition to any logistics services. Furthermore, the storage of goods must be more than incidental to the performance of a service such as price marking.

Both public and contract warehousing are included in this subsector. Public warehousing generally provides short-term storage, typically for less than thirty days. Contract warehousing generally involves a longer-term contract, often including the provision of logistical services and dedicated facilities.

Bonded warehousing and storage services, and warehouses located in free trade zones, are included in the industries of this subsector. However, storage services primarily associated with the provision of credit are not.

B. Subsector-Specific Details of Transport Canada TFP Data

This appendix provides some additional information on the data used from Transport Canada's productivity database. Most of the information in this appendix was obtained from a similar appendix in Iacobacci and Schulman (2009).[80] For most industries, this appendix discusses the original data source, the physical unit of output used, the categories of output used in constructing the output index, and select details regarding the input data.

Trucking

The data on trucking is based on a sample of for-hire carriers with revenues exceeding $1 million dollar surveyed in Statistics Canada's Trucking Commodity Origin and Destination Survey. Private trucking (own-account trucking) is excluded.

The output price index used to deflate total revenues for this subsector is based on a sample of prices in categories defined by geographic location, weight class, distance. Some distinction is also made between intermodal and trucking services, but intermodal is relatively small.

Labour inputs, measured by the number of employees, are categorized by the region of employment because there is no available information on the breakdown by occupation.[81] The regions considered are the Atlantic, Quebec, Ontario, the Prairies, and British Columbia. The capital index is constructed using data on buildings, vehicles, equipment, and land. Fuel inputs are based on the total volume of diesel consumed.

Air Transportation

The data on air transportation is from Statistics Canada's Air Carrier Operations in Canada Survey, specifically statements 10 (unit toll services), 12 (charter services), 20 (aviation services), and 21 (statement of revenues and expenses). The data only includes Level 1 and Level 2 air carriers. Level 1 carriers include all air carriers that, in each of the two years preceding the reporting year, carried at least one million revenue passengers, at least 200,000 tonnes of revenue goods, or both. Level 2 carriers includes all air carriers that, in each of the two years preceding the reporting year, carried one million or more revenue passengers, 30,000 or more tonnes of revenue goods, or both.

[80] We also draw upon a more detailed paper describing the methodology used in the air transportation sector (Gregory, 2012) and information provided by Transport Canada officials including an excerpt from an internal Transport Canada document, "Transport Price and Productivity 2008".

[81] In most sectors, breakdowns by occupation are used with the relative wage rate of the occupation reflecting its relative importance in constructing the labour index.

The industry's output is a combination of passenger-kilometers and freight-tonne-kilometers. Both types of output are broken down by carrier, service (scheduled or chartered), and service area (domestic, transborder, Atlantic, Pacific, southern, or other international).

Labour input, the number of employees, in the subsector is broken down into 6 occupations: pilots, flight personnel, administrative staff, maintenance, aircraft servicing personnel, and other labour (Gregory, 2012). The capital stock is constructed based on data from Statistics Canada and the book value of the sector's assets in 1988 as described in the data section of this report. Leased capital is included in the capital stock for this sector. Fuel input is a combination of jet fuel and aviation gasoline (used by propeller powered aircraft), both converted into joules.

Freight Rail

The freight rail data are obtained from rail carrier filings to Transport Canada. Only the two Class I railways, Canadian National (CN) and Canadian Pacific (CP), are included.

The output measure in this sector is tonne-kilometers of freight. The output price measure used to deflate total revenues is constructed from freight and revenue data for thirteen commodity categories by rail carrier.

There are four labour input categories measured in hours worked and fuel input is simply the number of litres of diesel consumed. Leasing is included in the capital measure in this industry.

Passenger Rail

The data on passenger rail originate from various financial and operating information submitted to Transport Canada by VIA Rail.

Output in this sector is based upon passenger-kilometers. Revenue and passenger-kilometer data for 20 different "corridors" are used to produce the passenger output index.

The index of inputs is constructed in the same way as that of freight rail: labour inputs are calculated from hours worked in four different categories weighted by cost shares; fuel is measured by litres of diesel used; and the capital stock in constant dollars provides the measure of capital input.

It is worth noting that there are some important differences between intercity rail passenger cost shares and freight rail cost shares, which are used to aggregate inputs. The capital share is lower in passenger rail, due in part to the infrastructure largely being owned by the freight carriers (the access costs for the infrastructure are classified as "other" expenses rather than as capital. Additionally, fuel costs constitute a lower share of total costs because passenger trains tend to to be lighter and shorter than freight trains.

Public Transit

The public transit data are provided by the Canadian Urban Transit Association (CUTA). All CUTA members that report data are included. This includes the majority of transit authorities in Canada.

While the preferred measure of output in this subsector is passenger kilometers, the real output measure used is passengers due to data limitations. This may create a bias due to the increasing importance of commuter rail over time which has average trip lengths much higher than the average.

Labour inputs are calculated based on the total number of hours worked in several employment categories. Energy inputs are calculated from diesel and electricity consumption which are converted into joules (there is also a small amount of consumption from other sources such as natural gas).

Comparison of Statistics Canada and Transport Canada Estimate

Appendix Table 1 presents the most comparable estimates over the longest time period available from our two data sources. One observes that, for the most part, the two sources display similar trends, although there are a few sizable discrepancies in terms of magnitudes. The two most notable disagreements which could potentially change the story are (1) that all productivity measures (labour and MFP) for trucking indicate positive productivity growth using the Statistics Canada data between 2000 and 2008, but significant declines using the Transport Canada data and (2) that labour productivity fell in urban transit from 2000-2013 based on the Statistics Canada data but increased slightly based on Transport Canada's data.

There are several other sizable differences in terms of magnitude although the signs are the same so that the general story is typically similar. For example, Transport Canada estimates that labour input in trucking increased by about 5 per cent, while Statistics Canada estimates of labour input growth are around 2 per cent. This discrepancy results in the disagreement as to whether labour productivity increased or decreased in the sector, as both sources estimate output growth in the realm of 3 per cent. In this case, the data from Statistics Canada is based on raw counts of employment or hours while the Transport Canada measure is constructed by weighting growth in four different labour input categories. Transport Canada officials inform us that the employment levels in Transport Canada's labour data are 60 per cent lower than those presented in this report based on Statistics Canada's data. This significant difference in the underlying labour data will be the source of the large differences in estimated labour input and labour productivity growth.

The Transport Canada data on freight rail also only includes the two largest carriers while Statistics Canada's includes all carriers.

Another very large disagreement occurs regarding the extent of capital growth in urban transit between 2000 and 2013. The Transport Canada data suggests a massive growth rate of 12 per cent while the data based on Statistics Canada's data only 6 per cent. Much of this strong rate of growth in the Transport Canada data can be traced to major investment in computer and automation systems. In this case, we do not possess data from Statistics Canada specifically on urban transit, we are using transit and ground passenger transportation as a proxy. The growth in urban transit is most likely lower in this proxy because it also includes other forms of transit such as school buses and taxis which may not have experienced the unusually large increase in capital as urban transit.

