CANADIAN TRANSPORTATION PRICE AND PRODUCTIVITY PERFORMANCE, 1981-2005

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1 INTRODUCTION

At the national level, productivity seems to have lagged behind in Canada, at least relative to the US. Productivity in transport impacts growth in other sectors, as productivity gains that translate into lower prices for shippers in effect lowers the "implicit tariff" of conducting business over distant locations. This paper examines trends in productivity of the transport sector from 1981 to 2005. In addition to labour productivity, productivity of fuel and total factor productivity are presented. Furthermore, the impact productivity growth has had in terms of profits and passenger/shipper prices is presented.

2 METHODOLOGY

Productivity can be measured in a number of different ways. For example, a partial factor productivity (PFP) measure can be defined as the output of a carrier relative to a single input, such as fuel. If a carrier increases its output from one year to the next at a pace greater than its increase in fuel consumption, it will have increased its productivity of fuel. An index number approach is used here (and then converted into annual percentage growth rates) in order to track the changes in performance factors over time.

Examining any given PFP measure in isolation can lead to some misleading or at least incomplete conclusions. For example, a carrier may be able to significantly increase its labour productivity by

[1] The views presented do not necessarily reflect those of Transport Canada.

outsourcing some of its services. The outsourcing may have little impact on its output but would also reduce the carrier's employees. However, consumption of another input would have increased at the expense of the decrease in the labour input. Therefore, in addition to the PFP measures, inputs can be combined into a single index in order to arrive at a total factor productivity (TFP) index (after dividing the output index by this single input index).

While TFP is more comprehensive than the PFP measures, it is also more difficult to calculate due to data requirements. The capital input in particular presents specific difficulties. In addition, the choice of weights assigned to each input can lead to different results. Therefore, both TFP and PFP indicators are presented here.

Quality change is always an important factor to consider when examining output and productivity growth. To some extent, accounting for changes in traffic mix deals with part of the quality change issue. For example, if a trucking carrier shifts its traffic to just-in-time services, this can be considered a shift towards higher quality traffic. Using a simple measure of output such as total tonne-kilometres would not capture this change. However, if traffic mixes are weighted against each other when determining output, then at least some of this change can be captured. Where possible, traffic mix is taken into account here.

Overall quality change is more difficult to deal with. For example, it is possible that quality has changed in air transportation as meals are often not included where they used to be and load factors have increased while legroom has decreased, resulting in less comfortable conditions.[2] Furthermore, congestion and weight times (due in part to increased security) have increased, resulting in further declines in quality. At the same time, service frequency has generally increased, as has the ease of purchasing tickets. It also might be said that increased security (assuming that it is effective) has also had a positive impact on quality, as passengers clearly value a safe and

[2] Duke, John and Torres, Victor (March 2005), Monthly Labor Review, "Multifactor Productivity Change in the Airline Industry."

secure environment. Accounting for these quality changes is extremely difficult and therefore not dealt with here, but the issue is one to keep with productivity indicators in general.

Description of outputs and inputs

The outputs and inputs of the various modes are defined as consistently as possible. However, there are key differences due to the nature of the businesses as well as data availability.

Among air carriers, the outputs are defined as a combination of passenger-kilometres (PKMs) and tonne-kilometres (TKMs) of cargo. As the outputs are weighted by revenue shares (tornqvist index), PKMs account for the bulk of the output. Traffic mix is captured by breaking-down both PKMs and TKMs by carrier, service (scheduled or charter) and service area (domestic, transborder, Atlantic, Pacific, southern or other international). The output is then weighted by its revenue share in each of those categories.

In terms of freight rail, the industry output is measured in tonne-kilometres of freight. The output index is an indirect quantity index as it is derived from carrier revenues divided by an output price index. The output price index is derived from freight and revenue data based on 13 commodity categories for each carrier. Passenger-kilometres are used in order to define intercity passenger outputs. Revenue and PKM data for 20 different 'corridors' are used in order to produce a weighted passenger output index.