While labour productivity looks fairly similar in air transportation regardless of the data source used, there are very large discrepancies between data sources in this sector for both labour and output. In both cases, the growth rates estimated using Transport Canada's data are around two percentage points higher. When Air Canada restructured in the early 2000s, its aircraft maintenance division was outsourced. This led to a reclassification of maintenance workers from labour input to "other" input in the Transport Canada data, leading to a drop in employment and a higher estimate of labour productivity. Since the Statistics Canada data classifies airline maintenance establishments into support activities for transportation rather than the air transportation sector, this change may not have shown up in the Statistics Canada data.

It is difficult to identify the specific sources of the differences between the estimates from the two data sources as they differ in terms of both coverage and methodology. In most cases, the coverage of the Statistics Canada data tends to be wider (the Transport Canada data is often limited to only the major firms, particularly in air and rail). Wider coverage has the advantage of providing a more comprehensive view of what is happening in an industry. However, to the extent that the situation facing small firms is different from that of large firms, more aggregated data may not be as informative about the actual situations of large or small firms – for example, if productivity is rising for large firms and falling for small firms it may appear that productivity is not changing if we look at all firms.

As we discussed in Box 1, employment estimates can vary considerably across Statistics Canada's products, so differences are to be expected. However, it would be useful to have a better understanding of what is driving the largest discrepancies.

Appendix Table 1: Comparison of Compound Annual Growth Rates, Transport Canada and Statistics Canada Data, 2000-2013

		Trucking	Air	Rail	Urban Transit
Output	Statistics Canada (real GDP)	2.98	**2.98**	0.87	2.08
	Transport Canada	3.32	**1.09**	1.56	2.66
	Difference	0.34	**1.89**	0.69	0.58
Labour	Statistics Canada (hours worked)	**1.67**	**-0.53**	-1.36	2.68
	Statistics Canada (jobs)	**2.14**	**0.14**	-1.59	2.84
	Transport Canada	**5.04**	**-2.45**	-1.90	2.46
	Difference (hours)	**3.37**	**1.92**	0.54	0.22
	Difference (jobs)	**2.90**	**2.59**	0.31	0.38
Labour Productivity	Statistics Canada (GDP per hour worked)	**1.29**	3.52	**2.26**	-0.59
	Statistics Canada (GDP per job)	**0.82**	2.84	**2.50**	**-0.74**
	Transport Canada	**-2.45**	2.63	**3.53**	**0.31**
	Difference (hours)	**3.74**	0.89	**1.27**	0.90
	Difference (jobs)	**3.27**	0.21	**1.03**	**1.05**
Capital	Statistics Canada (net capital stock)	**4.86**	-0.19	**-0.11**	**5.94**
	Transport Canada	**5.92**	-0.03	**1.53**	**12.27**
	Difference	**1.06**	0.16	**1.64**	**6.33**
MFP	Statistics Canada (based on gross output)	**0.33**	..	..	-2.22
	Transport Canada	**-1.50**	2.29	1.26	-2.88
	Difference	**1.83**	..	..	0.66

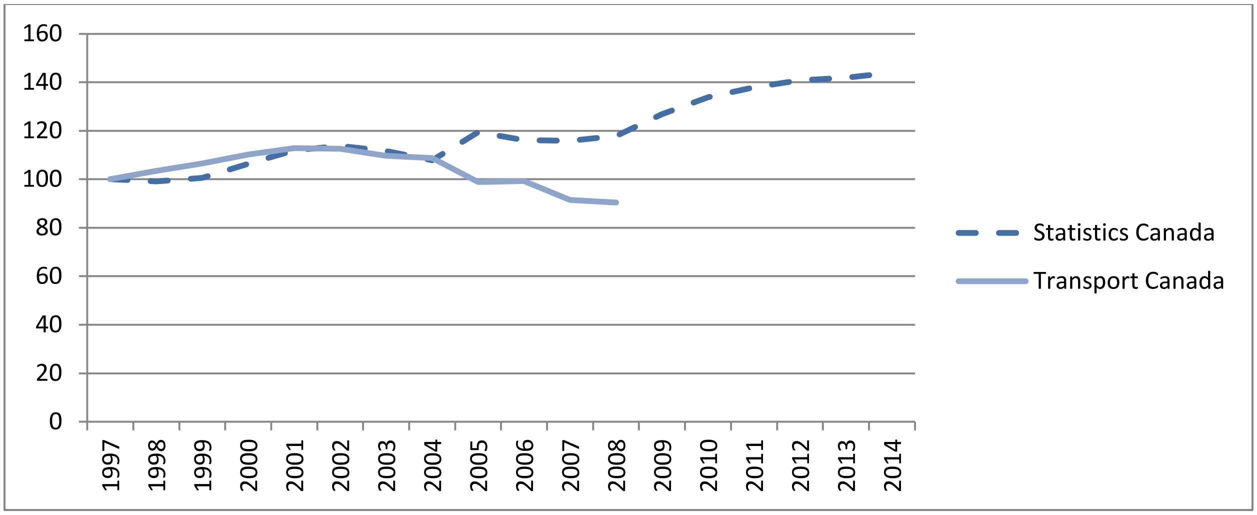
Note: Data for trucking is for the 2000-2008 period, as that is the most recent year available from the Transport Canada database. Capital and MFP for urban transit using Statistics Canada data are for Transit and Ground Passenger Transportation because data are not available for urban transit. The MFP estimates for "Urban Transit" span the 2000-2010 period, as this is the most recent year available from Statistics Canada.

Differences of one percentage point or greater are in bold.

Source: Transport Canada productivity database and CSLS Transportation Database

Appendix Charts 1 through 4 depict how labour productivity growth rates from the two data sources compared over the 1997 to 2014 period.

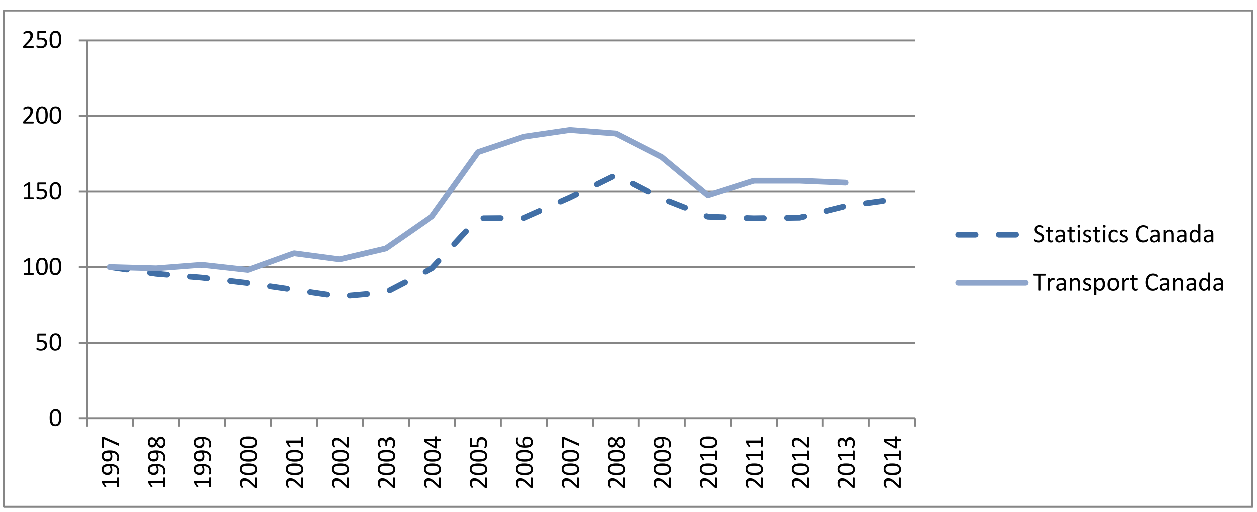
Appendix Chart 1: Comparison of Labour Productivity Growth, Statistics Canada and Transport Canada Data, Trucking, 1997-2014



Note: Statistics Canada estimates based on real GDP per hour worked

Source: Transport Canada productivity database and CSLS Transportation Database

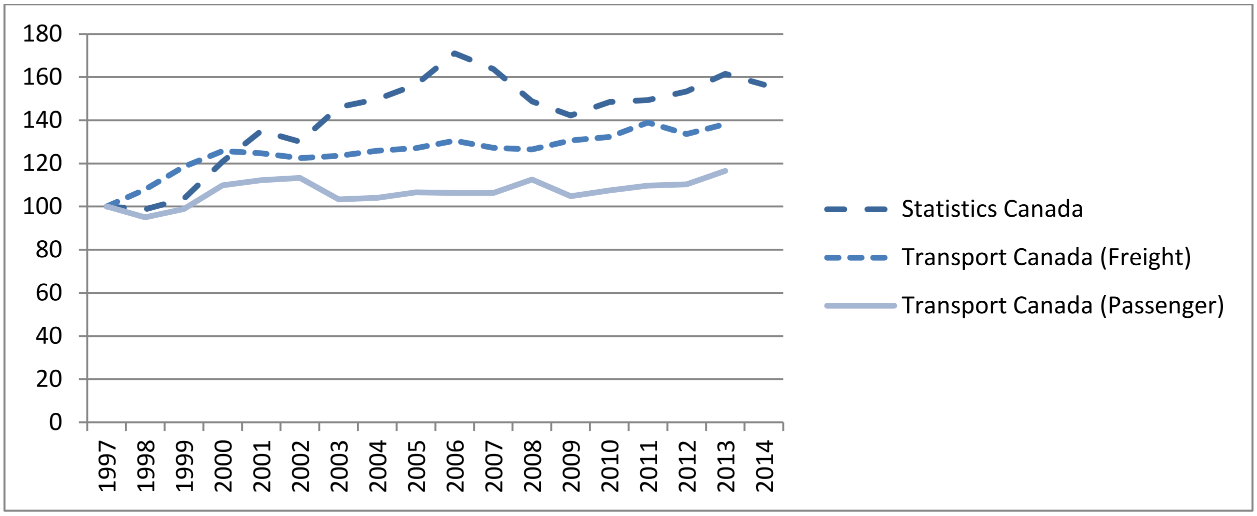
Append ix Chart 2: Comparison of Labour Productivity Growth, Statistics Canada and Transport Canada Data, Air, 1997-2014



Note: Statistics Canada estimates based on real GDP per hour worked

Source: Transport Canada productivity database and CSLS Transportation Database

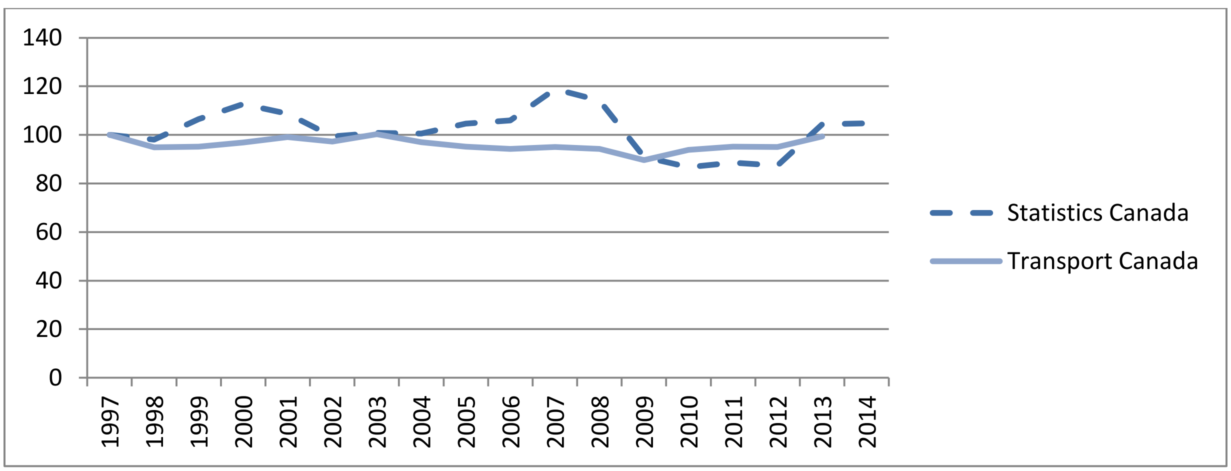
Appendix Chart 3: Comparison of Labour Productivity Growth, Statistics Canada and Transport Canada Data, Rail, 1997-2014



Note: Statistics Canada estimates based on real GDP per hour worked

Source: Transport Canada productivity database and CSLS Transportation Database

Appendix Chart 4: Comparison of Labour Productivity Growth, Statistics Canada and Transport Canada Data, Urban Transit, 1997-2014



Note: Statistics Canada estimates based on real GDP per hour worked in NAICS 4851, Urban Transit Systems

Source: Transport Canada productivity database and CSLS Transportation Database

C. OECD Sector Regulation Indicators

The OECD produces indices of product market regulation which include indicators for the degree of regulation in the rail, air, and road (freight) industries. These indices are available for Canada and many other countries over the 1975-2013 period. Each industry has an overall index which ranges from 0 (low regulation) to 6 (high regulation). The overall indices are constructed from several sub-indices. The indices are constructed using data from a series of questionnaires completed by national governments every 5 years supplemented by data from publically available sources. The weighting of the various components of the indices tends to be arbitrary (usually equally weighted), but the indices provide a measure of how the stringency of regulation varies across countries and through time.

Appendix Tables 2, 3, and 4 provide the details of the coding scheme as laid out by Koske et al. (2014). Appendix Tables 5 through 13 contain international comparisons of Canada and other countries in the years 1975, 1997, and 2013. Appendix Table 14 presents the complete time series for Canada and Appendix Table 15 presents a time series of how Canada ranked internationally.