An indirect output index is derived by dividing trucking revenues by a price index. The price index is based on a sample of prices across a number of categories defined by geographic location, weight class and distances. There is also a segregation between trucking and intermodal services.

Unfortunately, data limitations do not allow for a direct measure of passenger-kilometres for public transit. Many transit authorities provide an estimate of passenger-kilometres through the use of a number of estimation tools. However, the quality and

accuracy of many of these estimates are questionable. As a result, this analysis utilizes passengers as the output measure. An alternative would be to use vehicle-kilometres, which would result in higher output growth (15 per cent higher over the past 20 years). PKMs would likely fall somewhere between these two measures.

Input indexes for the modes are combined from weighted shares of labour, fuel, other materials & services and capital (including leasing). Labour inputs are generally comprised of hours worked in different labour categories (such as pilots/drivers, flight attendants, administrative), weighted by cost shares. Fuel inputs are defined by litres of fuel consumed. Where multiple fuel sources are present, all fuel is converted to petajoule equivalents before developing an index of use.

The capital stock in constant dollars is used as a simple measure for capital input. Using a flow measure is ideal and the possibility of doing so will be examined in the future. Using the stock measure rather than the flow measure will differ in particular when depreciation rates change significantly or the mix of assets changes significantly. It is also possible to use capital usage data (such as vehicle-hours) as a capital input. However, this in effect penalizes carriers for fully-utilizing their vehicle stock as it is generally accepted to be inefficient to have idle capacity.

Industry Coverage

As indicated, air carriers, rail carriers, trucking carriers and public transit authorities are included in this analysis. The extent of coverage depends for the most part on data availability. The main data sources are Statistics Canada and Transport Canada.

The air carriers that are included in the analysis have changed over the series due to new entrants as well as exits from the industry. The recent data includes Air Canada and it's regional affiliates, First Air, Air Transat, Sky Service, Westjet and Canjet.

Class I carriers (the Canadian operations of CN Rail, CP Rail and VIA Rail) are included in the rail carrier analysis. Due to data limitations, the intercity passenger rail series begins in 1986.

Trucking productivity performance tracks the productivity growth of for-hire carriers with revenues in excess of $1 million. In 2003, 748 carriers were sampled out of an estimated total population of 2,894. Due to remodeling of the survey, 2003 is the most recent year of analysis in this paper (updates with the new data are currently being performed).

Transit authorities included are those who report data to The Canadian Urban Transit Association of Canada, filtered to some extent due to data irregularities. This accounts for the vast majority of traffic, as all major transit authorities are CUTA members (data from 74 authorities are included here). As is the case with intercity passenger rail, the time-series begins in 1986 due to data limitations.

3 Output and Productivity Trends

Output growth has varied among the modes over the past 20 years. For example, while rail freight services went through a period of rationalization and slower output growth as a result, trucking services increased rapidly (because only class I rail carriers are included this does not take into account the growth of shortline railways).

Table 1 – Output, annualized growth rates

	81-86	86-91	91-96	96-01	01-05	86-05
Air Transport	3.1%	1.8%	5.4%	4.1%	0.7%	3.0%
Rail Passenger		-9.5%	1.7%	1.7%	-0.7%	-1.9%
Rail Freight	0.1%	-0.8%	1.9%	3.4%	3.3%	1.9%
Trucking*	4.0%	2.3%	9.7%	6.9%	-0.3%	5.2%
Public Transit		-0.3%	-1.8%	2.0%	2.7%	0.5%
Economy	2.7%	1.6%	3.0%	5.0%	2.7%	3.1%

*Trucking series is only current to 2003

Since 1986, output in trucking has outpaced the rest, with growth at approximately 5.2 per cent per year. Air carrier output has

generally kept pace with general economic growth (3 per cent per year), while the others have seen lesser growth.