Appendix Table 2: Coding Scheme, OECD Sector Regulation Indicators, Rail

	Topic weight	Question weight	Coding of data			
Entry regulation	1/4		free entry (upon paying access fees)	entry franchised to several firms that compete in the same geographic area	entry franchised to several firms, each having exclusive rights to a geographic area	entry franchised to single firm
What are the legal conditions of entry into the passenger/freight transport market?[1]		1	0	2	4	6
Public ownership	1/4					
What percentage of shares in the largest firm in operation of infrastructure sector is owned by government?		1/2	% of shares owned by government / 100 * 6			
What percentage of shares in the largest firm in the passenger/freight transport sector is owned by government?[1]		1/2	% of shares owned by government / 100 * 6			
Vertical Separation	1/4		ownership separation	legal separation	accounting separation	no separation
What is the degree of separation between the operation of infrastructure and the provision of railway services (the actual transport of passengers or freight)?		1	0	3	4.5	6
Market structure	1/4		>2	2		1
What is the maximum number of operators that compete in the same area/rail district passenger/freight transport market?[1]		1	0	3		6

Source: OECD Sector Regulation Indicators, http://www.oecd.org/eco/reform/indicatorsofproductmarketregulationhomepage.htm#indicators

Appendix Table 3: Coding Scheme, OECD Sector Regulation Indicators, Air

	Topic weight	Question weight	Coding of data	
Entry regulation:	1/2			
Does your country have an open skies agreement with the United States?		1/3	Yes 0	No 6
Is your country participating in a regional agreement?		1/3	0	6
Is the domestic aviation market in your country fully liberalised? That is, there are no restrictions on the number of (domestic) airlines that are allowed to operate on domestic routes?		1/3	0	6
Public ownership:	1/2			
What percentage of shares in the largest carrier (domestic and international traffic combined) are owned by national, state or provincial authorities?		1	% of shares owned by government / 100 * 6	

Source: OECD Sector Regulation Indicators,
http://www.oecd.org/eco/reform/indicatorsofproductmarketregulationhomepage.htm#indicators

Appendix Table 4: Coding Scheme, OECD Sector Regulation Indicators, Road

	Topic weight	Question weight	Coding of data	
Entry regulation	1/2			
			no/not applicable	yes
In order to establish a national road freight business (other than for transporting dangerous goods or goods for which sanitary assurances are required) do operators need to obtain a license (other than a driving license) or permit from the government?		1/4	0	6
Are criteria other than technical and financial fitness and compliance with public safety requirements considered in decisions on entry of new operators?		1/4	0	6
Does the regulator, through licenses or otherwise, have any power to limit industry capacity?		1/4	0	6
Are professional bodies or representatives of trade and commercial interests involved in specifying or enforcing entry regulations?		1/4	0	6
Price controls	1/2			
Are retail prices of road freight services in any way regulated by the government?		1/3	0	6
Does the government provide pricing guidelines to road freight companies?		1/3	0	6
Are professional bodies or representatives of trade and commercial interests involved in specifying or enforcing pricing guidelines or regulations?		1/3	0	6

Source: OECD Sector Regulation Indicators,
http://www.oecd.org/eco/reform/indicatorsofproductmarketregulationhomepage.htm#indicators

Appendix Table 5: International Ranking of Sectoral Regulation, Rail, 1975

		Rail				
Rank	***Country***	***Overall***	***Entry***	***Public Ownership***	***Vertical Integration***	***Market Structure***
1	**Canada**	**4.88**	**6.00**	**1.50**	**6.00**	**6.00**
2	Luxembourg	5.93	6.00	5.73	6.00	6.00
3	Australia	6.00	6.00	6.00	6.00	6.00
4	Austria	6.00	6.00	6.00	6.00	6.00
5	Belgium	6.00	6.00	6.00	6.00	6.00
6	Chile	6.00	6.00	6.00	6.00	6.00
7	Czech Republic	6.00	6.00	6.00	6.00	6.00
8	Denmark	6.00	6.00	6.00	6.00	6.00
9	Estonia	6.00	6.00	6.00	6.00	6.00
10	Finland	6.00	6.00	6.00	6.00	6.00
11	France	6.00	6.00	6.00	6.00	6.00
12	Germany	6.00	6.00	6.00	6.00	6.00
13	Greece	6.00	6.00	6.00	6.00	6.00
14	Hungary	6.00	6.00	6.00	6.00	6.00
15	Ireland	6.00	6.00	6.00	6.00	6.00
16	Israel	6.00	6.00	6.00	6.00	6.00
17	Italy	6.00	6.00	6.00	6.00	6.00
18	Japan	6.00	6.00	6.00	6.00	6.00
19	Korea	6.00	6.00	6.00	6.00	6.00
20	Mexico	6.00	6.00	6.00	6.00	6.00
21	Netherlands	6.00	6.00	6.00	6.00	6.00
22	New Zealand	6.00	6.00	6.00	6.00	6.00
23	Norway	6.00	6.00	6.00	6.00	6.00
24	Poland	6.00	6.00	6.00	6.00	6.00
25	Portugal	6.00	6.00	6.00	6.00	6.00
26	Slovak Republic	6.00	6.00	6.00	6.00	6.00
27	Slovenia	6.00	6.00	6.00	6.00	6.00
28	Spain	6.00	6.00	6.00	6.00	6.00
29	Sweden	6.00	6.00	6.00	6.00	6.00
30	Switzerland	6.00	6.00	6.00	6.00	6.00
31	Turkey	6.00	6.00	6.00	6.00	6.00
32	United Kingdom	6.00	6.00	6.00	6.00	6.00
33	Brazil	6.00	6.00	6.00	6.00	6.00
34	South Africa	6.00	6.00	6.00	6.00	6.00
35	Iceland	.	.	.	.	.

Source: OECD Sector Regulation Indicators, http://www.oecd.org/eco/reform/indicatorsofproductmarketregulationhomepage.htm#indicators

Appendix Table 6: International Ranking of Sectoral Regulation, Airlines, 1975

		Airlines		
Rank	*Country*	*Overall*	*Entry Barriers*	*Public Ownership*
1	Brazil	3.00	6.00	0.00
2	Iceland	3.00	6.00	0.00
3	Korea	3.00	6.00	0.00
4	Mexico	3.00	6.00	0.00
5	Denmark	3.50	4.00	3.00
6	Switzerland	3.63	6.00	1.26
7	Luxembourg	4.00	4.00	.
8	Norway	4.50	6.00	3.00
9	Sweden	4.50	6.00	3.00
10	Austria	5.00	4.00	6.00
11	Belgium	5.00	4.00	6.00
12	Finland	5.00	4.00	6.00
13	Ireland	5.00	4.00	6.00
14	Netherlands	5.00	4.00	6.00
15	Slovenia	5.00	4.00	6.00
16	South Africa	5.00	4.00	6.00
17	United Kingdom	5.00	4.00	6.00
18	Germany	5.40	6.00	4.80
19	Australia	6.00	6.00	6.00
20	**Canada**	**6.00**	**6.00**	**6.00**
21	Chile	6.00	6.00	6.00
22	Czech Republic	6.00	6.00	6.00
23	Estonia	6.00	6.00	6.00
24	France	6.00	6.00	6.00
25	Greece	6.00	6.00	6.00
26	Hungary	6.00	6.00	6.00
27	Israel	6.00	6.00	6.00
28	Italy	6.00	6.00	6.00
29	Japan	6.00	6.00	6.00
30	New Zealand	6.00	6.00	6.00
31	Poland	6.00	6.00	6.00
32	Portugal	6.00	6.00	6.00
33	Slovak Republic	6.00	6.00	6.00
34	Spain	6.00	6.00	6.00
35	Turkey	6.00	6.00	6.00

Source: OECD Sector Regulation Indicators,
http://www.oecd.org/eco/reform/indicatorsofproductmarketregulationhomepage.htm#indicators

Appendix Table 7: International Ranking of Sectoral Regulation, Road, 1975

		Road		
Rank	*Country*	*Overall*	*Entry*	*Prices*
1	Australia	0.00	0.00	0.00
2	Switzerland	0.00	0.00	0.00
3	Chile	0.75	1.50	0.00
4	United Kingdom	0.75	1.50	0.00
5	Sweden	2.25	4.50	0.00
6	Turkey	3.00	6.00	0.00
7	Belgium	5.00	6.00	4.00
8	**Canada**	**5.00**	**6.00**	**4.00**
9	Austria	6.00	6.00	.
10	Czech Republic	6.00	6.00	6.00
11	Denmark	6.00	6.00	6.00
12	Finland	6.00	6.00	6.00
13	France	6.00	6.00	6.00
14	Germany	6.00	6.00	6.00
15	Greece	6.00	6.00	6.00
16	Hungary	6.00	6.00	6.00
17	Iceland	6.00	6.00	.
18	Ireland	6.00	6.00	6.00
19	Israel	6.00	6.00	6.00
20	Italy	6.00	6.00	6.00
21	Japan	6.00	6.00	6.00
22	Korea	6.00	6.00	.
23	Luxembourg	6.00	6.00	.
24	Mexico	6.00	6.00	6.00
25	Netherlands	6.00	6.00	6.00
26	New Zealand	6.00	6.00	6.00
27	Norway	6.00	6.00	6.00
28	Poland	6.00	6.00	.
29	Portugal	6.00	6.00	6.00
30	Slovak Republic	6.00	6.00	6.00
31	Slovenia	6.00	6.00	.
32	Spain	6.00	6.00	6.00
33	Brazil	.	.	.
34	Estonia	.	.	.
35	South Africa	.	.	.

Source: OECD Sector Regulation Indicators, http://www.oecd.org/eco/reform/indicatorsofproductmarketregulationhomepage.htm#indicators

Appendix Table 8: International Ranking of Sectoral Regulation, Rail, 1997

		Rail				
Rank	Country	***Overall***	***Entry***	***Public Ownership***	***Vertical Integration***	***Market Structure***
1	United Kingdom	1.38	1.00	0.00	0.00	4.50
2	**Canada**	**2.25**	**0.00**	**1.50**	**6.00**	**1.50**
3	Poland	3.50	2.00	6.00	4.50	1.50
4	Slovak Republic	3.50	2.00	6.00	4.50	1.50
5	Australia	3.75	3.00	4.50	3.00	4.50
6	Mexico	3.95	4.00	1.29	6.00	4.50
7	New Zealand	4.13	6.00	0.00	4.50	6.00
8	Estonia	4.25	2.00	6.00	6.00	3.00
9	Brazil	4.35	4.00	1.40	6.00	6.00
10	Czech Republic	4.38	1.00	6.00	4.50	6.00
11	Chile	4.50	0.00	6.00	6.00	6.00
12	Germany	4.63	2.00	6.00	4.50	6.00
13	Sweden	4.75	4.00	6.00	3.00	6.00
14	Hungary	4.88	3.00	6.00	4.50	6.00
15	Japan	4.88	4.00	3.50	6.00	6.00
16	Denmark	5.25	6.00	6.00	3.00	6.00
17	Finland	5.25	6.00	6.00	3.00	6.00
18	France	5.25	6.00	6.00	3.00	6.00
19	Netherlands	5.25	6.00	6.00	3.00	6.00
20	Norway	5.25	6.00	6.00	3.00	6.00
21	Portugal	5.25	6.00	6.00	3.00	6.00
22	Luxembourg	5.56	6.00	5.73	4.50	6.00
23	Austria	5.63	6.00	6.00	4.50	6.00
24	Belgium	5.63	6.00	6.00	4.50	6.00
25	Spain	5.63	6.00	6.00	4.50	6.00
26	Switzerland	5.63	6.00	6.00	4.50	6.00
27	Greece	6.00	6.00	6.00	6.00	6.00
28	Ireland	6.00	6.00	6.00	6.00	6.00
29	Israel	6.00	6.00	6.00	6.00	6.00
30	Italy	6.00	6.00	6.00	6.00	6.00
31	Korea	6.00	6.00	6.00	6.00	6.00
32	Slovenia	6.00	6.00	6.00	6.00	6.00
33	Turkey	6.00	6.00	6.00	6.00	6.00
34	South Africa	6.00	6.00	6.00	6.00	6.00
35	Iceland	.	.	.	.	.

Source: OECD Sector Regulation Indicators, http://www.oecd.org/eco/reform/indicatorsofproductmarketregulationhomepage.htm#indicators

Appendix Table 9: International Ranking of Sectoral Regulation, Airlines, 1997

		Airlines		
Rank	Country	***Overall***	***Entry Barriers***	***Public Ownership***
1	Chile	0.00	0.00	0.00
2	Iceland	0.00	0.00	0.00
3	Luxembourg	0.00	0.00	.
4	New Zealand	0.00	0.00	0.00
5	Netherlands	0.85	0.00	1.70
6	Australia	1.00	2.00	0.00
7	**Canada**	**1.00**	**2.00**	**0.00**
8	United Kingdom	1.00	2.00	0.00
9	Germany	1.07	0.00	2.14
10	Denmark	1.50	0.00	3.00
11	Norway	1.50	0.00	3.00
12	Sweden	1.50	0.00	3.00
13	Belgium	1.53	0.00	3.06
14	Austria	1.56	0.00	3.11
15	Finland	1.85	0.00	3.70
16	Brazil	2.00	4.00	0.00
17	Japan	2.00	4.00	0.00
18	Italy	2.58	0.00	5.16
19	Switzerland	2.99	4.00	1.98
20	Korea	3.00	6.00	0.00
21	Estonia	3.02	4.00	2.04
22	Mexico	3.65	4.00	3.30
23	France	4.00	2.00	6.00
24	Ireland	4.00	2.00	6.00
25	Spain	4.00	2.00	6.00
26	Czech Republic	4.69	4.00	5.37
27	Greece	5.00	4.00	6.00
28	Portugal	5.00	4.00	6.00
29	Slovenia	5.00	4.00	6.00
30	South Africa	5.00	4.00	6.00
31	Hungary	5.94	6.00	5.88
32	Turkey	5.94	6.00	5.88
33	Israel	6.00	6.00	6.00
34	Poland	6.00	6.00	6.00
35	Slovak Republic	6.00	6.00	6.00