Air carrier productivity

Air carriers have experienced significant productivity growth over the past several years. 2004 in particular saw rapid growth in labour productivity. However, that particular year reflects to a large extent the spin-off of Air Canada's maintenance division. Those maintenance labour services are now entirely in the services category of inputs. Therefore, gains in labour productivity are to some extent offset by the decrease in Other Materials and Services productivity. Nevertheless, labour productivity gains have been significant from the late 1990s. The recent rise is not attributed to the output side. Though output has increased from 2003 it is only now recovering to peak levels achieved in 2000.

Fuel productivity has shown a more steady increase over the period. Over the last five years of the period fuel productivity has grown by approximately 12 per cent. While output is recovering to its 2000 peak, fuel consumption is still substantially below its 2000 level (nearly 13 per cent below in 2005). Over the period from 1986 to 2005 jet fuel consumption has grown from approximately 3.74 million litres to 4.85 million litres, peaking at 5.55 million litres in 2000. Without any gains in fuel productivity since 1986, fuel consumption would have been 6.7 billion litres in 2005 given the same level of output, nearly two billion litres over actual 2005 levels (assuming the same level of traffic). Substantial fleet renewal over the past several years (such as retirement of first and second generation 737s in favour of third generation 737s) and perhaps smaller enhancements (such as the use of winglets) has contributed to the increased fuel efficiency. Carriers can improve their fuel productivity through yield management as well, as increased load factors contribute to more passenger-kilometres for a given level of vehicle-kilometres. Load factors have increased from approximately 66 to 76 per cent over the period for the carriers in the analysis.

In terms of TFP, the air carriers have also seen significant gains over the latter portion of the period. From 2002 to 2005 growth has been particularly strong, with a 26 per cent growth in TFP over that period. Much of the growth in recent years can be attributed to the fuel and labour input reductions, although there have been reductions across all categories as output has recovered.

The interruptions in TFP growth over the period (the early 1990s and early 2000s) can be attributed in part due to a drop in demand as a result of exogenous factors. These include the wars in Iraq, the events of September 2001 and the SARS outbreak in 2003. International passenger travel has felt a greater impact than domestic markets due to these events. Total passenger output still grew over the 1986 – 1991 period due to strong growth in the late 1980s in international markets in particular. The following table summarizes the various partial productivity growth indicators for air carriers.

Table 2 – Air Carrier Productivity Annual Percentage Growth

	81-86	86-91	91-96	96-01	01-05	81-05
Labour	4.5	-0.8	7.5	3.2	14.8	5.4
Fuel	2.5	0.8	1.5	1.7	3.1	1.9
Other	-0.3	-2.5	3.7	1.1	6.0	1.4
Capital	3.0	-5.6	5.7	5.6	-1.6	1.4
TFP	2.4	-2.1	4.8	2.5	5.7	2.5
Economy	0.5	-1.1	0.6	1.2	0.0	0.2

Rail carrier productivity

Freight rail has seen steady growth in productivity over the period of analysis while growth in passenger rail productivity has been somewhat uneven. While freight labour productivity growth was up only slightly in 2005, there was an overall increase of over 21 per cent in the period from 2000 to 2005. The passenger side saw strong gains in labour productivity from the early 1990s to 2002, following the cuts in subsidies and services, but labour productivity has dropped by 6 per cent since then.

Growth in fuel productivity has been uneven over the period. While growth has only been slightly over one per cent on the freight

side in the 2000 to 2005 period, since 1995 fuel productivity has grown by 40 per cent. Passenger rail fuel productivity has been virtually flat over the last five years but may increase in coming years due to the replacement of aging equipment.

Freight TFP growth has been steady over the entire period, in particular since the early 1990s. TFP has grown by 10 per cent overall from the year 2000. Passenger rail TFP is still 7 per cent below its 2000 peak, despite small gains over the past two years. VIA did experience significant productivity gains during the 1990s following the cuts in subsidies that forced the elimination of lower-density routes. The following tables summarize the percentage growth rates of the partial and total factor productivity indexes.