Source: OECD Sector Regulation Indicators,
http://www.oecd.org/eco/reform/indicatorsofproductmarketregulationhomepage.htm#indicators

Appendix Table 10: International Ranking of Sectoral Regulation, Road, 1997

			Road	
Rank	Country	***Overall***	***Entry***	***Prices***
1	Australia	0.00	0.00	0.00
2	Switzerland	0.00	0.00	0.00
3	**Canada**	**0.75**	**1.50**	**0.00**
4	Chile	0.75	1.50	0.00
5	Ireland	0.75	1.50	0.00
6	Denmark	1.50	3.00	0.00
7	Finland	1.50	3.00	0.00
8	New Zealand	1.50	3.00	0.00
9	Norway	1.50	3.00	0.00
10	Sweden	1.50	3.00	0.00
11	United Kingdom	1.50	3.00	0.00
12	Belgium	2.25	4.50	0.00
13	Netherlands	2.25	4.50	0.00
14	Portugal	2.25	4.50	0.00
15	Austria	3.00	3.00	.
16	Czech Republic	3.00	6.00	0.00
17	Germany	3.00	6.00	0.00
18	Slovak Republic	3.00	6.00	0.00
19	Turkey	3.00	6.00	0.00
20	France	3.25	4.50	2.00
21	Mexico	4.50	3.00	6.00
22	Japan	5.25	4.50	6.00
23	Greece	6.00	6.00	6.00
24	Hungary	6.00	6.00	6.00
25	Iceland	6.00	6.00	.
26	Israel	6.00	6.00	6.00
27	Italy	6.00	6.00	6.00
28	Korea	6.00	6.00	.
29	Luxembourg	6.00	6.00	.
30	Poland	6.00	6.00	.
31	Slovenia	6.00	6.00	.
32	Spain	6.00	6.00	6.00
33	Brazil	.	.	.
34	Estonia	.	.	.
35	South Africa	.	.	.

Source: OECD Sector Regulation Indicators, http://www.oecd.org/eco/reform/indicatorsofproductmarketregulationhomepage.htm#indicators

Appendix Table 11: International Ranking of Sectoral Regulation, Rail, 2013

		Rail				
Rank	Country	***Overall***	***Entry***	***Public Ownership***	***Vertical Integration***	***Market Structure***
1	United Kingdom	0.25	1.00	0.00	0.00	0.00
2	**Canada**	**2.25**	**0.00**	**1.50**	**6.00**	**1.50**
3	Czech Republic	2.25	0.00	6.00	3.00	0.00
4	Denmark	2.25	0.00	4.50	3.00	1.50
5	Germany	2.25	0.00	6.00	3.00	0.00
6	Romania	2.25	0.00	6.00	3.00	0.00
7	Australia	2.63	0.00	4.50	3.00	3.00
8	Austria	2.63		6.00	4.50	0.00
9	Estonia	2.63	0.00	4.50	3.00	3.00
10	Latvia	2.63	0.00	6.00	3.00	1.50
11	Lithuania	2.63	0.00	6.00	4.50	0.00
12	Italy	2.75	2.00	6.00	3.00	0.00
13	Poland	2.75	2.00	6.00	3.00	0.00
14	Norway	2.96	2.00	5.32	3.00	1.50
15	Japan	3.00	0.00	1.50	6.00	4.50
16	Sweden	3.00	0.00	6.00	3.00	3.00
17	Hungary	3.13	2.00	4.50	3.00	3.00
18	Netherlands	3.13	2.00	4.50	3.00	3.00
19	Slovak Republic	3.13	2.00	6.00	3.00	1.50
20	Belgium	3.75	3.00	6.00	3.00	3.00
21	France	3.75	3.00	6.00	3.00	3.00
22	Slovenia	3.75	3.00	6.00	3.00	3.00
23	Bulgaria	3.75	3.00	6.00	3.00	3.00
24	Portugal	3.88	2.00	6.00	3.00	4.50
25	Switzerland	3.88	2.00	6.00	4.50	3.00
26	Mexico	4.00	4.00	0.00	6.00	6.00
27	Spain	4.00	4.00	6.00	3.00	3.00
28	Brazil	4.11	4.00	0.42	6.00	6.00
29	Chile	4.13	0.00	6.00	6.00	4.50
30	Finland	4.38	4.00	6.00	3.00	4.50
31	Greece	4.50	3.00	6.00	3.00	6.00
32	India	4.50	3.00	6.00	6.00	3.00
33	Korea	4.75	4.00	6.00	3.00	6.00
34	Ireland	4.88	3.00	6.00	4.50	6.00
35	Croatia	5.25	6.00	6.00	3.00	6.00
36	Luxembourg	5.41	6.00	5.16	4.50	6.00
37	Israel	6.00	6.00	6.00	6.00	6.00
38	New Zealand	6.00	6.00	6.00	6.00	6.00
39	Turkey	6.00	6.00	6.00	6.00	6.00
40	China	6.00	6.00	6.00	6.00	6.00
41	South Africa	6.00	6.00	6.00	6.00	6.00
42	Iceland	.	.	.	.	.
43	Cyprus	.	.	.	.	.
44	Malta	.	.	.	.	.

Source: OECD Sector Regulation Indicators,
http://www.oecd.org/eco/reform/indicatorsofproductmarketregulationhomepage.htm#indicators