Table 3 – Rail Freight Productivity Annual Percentage Growth**Error!**

	81-86	86-91	91-96	96-01	01-05	81-05
Labour	4.2	4.2	7.1	8.1	3.9	5.5
Fuel	0.5	0.2	2.4	5.1	0.5	1.8
Other	1.7	2.1	4.6	2.7	0.3	2.4
Capital	0.2	0.2	3.6	5.3	2.8	2.4
TFP	2.4	2.2	5.2	5.7	2.3	3.6
Economy	0.5	-1.1	0.6	1.2	0.0	0.2

Table 4 – Rail Passenger Productivity Annual Percentage Growth **Error!**

	86-91	91-96	96-01	01-05	86-05
Labour	-6.6	8.4	3.1	-1.3	0.9
Fuel	5.5	2.5	1.7	-0.2	2.5
Other	9.8	7.2	2.6	1.1	5.3
Capital	-6.7	7.2	0.3	-2.8	-0.5
TFP	-2.2	7.5	2.4	-0.6	1.8
Economy	-1.1	0.6	1.2	0.0	0.4

Productivity gains have been most significant in terms of labour on the freight side, corresponding with the relaxation of some labour rules over the period. Gains have been spread more evenly on the passenger side with the exception of capital productivity, which has lagged the other categories. More recent years have seen the

purchase of new equipment, which is the cause of the increase in capital input over that time. Both passenger and freight rail outpaced overall economy productivity over the entire period.

A number of factors may have contributed to the growth in TFP in freight rail. Over the particularly rapid period of TFP growth in the 1990s, the rail carriers focused more on bulk activity over larger distances, leaving the perhaps less efficient (for rail) shorter-haul markets to trucking. Furthermore, the relaxation of regulatory rules and the movement towards 286k lbs. cars are other potential sources of significant productivity gains.

Trucking Productivity

Trucking output has grown more rapidly than output in the other modes, with growth being particularly strong in the early 1990s. Some of this growth can be attributed to a shift from short-haul movements among the rail carriers as well as deregulation during the 1980s. Furthermore, while output did decline during the 1990-1992 period due to the recession, the general trend of transborder freight growth due to deregulation and NAFTA contributed to a quick recovery and rapid growth for the rest of the decade. The early 2000s saw another period of soft demand with the domestic market again being weaker than the transborder market.

Labour productivity has risen steadily over the period of analysis. However, growth has slowed slightly over the 2001 to 2003 period. Growth in fuel consumption has largely kept pace with the growth in output over the period. As a result, fuel productivity has been negligible over the period. The uneven growth in fuel productivity is at odds with the results of the other modes. Furthermore, it is somewhat unexpected due to the fact that heavy trucks have become steadily more fuel-efficient over the same period. It is estimated that energy use by a truck to move one tonne-kilometre of freight declined by 20.5 per cent from 1990 to 1999.[3] Estimates in

[3] The Railway Association of Canada, "Trends in Freight Energy Use"

the US peg unit fuel increases at approximately one per cent per annum from 1988-2003.[4]

A number of factors may have prevented the sector from increasing overall productivity of fuel. One factor is the change in the mix of traffic being handled. A shift towards more just-in-time manufacturing strategies may have resulted in a greater number of empty-backhauls and less-than-truckload shipments. Furthermore, trucks are subject to congestion and border delays. The former in particular has become an increasing problem on some portions of the network and would have contributed to increase accelerating and breaking activity and weaker fuel efficiency as a result. The congestion could also encourage drivers to increase speed during non-congested portions of the trip (in order to make-up the time lost due to congestion), resulting in further losses in fuel efficiency.

Despite the stagnate growth in fuel productivity over the period, TFP growth has been strong for the most part, although growth has been negative from 2001 to 2003.