Appendix Table 12: International Ranking of Sectoral Regulation, Airlines, 2013

		Airlines		
Rank	Country	***Overall***	***Entry Barriers***	***Public Ownership***
1	Australia	0.00	0.00	0.00
2	Austria	0.00	0.00	0.00
3	Brazil	0.00	0.00	0.00
4	Bulgaria	0.00	0.00	.
5	Chile	0.00	0.00	0.00
6	Germany	0.00	0.00	0.00
7	Greece	0.00	0.00	0.00
8	Hungary	0.00	0.00	0.00
9	Iceland	0.00	0.00	0.00
10	Italy	0.00	0.00	0.00
11	Slovak Republic	0.00	0.00	0.00
12	Spain	0.00	0.00	0.00
13	Switzerland	0.00	0.00	0.00
14	United Kingdom	0.00	0.00	0.00
15	Belgium	0.12	0.00	0.25
16	Netherlands	0.18	0.00	0.35
17	Denmark	0.43	0.00	0.86
18	Norway	0.43	0.00	0.86
19	France	0.48	0.00	0.95
20	Sweden	0.64	0.00	1.28
21	Ireland	0.75	0.00	1.50
22	**Canada**	**1.00**	**2.00**	**0.00**
23	India	1.00	2.00	0.00
24	Japan	1.00	2.00	0.00
25	Korea	1.00	2.00	0.00
26	Israel	1.03	2.00	0.07
27	Lithuania	1.50	3.00	0.00
28	Luxembourg	1.53	0.00	3.06
29	Finland	1.68	0.00	3.36
30	China	1.91	0.00	3.82
31	Mexico	2.00	4.00	0.00
32	Cyprus	2.09	0.00	4.17
33	New Zealand	2.19	0.00	4.39
34	Turkey	2.47	2.00	2.95
35	Poland	2.79	0.00	5.59
36	Romania	2.85	0.00	5.70
37	Czech Republic	2.87	0.00	5.74
38	Estonia	2.92	0.00	5.84
39	Malta	2.94	0.00	5.88
40	Latvia	2.99	0.00	5.99
41	Portugal	3.00	0.00	6.00
42	Slovenia	3.55	2.00	5.10
43	Croatia	3.95	2.00	5.90
44	South Africa	5.00	4.00	6.00

Source: OECD Sector Regulation Indicators, http://www.oecd.org/eco/reform/indicatorsofproductmarketregulationhomepage.htm#indicators

Appendix Table 13: International Ranking of Sectoral Regulation, Road, 2013

		Road		
Rank	Country	***Overall***	***Entry***	***Prices***
1	Australia	0.00	0.00	0.00
2	Brazil	0.75	1.50	0.00
3	**Canada**	**0.75**	**1.50**	**0.00**
4	Israel	0.75	1.50	0.00
5	South Africa	0.75	1.50	0.00
6	Switzerland	0.75	1.50	0.00
7	India	1.00	2.00	0.00
8	Austria	1.50	3.00	0.00
9	Croatia	1.50	3.00	0.00
10	Cyprus	1.50	3.00	0.00
11	Denmark	1.50	3.00	0.00
12	Finland	1.50	3.00	0.00
13	Germany	1.50	3.00	0.00
14	Ireland	1.50	3.00	0.00
15	Japan	1.50	3.00	0.00
16	Latvia	1.50	3.00	0.00
17	Lithuania	1.50	3.00	0.00
18	Luxembourg	1.50	3.00	0.00
19	Malta	1.50	3.00	0.00
20	Mexico	1.50	3.00	0.00
21	New Zealand	1.50	3.00	0.00
22	Norway	1.50	3.00	0.00
23	Slovak Republic	1.50	3.00	0.00
24	Sweden	1.50	3.00	0.00
25	United Kingdom	1.50	3.00	0.00
26	Hungary	2.00	4.00	0.00
27	Belgium	2.25	4.50	0.00
28	Czech Republic	2.25	4.50	0.00
29	Estonia	2.25	4.50	0.00
30	Iceland	2.25	4.50	0.00
31	Korea	2.25	4.50	0.00
32	Netherlands	2.25	4.50	0.00
33	Poland	2.25	4.50	0.00
34	Portugal	2.25	4.50	0.00
35	Slovenia	2.25	4.50	0.00
36	Spain	2.25	4.50	0.00
37	Chile	2.75	1.50	4.00
38	Bulgaria	3.00	6.00	0.00
39	Romania	3.00	6.00	0.00
40	China	3.25	4.50	2.00
41	Greece	3.25	4.50	2.00
42	France	4.00	6.00	2.00
43	Turkey	4.00	6.00	2.00
44	Italy	4.25	4.50	4.00

Source: OECD Sector Regulation Indicators,
http://www.oecd.org/eco/reform/indicatorsofproductmarketregulationhomepage.htm#indicators

Appendix Table 14: OECD Transport Sector Regulation Indicators, Canada, 1975-2013

	Rail					Airlines			Road		
Year	Overall	Entry	Public Ownership	Vertical Integration	Market Structure	Overall	Entry Barriers	Public Ownership	Overall	Entry	Prices
1975	4.88	6.00	1.50	6.00	6.00	6.00	6.00	6.00	5.00	6.00	4.00
1976	4.88	6.00	1.50	6.00	6.00	6.00	6.00	6.00	5.00	6.00	4.00
1977	4.88	6.00	1.50	6.00	6.00	6.00	6.00	6.00	5.00	6.00	4.00
1978	4.88	6.00	1.50	6.00	6.00	6.00	6.00	6.00	5.00	6.00	4.00
1979	4.88	6.00	1.50	6.00	6.00	6.00	6.00	6.00	5.00	6.00	4.00
1980	4.88	6.00	1.50	6.00	6.00	6.00	6.00	6.00	5.00	6.00	4.00
1981	4.88	6.00	1.50	6.00	6.00	6.00	6.00	6.00	5.00	6.00	4.00
1982	4.88	6.00	1.50	6.00	6.00	6.00	6.00	6.00	5.00	6.00	4.00
1983	4.88	6.00	1.50	6.00	6.00	6.00	6.00	6.00	5.00	6.00	4.00
1984	4.88	6.00	1.50	6.00	6.00	6.00	6.00	6.00	5.00	6.00	4.00
1985	4.88	6.00	1.50	6.00	6.00	6.00	6.00	6.00	5.00	6.00	4.00
1986	4.88	6.00	1.50	6.00	6.00	6.00	6.00	6.00	5.00	6.00	4.00
1987	4.88	6.00	1.50	6.00	6.00	6.00	6.00	6.00	3.50	3.00	4.00
1988	4.88	6.00	1.50	6.00	6.00	4.71	6.00	3.42	0.75	1.50	0.00
1989	4.88	6.00	1.50	6.00	6.00	3.00	6.00	0.00	0.75	1.50	0.00
1990	4.88	6.00	1.50	6.00	6.00	3.00	6.00	0.00	0.75	1.50	0.00
1991	4.88	6.00	1.50	6.00	6.00	3.00	6.00	0.00	0.75	1.50	0.00
1992	4.88	6.00	1.50	6.00	6.00	3.00	6.00	0.00	0.75	1.50	0.00
1993	4.88	6.00	1.50	6.00	6.00	3.00	6.00	0.00	0.75	1.50	0.00
1994	4.88	6.00	1.50	6.00	6.00	3.00	6.00	0.00	0.75	1.50	0.00
1995	4.88	6.00	1.50	6.00	6.00	2.00	4.00	0.00	0.75	1.50	0.00
1996	2.25	0.00	1.50	6.00	1.50	2.00	4.00	0.00	0.75	1.50	0.00
1997	2.25	0.00	1.50	6.00	1.50	1.00	2.00	0.00	0.75	1.50	0.00
1998	2.25	0.00	1.50	6.00	1.50	1.00	2.00	0.00	0.75	1.50	0.00
1999	2.25	0.00	1.50	6.00	1.50	1.00	2.00	0.00	0.75	1.50	0.00
2000	2.25	0.00	1.50	6.00	1.50	1.00	2.00	0.00	0.75	1.50	0.00
2001	2.25	0.00	1.50	6.00	1.50	1.00	2.00	0.00	0.75	1.50	0.00
2002	2.25	0.00	1.50	6.00	1.50	1.00	2.00	0.00	0.75	1.50	0.00
2003	2.25	0.00	1.50	6.00	1.50	1.00	2.00	0.00	0.75	1.50	0.00
2004	2.25	0.00	1.50	6.00	1.50	1.00	2.00	0.00	0.75	1.50	0.00
2005	2.25	0.00	1.50	6.00	1.50	1.00	2.00	0.00	0.75	1.50	0.00
2006	2.25	0.00	1.50	6.00	1.50	1.00	2.00	0.00	0.75	1.50	0.00
2007	2.25	0.00	1.50	6.00	1.50	1.00	2.00	0.00	0.75	1.50	0.00
2008	2.25	0.00	1.50	6.00	1.50	1.00	2.00	0.00	0.75	1.50	0.00
2009	2.25	0.00	1.50	6.00	1.50	1.00	2.00	0.00	0.75	1.50	0.00
2010	2.25	0.00	1.50	6.00	1.50	1.00	2.00	0.00	0.75	1.50	0.00
2011	2.25	0.00	1.50	6.00	1.50	1.00	2.00	0.00	0.75	1.50	0.00
2012	2.25	0.00	1.50	6.00	1.50	1.00	2.00	0.00	0.75	1.50	0.00
2013	2.25	0.00	1.50	6.00	1.50	1.00	2.00	0.00	0.75	1.50	0.00