Table 5 – Trucking Productivity Annual Percentage Growth**Error!**

	81-86	86-91	91-96	96-01	01-03	81-03
Labour	2.7	2.7	2.2	3.3	-0.6	2.5
Fuel	-0.7	0.1	-2.2	1.7	-1.5	0.1
Other	-0.2	1.9	1.7	-0.6	-4.0	0.3
Capital	0.9	2.8	3.2	-0.4	5.5	1.9
TFP	1.1	2.7	2.0	1.7	-1.0	1.8
Economy	0.5	-1.1	0.6	1.2	0.1	0.3

Over the entire period the strong growth in productivity of labour and capital has helped to maintain strong TFP growth, despite the weak growth in fuel productivity. This is an indicator that average trucks speeds are indeed increasing, as that would contribute to productivity increases for the most part (labour and capital in particular), while adversely affecting fuel productivity.

Public transit productivity

[4] K.G. Duleep, "Fuel Efficiency of Heavy-Duty Trucks in the U.S.A."

For the most part, productivity performance has been week in public transit. The following figures would likely be to some extent better if a more adequate measure of output was available. However, the difference would not be exceptional. For example, output in terms of total passengers has grown by approximately 10 per cent over the entire period, while total vehicle kilometres (VKMs) has grown by approximately 24 per cent. The actual number of PKMs would likely fall somewhere in between these two figures.

Labour productivity has dropped by five per cent from 2003 to 2005. Fuel productivity performance has been uneven during the period and virtually flat over the past ten years. Transit TFP has decreased steadily over the period, with performance declining nearly eight per cent over the 2000 to 2005 period. Using a more favourable measure of output such as VKMs would result in approximately 12 per cent better performance overall.

Table 6 – Public transit productivity annual percentage growth**Error!**

	86-91	91-96	96-01	01-05	86-05
Labour	-0.9	-0.7	0.0	-1.0	-0.7
Fuel	-1.1	-0.5	0.0	0.0	-0.6
Other	-1.4	2.4	-2.4	-5.3	-2.5
Capital	-2.3	-3.3	-1.7	-3.9	-2.5
TFP	-1.3	-0.8	-0.8	-2.3	-1.4
Economy	-1.1	0.6	1.2	0.0	0.4

Transit TFP lagged general economy productivity over the entire period. There are a number of factors contributing to the declining productivity performance of the transit authorities. Of the factors that are by in large exogenous to the transit operators, the most important is likely the mandate to provide public transportation in the suburban areas, where population density is generally much lower and car ownership is generally higher.

4 PRODUCTIVITY IMPACT

Productivity improvements over time allow carriers to produce more goods or services at a lower cost (relative to a given level of input

prices). This in turn allows for higher profits (or a return to profitability), lower prices for consumers, or a combination of both. The extent to which productivity contributes to either of these depends on a number of factors, such as the level of competitiveness in the industry, regulations, current financial health of the carriers, etc.

If input prices hold constant, all of the productivity improvements can be used in order to increase (or restore) profits or lower prices to consumers. In reality, input prices have risen over time (such as rising fuel prices). Therefore, in order to gauge the extent to which productivity improvements have contributed to lower prices or increased profits, a measure of "total price performance" (TPP) is estimated. TPP is simply an index of changes in the ratio of input to output prices over time. TPP performance is said to increase if the index rises, as this indicates that the carrier has been able to increase output prices at a slower rate than input prices.

Due to space constraints, the underlying input and output prices are not presented here. Rather, the growth in TPP is presented relative to the growth in TFP. The ratio between TPP and TFP indicates the extent to which the productivity gains have contributed to lower prices. TPP, TFP and the ratio between the two are presented for the air carriers below.

Table 7 – Air Carrier Price Performance

	TPP	TFP	Ratio
2000-2005	19.5%	35.6%	54.8%
1995-2000	12.8%	12.4%	103.1%
1986-2005	34.5%	60.4%	57.1%

For the most recent five years of the analysis, 54.8 per cent of productivity gains have contributed to lower prices, while the rest has contributed to restoring profitability. Over the previous five-year period, TPP actually outpaced TFP (which was not nearly as strong over that period), meaning that prices were held lower while profitability deteriorated. Overall, productivity gains have been spread between savings to passengers and restored profits fairly evenly (57 per cent to 43 per cent), with much of the contribution to profit occurring over the past two years. TPP relative to TFP is presented for both rail freight and rail passenger below.

Table 8 – Rail Freight Price Performance

	TPP	TFP	Ratio
2000-2005	-1.1%	9.4%	-12.0%
1995-2000	25.8%	45.3%	56.9%
1986-2005	62.5%	106.5%	58.7%

Because TPP has actually decreased slightly over the 2000 to 2005 period (meaning that output prices have slightly outpaced input prices), the ratio of TPP to TFP is negative over the same period, indicating that recent productivity gains have contributed to carrier profits. Over the entire period, nearly 59 per cent of productivity gains have been passed on to shippers in the form of lower prices.

Table 9 – Rail Passenger Price Performance

	TPP	TFP	Ratio
2000-2005	-8.8%	-6.8%	129.8%
1995-2000	-4.7%	32.6%	-14.3%
1986-2005	-21.1%	40.9%	-51.7%

In the most recent five-year period, both TPP and TFP are negative, resulting in a positive ratio between the two. This indicates that all of the productivity *losses* have contributed to an increase in price (rather than an increase in subsidies/carrier profits). However, over the entire period TFP has been positive while TPP has been negative, suggesting that more than all of the productivity gains have contributed to lowering reliance on subsidies while prices continued to increase. In this case the reduction in subsidies was the exogenous factor (as the reduction was determined ex ante), which in-turn forced the combination of both price and productivity increases. Subsidies fell from a peak of over $500 million to below $170 million over the entire period. Trucking TPP and TFP are presented relative to each other next.

Table 10 – Trucking Price Performance

	TPP	TFP	Ratio
1998-2003	3.8%	2.9%	130.6%
1993-1998	11.3%	14.1%	79.8%
1986-2003	35.1%	38.9%	90.0%

Over the entire period, TPP has been 90 per cent of TFP, indicating that 90 per cent of productivity gains have been passed on to shippers. In the last five years of analysis, TPP has outpaced TFP, although TFP growth has slowed over this period. This has led to deterioration in carrier profits. It is expected that this trend revert back to a ratio closer to the average over the entire period, as it is not sustainable for TPP to continue to increase faster

than TFP over a long period of time, as this would prompt exit from the industry. Finally, TPP and TFP are presented relative to each other for public transit.

Table 11 – Public Transit Price Performance

	TPP	TFP	Ratio
2000-2005	-9.6%	-7.7%	124.2%
1995-2000	-15.5%	-5.4%	288.4%
1986-2005	-34.7%	-23.3%	148.7%

Over the entire period, TPP has declined by nearly 50 per cent more than TFP, suggesting that subsidies should have declined along with productivity, with both contributing to the increase in passenger prices. However, operating losses continue to grow in recent years (operating losses are not synonymous with operating subsidies from year-to-year, though they do follow a very similar trend over time). This anomalous result may be explained by the computation of the output prices, which are based on passengers rather than passenger-kilometres. However, the inclusion of a PKM measure would also contribute to higher (or less negative) TFP growth. More investigation into this result is required.

5 CONCLUSION

In contrast to much of the Canadian economy, the transportation sector has seen large productivity gains over the past two decades. Some of this growth can be attributed to deregulation and privatization/commercialization. Furthermore, liberalization of international trade has created greater competition and has opened up new markets for Canadian carriers.

The productivity gains have benefited both the owners of capital and consumers through increased profits and lower prices. Even the air carriers, who have experienced long periods of turmoil and financial duress, have been able to achieve reasonably stable positions. However, it is possible that much of the low-hanging productivity gains have been obtained and continued accelerated productivity gains will be more difficult to achieve. Furthermore, current economic conditions may result in financial pressure for some of the transportation carriers.

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