Source: OECD Sector Regulation Indicators,
http://www.oecd.org/eco/reform/indicatorsofproductmarketregulationhomepage.htm#indicators

Appendix Table 15: OECD Transport Sector Regulation International Ranking, Canada, 1975-2013

	Rail					Airlines			Road		
Year	Overall	Entry	Public Ownership	Vertical Integration	Market Structure	Overall	Entry Barriers	Public Ownership	Overall	Entry	Prices
1975	1/34	1/34	1/34	1/34	1/34	19/35	11/35	10/34	7/32	6/32	7/26
1976	1/34	1/34	1/34	1/34	1/34	19/35	11/35	11/34	7/32	6/32	7/26
1977	1/34	1/34	1/34	1/34	1/34	19/35	11/35	11/34	7/32	6/32	7/26
1978	1/34	1/34	1/34	1/34	1/34	19/35	11/35	11/34	7/32	6/32	7/26
1979	1/34	1/34	1/34	1/34	1/34	20/35	12/35	11/34	7/32	6/32	7/26
1980	1/34	1/34	1/34	1/34	1/34	20/35	12/35	11/34	7/32	6/32	7/26
1981	1/34	1/34	1/34	1/34	1/34	20/35	12/35	11/34	7/32	6/32	7/26
1982	1/34	1/34	1/34	1/34	1/34	20/35	12/35	11/34	7/32	6/32	7/26
1983	1/34	1/34	1/34	1/34	1/34	20/35	12/35	11/34	8/32	7/32	8/26
1984	1/34	1/34	1/34	1/34	1/34	20/35	12/35	11/34	9/32	8/32	9/26
1985	1/34	1/34	1/34	1/34	1/34	22/35	12/35	13/34	9/32	8/32	9/26
1986	1/34	1/34	1/34	1/34	1/34	23/35	13/35	14/34	11/32	10/32	10/26
1987	1/34	2/34	1/34	1/34	1/34	23/35	13/35	16/34	12/32	6/32	11/26
1988	1/34	2/34	1/34	2/34	1/34	15/35	14/35	11/34	3/32	3/32	1/26
1989	1/34	2/34	1/34	2/34	1/34	5/35	14/35	1/34	3/32	3/32	1/26
1990	1/34	2/34	1/34	2/34	1/34	5/35	15/35	1/34	3/32	3/32	1/26
1991	1/34	2/34	1/34	3/34	1/34	5/35	20/35	1/34	3/32	3/32	1/26
1992	1/34	2/34	1/34	4/34	1/34	7/35	20/35	1/34	3/32	3/32	1/26
1993	4/34	6/34	1/34	7/34	2/34	13/35	24/35	1/34	3/32	3/32	1/26
1994	6/34	7/34	2/34	10/34	2/34	14/35	25/35	1/34	3/32	3/32	1/26
1995	8/34	10/34	2/34	12/34	3/34	11/35	17/35	1/34	3/32	3/32	1/26
1996	2/34	1/34	4/34	18/34	1/34	13/35	17/35	1/34	3/32	3/32	1/26
1997	2/34	1/34	5/34	21/34	1/34	6/35	14/35	1/34	3/32	3/32	1/26
1998	2/35	1/35	5/35	23/35	1/35	6/36	14/36	1/36	4/34	4/34	1/31
1999	2/34	1/34	5/34	24/34	1/34	6/35	14/35	1/35	3/33	3/33	1/30
2000	2/34	1/34	5/34	24/34	2/34	6/35	14/35	1/35	3/33	3/33	1/30
2001	2/34	1/34	6/34	24/34	2/34	10/35	16/35	1/35	2/33	2/33	1/30
2002	2/34	1/34	6/34	24/34	2/34	10/35	18/35	1/35	2/33	2/33	1/30
2003	2/35	1/35	6/35	24/35	2/35	10/36	18/36	1/36	2/34	2/34	1/32
2004	2/34	1/34	6/34	25/34	2/34	10/35	20/35	1/35	2/33	2/33	1/31
2005	2/34	1/34	5/34	25/34	3/34	10/35	20/35	1/35	2/33	2/33	1/31
2006	2/34	1/34	5/34	25/34	4/34	11/35	20/35	1/35	2/33	2/33	1/31
2007	2/34	1/34	4/34	25/34	4/34	12/35	20/35	1/35	2/34	2/34	1/32
2008	2/38	1/38	4/38	25/38	5/38	17/39	27/39	1/39	2/38	2/38	1/38
2009	2/34	1/34	4/34	25/34	5/34	20/35	27/35	1/35	2/35	2/35	1/35
2010	2/34	1/34	4/34	26/34	5/34	19/35	27/35	1/35	2/35	2/35	1/35
2011	2/34	1/34	4/34	26/34	5/34	19/35	27/35	1/35	2/35	2/35	1/35
2012	2/34	1/34	4/34	26/34	7/34	21/35	28/35	1/35	2/35	2/35	1/35
2013	2/41	1/41	4/41	31/41	9/41	22/44	34/44	1/43	2/44	2/44	1/44

Note: Entries in this table take the form x/y, where x is Canada's rank and y is the number of countries being compared.

Source: OECD Sector Regulation Indicators, http://www.oecd.org/eco/reform/indicatorsofproductmarketregulationhomepage.htm#indicators